

COMPARISON BETWEEN ULTRASOUND-GUIDED SUPRACLAVICULAR AND INFRACLAVICULAR APPROACHES FOR SUBCLAVIAN VENOUS CATHETERISATION IN ADULTS

Paul Ovungal Raphael¹, Binu Puthur Simon², Chandan Thankappan³, Lini Chacko⁴

¹Associate Professor, Department of Anaesthesia, Amala Institute of Medical Sciences, Thrissur, Kerala, India.

²Associate Professor, Department of Anaesthesia, Amala Institute of Medical Sciences, Thrissur, Kerala, India.

³Junior Registrar, Department of Anaesthesia, Amala Institute of Medical Sciences, Thrissur, Kerala, India.

⁴Associate Professor, Department of Anaesthesia, Amala Institute of Medical Sciences, Thrissur, Kerala, India.

ABSTRACT

BACKGROUND

The Subclavian Vein (SV) is one of the preferred route for central venous catheterisation. There is limited data comparing the efficacy of Ultrasound (US) guided Supraclavicular (SC) and Infraclavicular (IC) approaches for SV cannulation in India. The purpose of this study was to compare the effectiveness of these procedures.

METHODOLOGY

We selected 130 patients aged ≥ 18 years (Mean age 59, men 57%) and recruited them equally into a supraclavicular and infraclavicular groups on alternate basis. Catheterisation was done by a single experienced anaesthesiologist using standard protocols. Information on age, sex, time for locating the vein, puncture time, number of attempts, catheter insertion time and incidence of complications were collected using a structured proforma. Data were analysed comparing the two groups using SPSS.

RESULTS

The mean time for locating the vein was 24 seconds (s) in the infraclavicular group which is significantly higher than that in the supraclavicular group, 17s ($p < 0.001$). The puncture time was 54 s in the IC group and 40 s in the SC group ($p = 0.001$). Catheterisation time was 132 s in the IC group and 120 s in the SC group ($p = 0.003$). Number of multiple attempts was 22 in the IC group and 8 in the SC group ($p = 0.005$). There were no complications and no guide wire misplacements in either group.

CONCLUSION

The supraclavicular approach for US-guided subclavian vein catheterisation in adults is clinically more advantageous in terms of shorter time for location, puncture time, catheterisation time, lower number of attempts & a potentially lower incidence of complications when compared to the infraclavicular approach.

KEYWORDS

Subclavian Vein, Cannulation, Ultrasound Imaging.

HOW TO CITE THIS ARTICLE: Raphael PO, Simon BP, Thankappan C, et al. Comparison between ultrasound-guided supraclavicular and infraclavicular approaches for subclavian venous catheterisation in adults. J. Evid. Based Med. Healthc. 2016; 3(36), 1774-1778. DOI: 10.18410/jebmh/2016/397

INTRODUCTION: Central venous catheterisation (CVC) is intended to be a reliable access to the venous system for therapeutic as well as diagnostic purposes.¹ Because of low incidence of infection and better patient comfort, subclavian vein (SV) cannulation is preferred over other sites.² Arterial puncture, haematoma, haemothorax, and pneumothorax are the known complications incurred while doing the procedure. Ultrasound (US) guided infraclavicular (IC) and supraclavicular (SC) approaches yield higher success rates and lower complication rates when compared to the blind technique.³⁻⁵ However, to date, information regarding their comparative efficacy in Indian population is limited. The aim of this study was to compare the ease in cannulation and the incidence of early complications for ultrasound-guided SC and IC approaches for subclavian cannulation in adults.

METHODOLOGY: The study was undertaken after the approval from the Institutional Ethical Committee and after having obtained written informed consent from the patients. The study group included 130 adult patients of age 18 and above undergoing general anaesthesia for elective surgeries requiring subclavian vein cannulation. Patients with severe lung disease, vascular malformations, chest wall deformities, and previous lung or chest surgeries were excluded.

The design of the study was a prospective cohort of patients divided into two groups, each group had 65 subjects. Sample size was estimated based on a previous study by HJ Byon et al "Comparison between ultrasound-guided supraclavicular and infraclavicular approaches for subclavian venous catheterization in children-A randomized trial".

Patients were recruited into either the supraclavicular or infraclavicular approach group on an alternate basis for subclavian vein cannulation until the required sample size was attained. Independent variables such as age and sex and dependent variables such as time taken for locating the vein, puncture time, catheterisation time, number of

Financial or Other, Competing Interest: None.
Submission 06-04-2016, Peer Review 22-04-2016,
Acceptance 28-04-2016, Published 05-05-2016.
Corresponding Author:
Dr. Paul Ovungal Raphael,
Ovungal House, Latin Church Road,
Thrissur-680001, Kerala, India.
E-mail: poloralph11@yahoo.com
DOI: 10.18410/jebmh/2016/397

attempts, complications and guide wire misplacements were measured.

Study Definitions:

1. Time Taken for Locating the Vein: Defined as the time taken from the point of placing the ultrasound probe over the skin to the point where a clear image of the subclavian vein is visualised in the monitor.
2. Puncture Time: Defined as the duration of time between the initial skin puncture to the aspiration of blood from the subclavian vein through the needle.
3. Catheter Insertion Time: Defined as the time taken from the point of aspiration of blood through the needle to the point of successful aspiration of blood from the catheter.
4. Number of Attempts.
 - a. Single Attempt: Defined as successful aspiration of blood in the first attempt without withdrawing the needle at any stage during its advancement.
 - b. Multiple Attempts: Two or more attempts were defined as multiple attempts.
5. Misplaced Guide Wire: Defined as an US image not visualizing the guide wire in the subclavian vein but in the internal jugular vein.
6. Early Complications: Defined as complications which occurred within 24 hours after initiation of the procedure.

The following complications were considered in this study.

1. Hematoma.
2. Pneumothorax.
3. Arterial Puncture.⁶⁻¹²

Procedure: Written informed consent was obtained after explaining the procedure and purpose of study to the patient during pre-anaesthetic visit. In the operating room after attaching the routine monitors, general anaesthesia was induced. After administration of muscle relaxant, patient was intubated and mechanically ventilated. Anaesthesia was maintained with inhalational agents. All procedures were performed on the right subclavian vein by the same anaesthesiologist. The operator who had more than 5 years of experience in ultrasound-guided central vein cannulation performed all the subclavian vein cannulation for the study. Another anaesthesiologist recorded the time for locating vein, puncture time, number of attempts, catheter insertion time, and complications. All times were measured in seconds.

Position: All patients were placed in a 15° head-down position. The head was turned towards the left side of the patient and the right arm was pulled down gently towards the knee.

Ultrasound-Guided Subclavian Vein Cannulation: VENUE 40, Ultrasound Machine (GE Medical Systems) with its linear probe was used for the study. For better visualisation and to maintain good ergonomics, the ultrasound machine was placed at the left side of the patient while anaesthesiologist stood at the right side of the patient

performing a right subclavian vein catheterisation.

Ultrasound probe including the wire was covered with sterile plastic sheath and all cannulations were performed under strict aseptic precaution. A single lumen 20 cm long 14 G central venous catheter (Straight soft tip Arrow Catheter, Arrow International) was used in all the patients. An 18 G, 6 cm needle attached to a 5 mL syringe was used for puncturing the vein.

In supraclavicular approach, the internal jugular vein (IJV) was traced down the neck under US guidance and after reaching the IJV-SV junction, the probe was turned laterally to obtain the longitudinal images of the subclavian vein and the brachiocephalic vein (Fig. 3). For the infraclavicular approach, the US probe was positioned below the clavicle to view the subclavian vein and subclavian artery (Fig. 4). For obtaining the best longitudinal view of subclavian vein, the ultrasound probe was slightly rotated and tilted with the subclavian artery in view.

The needle was advanced under the guidance of US using an in plane approach. Position of needle tip in the subclavian vein was confirmed by ultrasound visualisation of needle tip and aspiration of blood through the needle. A guide wire was threaded through the needle after confirming the position of the needle tip in the subclavian vein. Position of guide wire in the subclavian vein was confirmed by ultrasound image (Fig. 3). Another anaesthesiologist noted the time in seconds, complications, guide wire misplacement and number of attempts in the proforma.

Statistical Analysis: All data collected were entered in Microsoft Excel sheet office 2007. Analysis was done after all the 130 data sheets were entered into the computer. Mean times in seconds were obtained. Frequency of complications, guide wire misplacements and frequency of multiple attempts were made in percentage in both groups. Associations with various variables were compared between groups by student T test, chi square test & Fisher exact test as appropriate. A p value <0.05 was considered statistically significant. Analysis was done with SPSS software version 17.

RESULTS

Demographic Data: The mean age in the infraclavicular group was 60.6±14.4 years and in the supraclavicular group was 57.4±12.4. Majority of the study population belonged to age group of 50-70. There were 38 males in the IC group & 36 males in the SC group. The number of females in the IC and SC groups was 27 and 29 respectively. Total number of patients in both groups was 65. There was no statistically significant difference in demographic data between two groups. (Fig. 1, 2)

Timings: The mean time for locating the vein, the puncture time and the catheterisation time were significantly lower in the supraclavicular group when compared to the infraclavicular group (Table 1). Time for locating the vein was significantly shorter in the supraclavicular group (17.26±5.15) compared to the infraclavicular group (24.87±5.45). The supraclavicular group took a mean

puncture time of only 39.86 ± 9.80 seconds for puncturing the subclavian vein while the infraclavicular group took 54.13 ± 10.56 seconds. The result was statistically significant $P < 0.01$. The catheter insertion time was statistically significant ($P < 0.01$) in the supraclavicular group (120.29 ± 8.61 seconds) compared to the infraclavicular group (132.29 ± 6.51 seconds).

Number of Attempts & Early Complications: Significantly higher incidence of multiple attempts was noted in the infraclavicular group (22) compared to supraclavicular group (8). (Table 2) $p = (0.005)$. None of the patients had early complications mentioned earlier. Catheterisation was successful in all the patients.

Tables and Figures

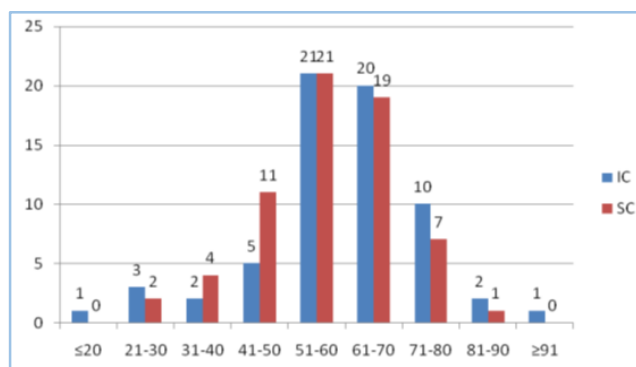


Fig. 1: Age Distribution among the Two Groups

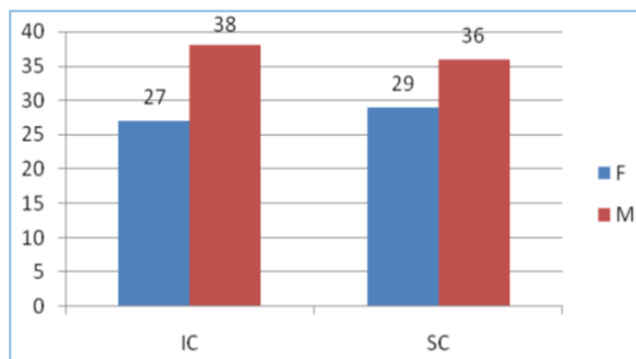


Fig. 2: Gender Distribution among the Groups

Measured Timings (s)	IC group (n=65)	SC group (n=65)	P value
Time for Locating Vein	24.87 ± 5.45	17.26 ± 5.15	<0.01
Puncture Time	54.13 ± 10.56	39.86 ± 9.80	<0.01
Catheter Insertion Time	132.29 ± 6.51	120.29 ± 8.61	<0.01

Table 1: Comparison of the Study Results between the IC Group and SC groups. Results Expressed as Mean Time (in seconds) $\pm$ SD. IC=Infraclavicular. SC=Supraclavicular

	IC Group (n=65)	SC Group (n=65)	P Value
Multiple Attempts	22	8	0.005
Complications	0	0	
Guide Wire Misplacement	0	0	

Table 2: Results Expressed as Number of Patients in Each Group



Fig. 3: Ultrasound-guided Supraclavicular Approach for Subclavian Vein Cannulation



Fig. 4: Ultrasound-guided Infraclavicular Approach for Subclavian Vein Cannulation

DISCUSSION: This prospective cohort study revealed that the supraclavicular approach for ultrasound-guided subclavian cannulation had shorter time for location, puncture time, cannulation time and lower number of attempts when compared to the infraclavicular approach. To the best of our knowledge, the time for locating the vein in US-guided subclavian cannulation has not been reported from the developing countries. Our study results show a significantly longer time for locating the vein in the infraclavicular group.

The more time taken in the infraclavicular approach may be because of the anatomic proximity of the vein to the clavicle and the difficulty in getting a longitudinal visualisation because of the acoustic shadow of clavicle as previously reported by Byon HJ et al and Zhong X et al^{13,14}

The puncture time in the supraclavicular approach was significantly short compared to the infraclavicular approach. The ease of obtaining and maintaining a longitudinal view without an acoustic shadow for the supraclavicular subclavian approach makes it different from the infraclavicular approach.

This has already been reported in a previous study by Byon HJ.¹³ We got a significantly prolonged puncture time in the infraclavicular approach compared to the supraclavicular approach. This may be explained by the difficulty in maintaining the US view of the vein and the needle simultaneously or the necessity of multiple attempts which was more frequent with the infraclavicular approach. It has been already reported that the real time access in the infraclavicular approach is limited by vessel identification in a single planar view and a more applicable multiplanar approach (Which is a combination of transverse, oblique and longitudinal view) was suggested by Zhong X et al¹⁴

Study by Lanspa and Fair reported a better visualisation of the subclavian vein in the infraclavicular approach with the use of a micro-convex ultrasound probe.¹⁵ In another study by Gaus et al, a new insertion site for the infraclavicular approach at the junction of axillary and subclavian veins was reported to have better visualisation and is technically easier.¹⁶

The catheterisation time difference between the two approaches was not specifically reported in previous studies except one by Byon HJ which reported comparable results in both the approaches.¹³ The significant difference in catheterisation time might be due to technical difficulty we faced while positioning the guide wire in the infraclavicular approach. The supraclavicular placement of ultrasound probe might have made it easy for locating the guide wire in the subclavian vein and brachiocephalic vein after its insertion making the catheterisation time shorter in the supraclavicular approach when compared to infraclavicular approach in which the probe had to be shifted to locate and confirm the guide wire in the subclavian vein.

In our study, we got a significantly higher incidence of multiple attempts in the infraclavicular approach. In previous studies by HJ Byon et al,¹³ multiple attempts were defined as more than 3 attempts where as we defined it as two or more attempts. This might be one of the reasons for our higher value. The previously mentioned anatomical factors might have also contributed to this. We did not have any complications in either of the approach indicating the quality of our procedure. The incidence of early complications was comparable between the two approaches when using ultrasound. However, when compared to land mark technique, US-guided technique yielded lower complication rates.^{3,4,5}

All these studies supported the use of dynamic 2D ultrasound for subclavian catheterisation to reduce adverse events and failed catheterisation. We did not have any case with a misplaced guide wire. The incidence of guide wire misplacement was reported to be comparable in both the approaches in most of the studies.^{17,18,19} But HJ Byon et al in his study reported significantly more number of guide wire misplacement in infraclavicular group compared to the supraclavicular group.¹³ This was explained because of the downward direction of the needle in the supraclavicular group which made the guide wire less frequently misplaced.

CONCLUSION: Our study reveals that while using ultrasound guidance for cannulation of the subclavian vein, the time for locating, puncturing and catheterising the vein in the infraclavicular approach was significantly prolonged when compared to supraclavicular approach. Previous studies comparing the difference in infraclavicular and supraclavicular land mark approaches for subclavian cannulation show comparable results.²⁰ However, when considering the use of ultrasound in subclavian access, the supraclavicular approach is found to be superior in terms of overall ease in cannulation. The difficulty in obtaining and maintaining the ultrasound view in the infraclavicular approach might have made this significant difference.

ACKNOWLEDGEMENT: We are grateful to the Department of Social and Preventive Medicine, Amala Institute of Medical Sciences, for their support in statistical analysis of data.

REFERENCES

1. Miller RD. cardiovascular monitoring: indications of central venous cannulation. *Anesthesiology* 2009;110(6):2756–2757.
2. Mermel LA, McCormick RD, Springman SR, et al. The pathogenesis and epidemiology of catheter-related infection with pulmonary artery Swan-Ganz catheters: a prospective study utilizing molecular subtyping. *Am J Med* 1991;91(3B):197S–205S.
3. Bruzoni M, Slater BJ, Wall J, et al. A prospective randomized trial of ultrasound- vs landmark-guided central venous access in the pediatric population. *J Am Coll Surg* 2013;216(5):939–943.
4. Hind D, Calvert N, McWilliams R, et al. Ultrasonic locating devices for central venous cannulation: meta-analysis. *BMJ* 2003;327(7411):361.
5. Lalu MM, Fayad A, Ahmed O, et al. Ultrasound-Guided Subclavian Vein Catheterization: a systematic review and meta-analysis. *Crit Care Med* 2015;43(7):1498–1507.
6. Shah KB, Rao TLK, Laughlin S, et al. A review of pulmonary artery catheterization in 6,245 patients. *Anesthesiology* 1984;61(3):271–275.
7. Heath KJ, Woulfe J, Lownie S, et al. A devastating complication of inadvertent carotid artery puncture. *Anesthesiology* 1998;89(5):1273–1275.
8. Khalil KG, Parker FB, Mukherjee N, et al. Thoracic duct injury. A complication of jugular vein catheterization. *JAMA* 1972;221(8):908–909.
9. Beilin Y, Bronheim D, Mandelbaum C. Hemothorax and subclavian artery laceration during “J” wire change of a right internal jugular vein catheter. *Anesthesiology* 1998;88(5):1399–1400.
10. Bernard RW, Stahl WM. Mediastinal hematoma: complication of subclavian vein catheterization. *NY State J Med* 1974;74(1):83–86.

11. Naguib M, Farag H, Joshi RN. Bilateral hydrothorax and hydromediastinum after a subclavian line insertion. *Can Anaesth Soc J* 1985;32(4):412–414.
12. Rudge CJ, Bewick M, McColl I. Hydrothorax after central venous catheterization. *BMJ* 1973;3(5870):23–25.
13. Byon HJ, Lee GW, Lee JH, et al. Comparison between ultrasound-guided supraclavicular and infraclavicular approaches for subclavian venous catheterization in children - a randomized trial. *Br J Anaesth* 2013;111(5):788–792.
14. Zhong X, Hamill M, Collier B, et al. Dynamic multiplanar real time ultrasound-guided infraclavicular subclavian vein catheterization. *Am Surg* 2015;81(6):621–625.
15. Lanspa MJ, Fair J, Hirshberg EL, et al. Ultrasound-guided Subclavian Vein Cannulation Using a Micro-Convex Ultrasound Probe. *Annals of the American Thoracic Society* 2014;11(4):583–586. doi:10.1513/AnnalsATS.201311-414BC.
16. Gaus P, Hess B, Muller-Breitenlohner H. Ultrasound-guided infraclavicular venipuncture at the junction of the axillary and subclavian veins. *Anaesthesist* 2015;64(2):145–151.
17. Pandey JC, Dubey PK. A method for rapid clinical diagnosis of misplaced subclavian vein catheters. *Anesth Analg* 2000;90(1):229.
18. Ambesh SP, Pandey JC, Dubey PK. Internal jugular vein occlusion test for rapid diagnosis of misplaced subclavian vein catheter into the internal jugular vein. *Anesthesiology* 2001;95(6):1377–1379.
19. Tripathi M, Dubey PK, Ambesh SP. Direction of the J-tip of the guidewire, in Seldinger technique, is a significant factor in misplacement of subclavian vein catheter: a randomized, controlled study. *Anesth Analg* 2005;100(1):21–24.
20. Thakur A, Kaur K, Lamba A, et al. Comparative evaluation of subclavian vein catheterisation using supraclavicular versus infraclavicular approach. *Indian J Anaesth* 2014;58(2):160–164.