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ASSESSMENT OF VARIATION IN THE DEPTH OF INTERSCALENE BRACHIAL PLEXUS USING ULTRASONOGRAPHY- A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Interscalene brachial plexus block via Classical or PNS guided approach has been associated with various complications, and should therefore be done under ultrasound guidance whenever possible. However, due to its unavailability at all centers, it is mandatory to have a thorough knowledge about the anatomy and the safe distance of needle insertion while using conventional approach. This led us to study the variation in the depth of brachial plexus at interscalene level using ultrasonography, in order to determine the safe depth of needle insertion and the variation of this depth with regards to anthropometric parameters namely age, weight, height and BMI. **Method:** In this prospective observational study, 250 patients were recruited. After proper positioning of patient, the neck was scanned using a high-frequency linear probe to obtain an optimal view of the brachial plexus at interscalene level using traceback method; and following two distances were measured, LD = Longest distance of the neural elements from the skin and SD= Shortest distance of the neural elements from the skin. **Result:** The LD varied between 0.78 cm to 2.12cm (mean value =1.53 ± 0.24 cm). SD ranged between 1.66 cm to 0.27cm (mean value=0.73 ± 0.14 cm). We observed that the difference between mean LD and mean SD was 0.80 ± 0.11 cm. There was significant correlation of LD and SD with weight, age and BMI in males and females. However, height was not significantly correlated to LD and SD. **Conclusion:** While using conventional techniques, 25mm needle should be used preferably, based on our observation of safest distance of 0.80 ± 0.11 cm. If brachial plexus is not encountered within 2cm, then further advancement of needle should be made with greater care so as to avoid complications.

KEYWORDS : Interscalene Block, Safe Distance, Needle Insertion, Brachial Plexus Depth

INTRODUCTION

Interscalene block (ISB) via classical landmark based approach, described by Winnie[1], or PNS (peripheral nerve stimulator) guided approach carries several risks of inadvertent total spinal anesthesia[2], bilateral epidural blockade and bilateral block without epidural or subarachnoid spread[3]. Other complications include Horner's syndrome[4], cardiac arrest[5], and ipsilateral phrenic nerve palsy.

This led to the use of Ultrasound (US) guidance as the gold standard for regional anesthesia[6]; though due to the cost factor and other constraints, access to USG machine is still difficult at all centers. Hence, sound knowledge of anatomy, including approximate safe depth of nerve advancement, would be beneficial to avoid unnecessary complications associated with conventional landmark or PNS guided techniques.

Various studies have been done recently to estimate the depth of brachial plexus in supraclavicular approach[7,8] and infraclavicular approach using ultrasound or MRI.

This study was conducted to assess the variation in the depth of brachial plexus in interscalene approach using ultrasonography, in order to determine the safe depth of needle insertion while using PNS guided or conventional techniques for interscalene block.

MATERIALS AND METHODS

This was a prospective observational cross-sectional study conducted in Tata Main Hospital, Jamshedpur from March 2019 to November 2019. After obtaining institutional ethical committee clearance, 250 patients of ASA Physical status I and II, undergoing elective upper limb surgeries, aged between 18 years and 60 years were selected for the study.

Patients unwilling to participate or those with previous history of surgery or any deformity of neck and shoulder were excluded from the study.

Assuming the prevalence of 20% for upper limb surgeries that are being conducted annually in our institute, based on the total number of admissions per month in the Orthopedics Department of Tata Main Hospital; keeping Z statistics of 1.96 at a confidence interval of 95%, alpha error at 0.05, a sample of 231 patients would be required.

We, thus, included 250 patients to compensate for potential dropouts. Written informed consent was taken from all the enrolled patients. Standard pre-anesthetic checkup was done one day before surgery.

In the operation theatre, the patient was positioned supine with a pillow kept between the shoulder blades, head turned to contralateral side by 45 degrees and arm adducted by the side of the body. This study was done by using SonoSite (M-Turbo, FujiFilm) ultrasound machine using traceback method.

The neck was scanned using a high-frequency (8–13 MHz) linear probe placed directly above and parallel to the clavicle in the supraclavicular fossa, supraclavicular brachial plexus was identified, appearing as a 'bunch of grapes' and the probe was then moved upwards to trace the interscalene level to obtain an optimal view of the C5 and C6 nerve roots of upper trunk of brachial plexus, which appear as hypoechoic nodules arranged like peas in a pod between the anterior and middle scalene muscles.

Once an optimal image was produced, the brachial plexus was kept in the middle of the screen and the image was frozen. The measurement was then taken by on-screen calipers. The following two distances were measured: LD = Longest distance of the neural elements from the skin and SD= Shortest distance of the neural elements from the skin (Fig 1)

AA' = Longest Distance (LD)
BB'= Shortest Distance (SD)
SCM= Sternocleidomastoid Muscle
ASM= Anterior Scaleneus Muscle
MSM= Middle Scaleneus Muscle

Fig 1: Ultrasound Image of measurement of depth of Interscalene brachial plexus

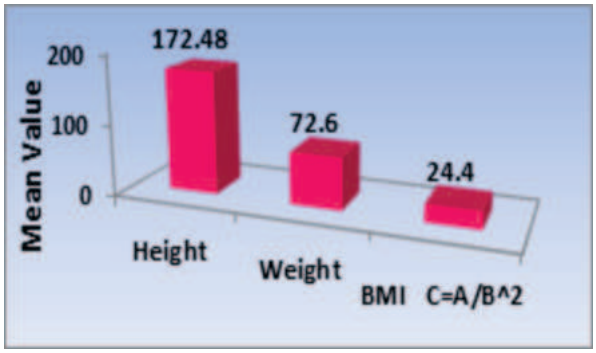
The demographic parameters (weight, height and body mass index (BMI)) and the measured distances (in centimeters) were expressed as Mean ± Standard Deviation. Pearson correlation was used to calculate the strength and significance of the co- relation between SD and LD from skin to the interscalene brachial plexus with the demographic parameters. P value of <0.05 was considered as statistically significant and <0.001 was considered as statistically highly significant.

RESULTS

250 patients were enrolled in the study, out of which 172 patients were male and 78 patients were female. Out of 250 patients, 107 patients belong to the age group of 31-40 years, 82 patients were below 30 years, 43 patients were between 41-50 years of age and only 18 patients were between 52- 60 years. Majority of the patients included in the study was between 20-40 years from both sexes. The mean age, weight, height and BMI of the study population along with their range are given in Table 1. The mean height of the studied patients was 172.48 cm, while mean weight was found to be 72.6 kg. The mean BMI was 24.4 kg/m^2. [Table 1]

Table 1: Demographic parameters of study population

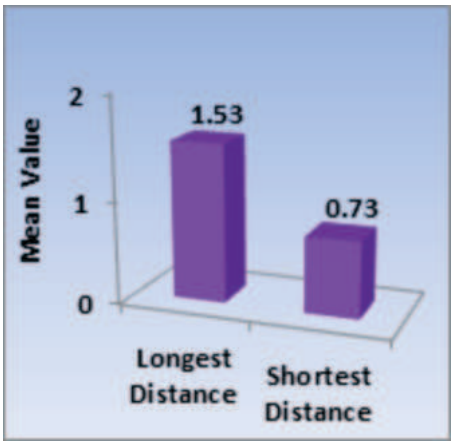
	Mean ± Std.D	Min – Max
Age (years)	34.73 ± 8.80	19 – 57
Height (cm)	172.48 ± 6.31	155 – 189
Weight (kg)	72.60 ± 10.23	50 – 104
BMI (kg/m2)	24.40 ± 3.17	17.48 - 35.53



The Longest Distance (LD) that is the maximum depth of the interscalene brachial plexus from skin, varied from 0.78 cm to maximum of 2.12 cm. The mean LD was found to be 1.53 cm. The Shortest Distance (SD) that is the depth of most superficial neural elements of interscalene brachial plexus from skin, was found to range between a maximum distance of 1.66 cm and a minimum of 0.27 cm. The mean SD among the population studied was 0.73 cm. [Table 2]

Table 2: Mean Shortest Distance(SD) and Longest Distance(LD) of Interscalene brachial plexus from skin

	Mean ± Std.D	Min – Max
Longest Distance	1.53 ± 0.24	0.78 - 2.12
Shortest Distance	0.73 ± 0.14	0.27 - 1.66



We found that both LD and SD of interscalene brachial plexus have statistically highly significant positive correlation with weight, BMI and age (p value <0.001). There was no statistically significant correlation of either LD or SD with height in all patients enrolled in the study. While studying the variation among both genders, we found statistically highly significant positive correlation of the LD and SD with weight and BMI in both males and females (p value < 0.001). LD showed statistically highly significant positive correlation with age as well in male population under study (p value <0.001); while SD showed statistically significant positive correlation with age (p value = 0.002). However, in females, only LD showed statistically significant positive correlation with age (p value =0.041), while SD did not show any significant correlation. [Table 3]

Out of 250 patients, majority(67.2%) of the population had the LD more than 1.5 cm. Only 4 patients had LD less than 0.9 cm, while 78 patients(31.2%) had LD ranging between 0.9-1.5 cm. Majority(80.4%) of the population had the SD ranging between 0.4-0.8 cm. Only 1 patient had SD less than 0.4 cm, while 48 patients(19.2%) had SD more than 0.8cm.

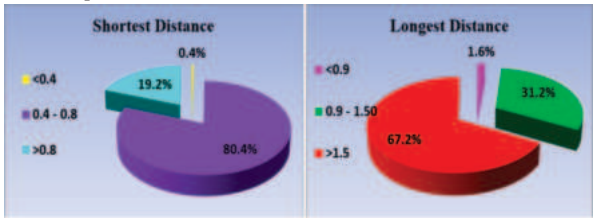


Figure 2 : Percentage Distribution of study population according to longest and shortest distance.

Table 3 : Correlation of longest and shortest distance with demographic parameters in study population and its variation among both genders

a. Correlation of longest distance and shortest distance with age, height, weight and BMI of 250 patients

Correlations					
		Age	Height	Weight	BMI
Longest Distance (LD)	Pearson Correlation	.261**	-0.048	.774**	.865**
	p value	<0.001	0.452	<0.001	<0.001
	N	250	250	250	250
Shortest Distance (SD)	Pearson Correlation	.206**	-0.07	.661**	.761**
	p value	0.001	0.268	<0.001	<0.001
	N	250	250	250	250

b. Correlation of longest distance and shortest distance with age, height, weight and BMI in males

Correlations					
		Age	Height	Weight	BMI
Longest Distance (LD)	Pearson Correlation	.277**	-0.088	.838**	.872**
	p value	<0.001	0.251	<0.001	<0.001
	N	172	172	172	172
Shortest Distance (SD)	Pearson Correlation	.232**	-0.116	.715**	.769**
	p value	0.002	0.13	<0.001	<0.001
	N	172	172	172	172
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

c. Correlation of longest distance and shortest distance with age, height, weight and BMI in females

Correlations					
		Age	Height	Weight	BMI
Longest Distance (LD)	Pearson Correlation	.232*	-0.081	.797**	.852**
	p value	0.041	0.479	<0.001	<0.001
	N	78	78	78	78
Shortest Distance (SD)	Pearson Correlation	0.15	0.01	.738**	.747**
	p value	0.191	0.930	<0.001	<0.001
	N	78	78	78	78
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

DISCUSSION

Interscalene brachial plexus block, like any other peripheral nerve block, should always be performed under US guidance, whenever possible due to its associated complications. However, due to its unavailability at all centers, it is mandatory to have a thorough knowledge about the anatomy and the safe distance of needle insertion while using paresthesia or PNS guided approach for this block. Even after thorough literature search (PubMed and Google Scholar), we could not find any study on variation of depth of brachial plexus at Interscalene level with anthropometric variables. Thus, we analyzed the variation of the longest and the shortest distance of interscalene brachial plexus from skin with the anthropometric parameters namely age, height, weight and BMI of the patient, along with the average safest longest and shortest distance of needle insertion for interscalene block among the study population.

The Longest Distance (LD) that is the maximum depth of the Interscalene brachial plexus , varied from minimum of 0.78 cm to maximum of 2.12 cm with a mean value of 1.53 ± 0.24 cm. The Shortest Distance (SD), that is the depth of most superficial neural elements of Interscalene brachial plexus from skin, ranged between the maximum of 1.66 cm and a minimum of 0.27 cm with a mean value of 0.73 ± 0.14 cm. We observed that the difference between mean LD and mean SD was 0.80 ± 0.11 cm in our study. The majority of the patients had L.D. of more than 1.5 cm and S.D. between 0.4 - 0.8 cm. **Perlas et al.**[9] found that the mean skin to nerve distance was 0.9 ± 0.2 cm (mean± SD), while the mean SD in our study was 0.73± 0.14 cm. However, Perlas et al. did not differentiate this distance into longest and shortest distance.

WEIGHT AND BMI correlation with SD and LD:

There was a highly significant correlation of LD and SD with weight and BMI in the study population and even in male and female groups when analyzed separately. These findings are similar to **Mistry et al.**[8] who used US to measure the shortest and longest distance of brachial plexus at supraclavicular region and analyzed its variation with anthropometric parameters and found a statistically significant positive correlation of the depths with BMI and weight.

Height:

No correlation of SD and LD was seen with height similar to the observations of **Mistry et al.**[8]

Age:

We found a statistically significant correlation of LD with age in the overall study population group while SD was correlated to age only in the male group (p value = 0.002) (table 8). This observation is in contrast to the findings of **Mistry et al.**[8] who had found no correlation between brachial plexus depth (in supraclavicular region) and age.

In our study, the maximum depth of the neural element was 2.12 cm (maximum LD). This indicates that 2.5cm needle should be enough to address the neural elements of interscalene brachial plexus similar to the findings of Chelly et al.[10] who recommended the use of 25mm needle size for performing interscalene blocks rather than 50 mm needle. **Sardesai et al.**[11] studied the depth at which the needle could reach intervertebral foramen, when C6 root is the target during the Interscalene brachial plexus block with the help of MRI Scan of 10 volunteers and found that at the level of C6, using the Classic Interscalene block approach, the intervertebral foramen could be reached between 2.5 - 5.9 cm. Thus, with a needle size of 5 cm, one could reach the intervertebral foramen in majority of the patients. However, it is essential to point out that the maximum BMI we had in our study was 35.53 kg/m^2. For higher BMI, the needle may need to traverse a longer distance before it reaches the target nerve as concluded in the study done by **Aswathappa et al.**[12] They observed that larger the neck circumference, more the adipose tissue deposition in the subcutaneous tissue and deeper will the neural elements of brachial plexus lie in obese patients.

In our study the measured depths of brachial plexus are the actual distances between the skin and the neural elements. However, the literature suggests that the depth of needle required to achieve a successful block may not be equal to the actual depth (from skin) of the target neural element. Studies by **Albrecht E et al.**[13] **and Spence et al.**[14], concluded that the actual depth to be traversed and the length of needle required for a successful brachial plexus block maybe even lesser than the depth of brachial plexus apparent on ultrasound imaging.

CONCLUSION

Interscalene brachial plexus block should always be performed under US guidance whenever possible. However, while performing interscalene block via paresthesia or PNS guided approach, 25mm needle should be used preferably based on our observation of safest distance of 0.80 ± 0.11 cm; calculated from the difference between mean LD (1.53 ± 0.24 cm) and mean SD (0.73 ± 0.14 cm). If brachial plexus is not encountered within 2cm, then further advancement of needle should be made with greater care so as to avoid complications. The depth of needle insertion required for performing an Interscalene brachial plexus block may differ with BMI of the patient. Hence, the needle should be manipulated accordingly. Further studies aimed at assessing variation in brachial plexus depth with neck circumference may provide a useful guide in assessing the brachial plexus depth in short time and probably with greater accuracy.

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