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ORIGINAL RESEARCH

A comparative study of subclavian vein catheterization with landmark technique versus Ultrasound-Guided technique

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ABSTRACT

Background: Infraclavicular approach of subclavian vein is the traditional and routinely practiced with landmark technique but use of infraclavicular approach with real time ultrasound is not strongly recommended yet. This study plans to compare ultrasound guided infraclavicular approach and landmark guided infraclavicular approach for subclavian vein catheterization.**Objectives:** To compare the success rate of subclavian vein catheterization between infraclavicular approach under USG-guidance and infraclavicular approach with landmark technique. To compare venous access time, catheterization time, procedural time and complications among study groups.**Methods:** Hospital based randomized control trial with a sample size of 45 cases in both groups. Randomization was done by using Research Randomiser computer software and patients were divided into two groups. Group A-Infraclavicular Subclavian vein catheterization by using real-time ultrasound. Group B-Infraclavicular Subclavian vein catheterization with the landmark technique.**Results:** The mean age of ultrasound group and landmark group were similar with the former group having a mean age of 43.1 (± 13.1) years and the latter group having mean age of 44.7 (± 12.4) years. The mean BMI of the study groups were also very much alike. Ultrasound group had 100% successful subclavian vein catheterization (all 45 patients in the ultrasound group were successfully catheterized) while the landmark group had a success rate of 88.9% (40 patients).**Conclusion:** Success rate of subclavian vein catheterization with ultrasound is more and complication are lesser than the blind landmark technique.

Key words: Subclavian vein catheterization, real time ultrasound, central venous catheterization, infraclavicular approach

INTRODUCTION

Central venous catheterization is an integral part of invasive monitoring and management in the modern era and subclavian vein is one of the commonest sites of central venous cannulation in anesthesia practice. Catheterization into subclavian vein has been found to be advantageous because of lesser chances of CVC related sepsis, fewer cases of thrombosis and better patient comfort[1].Another common complication associated with subclavian vein cannulation is pneumothorax[2].It is also considered in case of failure of internal jugular vein cannulation, and also in obese and hypovolemic patients[3].

Infraclavicular approach of subclavian vein is the traditional and routinely practiced with landmark technique but use of infraclavicular approach with real time ultrasound is not strongly recommended yet. National Institute for health and Clinical Excellence, London have acknowledged the role of real time ultrasound guidance for vessel localization and venipuncture when internal jugular vein is selected for cannulation and also agree that when feasible, the same may be used for subclavian vein[4].This study has made an attempt to compare the ultrasound guided infraclavicular approach with the traditional landmark guided infraclavicular approach in subclavian vein catheterization.

OBJECTIVES

To compare the success rate of subclavian vein catheterization between infraclavicular approach

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under USG-guidance and infraclavicular approach with landmark technique.

To compare no. of attempts, duration of the procedure and complication rate in patients undergoing subclavian vein catheterization using the two techniques.

METHODS

The present study was conducted in the Department of Anaesthesiology and Critical Care in a tertiary care hospital of Chandigarh, India between 2021 to 2022. All patient in the age group of 18 to 65 years and taken in the Operation Theatre for major surgery, who requires a central venous access were considered for the study. Patients with coagulopathies, on heparin/warfarin treatment, abnormal chest anatomy, superior vena cava syndrome, pregnant women, patients with evidence of any infection (fever, pneumonia, urinary tract infection, cellulitis, septicemia) were excluded from the study. Informed written consent was obtained from all the study participants after explaining the details of the study in their vernacular language.

Sample size was calculated using the formula for randomized control trials with difference in proportion between two study groups. In a previous study by Wang Q *et al.* [5], cannulation success rate of 100% was noted in ultrasound technique whereas the same for landmark technique was 87.5%. At a power of 80% and 95% confidence level, the sample size was calculated to be 45 for each group.Randomization was done by using Research Randomiser computer software(www.sealedenveloped.com) and patients were divided into two groups.

ULTRASOUND GROUP

consisted ofpatients undergoinginfraclavicular subclavian vein catheterization by using real-time ultrasound whereas **landmark group** consisted of patients undergoing the same catheterization by landmark technique. If the catheter was not successfully placed after two attempts, then it was considered as failure. Venous puncture time was defined as the time taken from the point of initial skin puncture to the point of aspiration of blood through the needle. Catheterization time and total procedure time were noted. Catheter related complications (malfunction/ malposition) and procedure related complications (arterial puncture, pneumothorax, hemothorax, hematoma etc.) were also noted.

Statistical testing was conducted with the statistical package for the social science version (SPSS 22.0). Continuous variables are presented as mean ± SD or median (IQR) for non-normally distributed data. Categorical variables are expressed as frequencies and percentages. The comparison of normally distributed continuous variables between the groups is performed using Student's t test. Nominal categorical data are compared using Chi-squared test or Fisher's exact test as appropriate. For all statistical tests, a p value less than 0.05 is taken to indicate significant difference.

ETHICAL CLEARANCE

Ethical clearance has been obtained from the institutional ethics committee.

RESULTS

A total of 90 patients of age between 18-65 years, who are undergoing a major surgery in operation theatre were selected for the study. The basic demographic characteristics of the study groups were analysed to know the comparability of the study groups. The mean (± SD) age of the ultrasound group was 43.1 (± 13.1) years and the same for landmark group was 44.7 (± 12.4) years. Body mass index (BMI) of the study subjects was also comparable in both the groups (table 1). The ultrasound group had a mean BMI of 23.7 ± 1.5 kg/m^2 while landmark group had a mean BMI of 23.8 ± 1.4 kg/m^2. There were 25 men (55.6%) and 20 women (44.4%) in ultrasound group whereas there were 31 men (68.9%) and 14 women (31.1%) in landmark group. There was no statistically significant difference (p value > 0.05) between the two groups in terms of baseline parameters of the study subjects (table 1).

Table 1: Baseline parameters of study participants

Parameter	Ultrasound group	Landmark group	Total
Age (years)			
Mean	43.1	44.7	43.9
Standard Deviation	13.1	12.4	12.7
Minimum	19.0	21.0	19.0
Maximum	65.0	65.0	65.0
p value	**0.553**		
BMI (kg/m^2)			
Mean	23.7	23.8	23.7
Standard Deviation	1.5	1.4	1.4
Minimum	20.4	20.6	20.4
Maximum	27.0	26.1	27.0
p value	**0.770**		
Gender (frequency/percentage)			

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Male	25 (55.6%)	31 (68.9%)	56 (62.6%)
Female	20 (44.4%)	14 (31.1%)	34 (37.8%)
Total	45 (100%)	45 (100%)	90 (100%)
p value	**0.192**		

In landmark group 40 patients (89.9%) cases were successfully catheterized with 05 (11.1%) failures in the group whereas all 45 patients (100%) were successfully catheterized by using ultrasound guided catheterization. Though there were no failures in ultrasound group and five failures in landmark group, the finding was not found to be statistically significant (p value-0.056). Subsequently three cases underwent internal jugular vein catheterization and femoral vein catheterization was done in two cases. Subclavian vein catheterization was successful in first attempt itself in 40 cases (88.9%) in ultrasound group and in five cases (11.1%) subclavian vein catheterization was not successful in first attempt. In contrast to the above, only 15 cases (33.3%) were successfully catheterized in first attempt in landmark group and 30 cases (66.7%) could not be catheterized. The finding was found to be statistically significant with a p value of less than 0.001 (table 2).

Table 2: Comparison of successful subclavian vein catheterization among study participants

Parameter	Ultrasound group		Landmark group		p-value
	No. of cases	Percentage	No. of cases	Percentage	
Subclavian vein catheterization					
Success	45	100%	40	88.9%	**0.056**
Failure	0	-	05	11.1%	
Catheterization on first attempt					
Success	40	88.9%	15	33.3%	**<0.001**
Failure	5	11.1%	30	66.7%	
Total	**45**	**100%**	**45**	**100%**	

Table 3: Access time required for successful subclavian vein catheterization among study groups

Access time(in seconds)	Ultrasound group	Landmark group
Mean	35.8	61.6
Standard Deviation	20.9	16.0
Minimum	17.4	35.0
Maximum	88.0	87.0
p value	**< 0.001**	

The quickest catheterization in ultrasound group was done in 17.4 and the maximum time taken for successful catheterization was 88 seconds and the same for landmark group was 35 seconds and 87 seconds respectively. Overall, the mean access time for catheterization in ultrasound group was 35.8 ± 20.9 seconds whereas mean access time for landmark group was 61.6 ± 16 seconds. The above findings were found to be statistically significant with a p value of less than 0.001 (table 3).

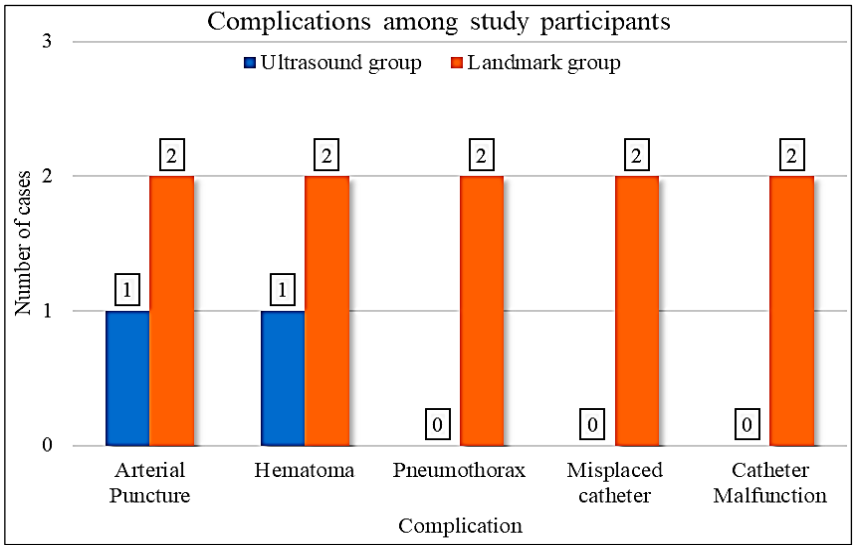

Figure 1: Complications occurred due to subclavian vein catheterization among study participants

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Majority of the study participants did not have any complications as a result of subclavian vein catheterization in both the study groups i.e., 43 patients (95.6%) in ultrasound group and 37 cases (82.2%) in landmark group. It was observed that a total of two cases (4.4%) had complications because of the procedure in ultrasound group whereas eight cases (17.8%) had complications in the landmark group. The number of patients having complications were higher in landmark group when compared to the ultrasound group and the same was found to be statistically significant (p value-0.044). In ultrasound group one incidence each of arterial puncture and hematoma were the only complications observed whereas in landmark group, there were two incidence each of arterial puncture, hematoma, pneumothorax, misplaced catheter and malfunctioning of catheter (figure 1).

DISCUSSION

Subclavian vein cannulation though considered as an alternative to IJV and femoral vein catheterization is commonly done by anatomical landmark technique as there are no standard guidelines for ultrasound use in subclavian vein catheterizations. In the present study we have made an attempt to compare subclavian vein catheterization done by traditional landmark technique with real time ultrasound guided subclavian vein cannulation by conducting a randomized control trial.

Before proceeding on to the with our study objectives, we analyzed the baseline demographic characteristics of both the groups for comparability. All the baseline parameters viz., age, BMI and gender-wise distribution had a p value of greater than 0.05 indicating the comparability of both the study groups.

In the present study it was observed that the ultrasound group had 100% successful subclavian vein catheterization while the landmark group had a success rate of 88.9% (40 patients) and five patients (11.1%) could not be catheterized even after two attempts. Similar were the results in a randomized control trial conducted by Qingyu Wang *et al.* [5] among patients admitted to the ICU and requiring subclavian vein puncture wherein the authors observed the ultrasound group had a higher puncture success rate (91.7% vs. 77.6%) in comparison to landmark group. Denys *et al.* [6] observed that ultrasound group had a success rate of 100% and landmark group had a success rate of 88.1% and the difference was found to be statistically significant. Similar were the findings in study by Fragou M*et al.* [7] and Sazdov D *et al.* [4] wherein ultrasound group had 100% success rate and that of landmark group was relatively lower (87.5% and 94.5% respectively). Alic et al[8] observed that overall success rate in landmark group was higher (94%) when compared to ultrasound group (89%), however their finding was statistically not significant. Overall, most of the studies including ours inferred that overall success rate for subclavian vein catheterization was higher in ultrasound guided technique in comparison to landmark technique except for one study conducted by Alic *et al.*[8]

On further comparison of success rate of subclavian vein catheterization on first attempt, it was observed in our study that most of the patients (40 out of 45 patients, 88.9%) were successfully catheterized in ultrasound group in contrast to only one-third of patients (15 out of 45 patients) in landmark group and the finding was statistically significant (p value-0.001). Similar were the findings in a prospective study conducted by Sidoti *et al.* [9] wherein the authors observed that 64% of patients in ultrasound group were successfully catheterized in first attempt while only 30% of patients in landmark group were successfully catheterized in first attempt. Sazdov D *et al.* [4] in their randomized control trial also observed that the success rate on first attempt was relatively higher in ultrasound group (83.1%) when compared to the landmark group (65.9%). Denys *et al.* [6] in their study on comparing ultrasound guided and landmark technique for central venous cannulation also observed that the first attempt success rates were significantly higher in ultrasound group. However, Alic et al[8] in their study observed that there was no difference in landmark technique and ultrasound guided method in terms of percentage of cases having successful catheterization.

The time from start of procedure till successful subclavian vein catheterization was noted as access time. The mean time noted for ultrasound group (35.8 seconds) was almost half of the time required for access by landmark method (61.6 seconds) and the findings were statistically significant with a p value of less than 0.001. Denys *et al.* [6] in their study also observed that the average success time was significantly shorter in ultrasound approach when compared to the landmark approach. Similarly, Fragou M*et al.* [7] in their prospective randomized controlled study noticed that the average access time was lower in ultrasound group and their finding was statistically significant. In contrast to the above findings, Alic et al[8] observed that the mean access time to catheterization was significantly longer in ultrasound group (230 ± 127 seconds) than the landmark group (178 ± 128 seconds). In another study conducted by Qingyu Wang *et al.* [5] the authors noted no significant difference in puncture time between the ultrasound group and landmark group.

In the ultrasound group there was one incidence each (2.2%) of hematoma and arterial puncture, whereas in landmark group there were a total of ten complications among eight patients. Similar were the results in a prospective study conducted by Sidoti et al[9] wherein the authors observed that complication rates were significantly less in ultrasound technique than in landmark technique (2 vs.13, p<0.001). Rezayat *et al.* [1] observed that use of real-time USG guidance for infraclavicular placement of subclavian vein catheterization allows for direct visualization of needle insertion and adjacent anatomical structures,

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guidewire location and direction, all of them leading to decreased mechanical complications and better cannulation success rate as compared to landmark technique. Sazdov D *et al.* [4] in their randomized control trial observed that complications due to the procedure were significantly higher (p value 0.004) in landmark group (16.5%) when compared to ultrasound group (2.82%).Rachna Subramony *et al.* [10] in their randomized control trial observed no significant difference in complication rates between ultrasound guided technique and landmark technique for central vein cannulation. In a study by Patrick Brass *et al.* [2] it was observed that two-dimensional ultrasound reduced the risk of inadvertent arterial puncture and haematoma formation when compared to traditional landmark method. In a meta-analysis carried out by Lalu MM *et al.*[11] the authors inferred that the overall complications rates were significantly reduced with use of ultrasound when compared to traditional landmark group.

CONCLUSION

The subclavian vein offers numerous advantages over other commonly used anatomical sites for central venous cannulation. Subclavian vein cannulation with ultrasound guidance has reduced mechanical complication and better success rate when compared to the tradition blind anatomical landmark technique.

CONFLICT OF INTEREST: Nil.

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