

Comparative efficacy of supraclavicular versus infraclavicular approach of subclavian vein cannulation under ultrasound guidance: A randomised clinical trial

Address for correspondence:

Dr. Deepak Singla,
Department of Anaesthesiology
and Critical Care, All India
Institute of Medical Sciences,
Rishikesh, Uttarakhand, India.
E-mail: deepak10.4u@gmail.
com

Submitted: 19-Oct-2020

Revised: 23-Nov-2020

Accepted: 02-Feb-2021

Published: 10-May-2021

Mageshwaran T, Deepak Singla, Ankit Agarwal, Ajit Kumar, Debendra K Tripathy, Sanjay Agrawal

Department of Anaesthesiology and Critical Care, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India

ABSTRACT

Background and Aims : Subclavian vein (SCV) cannulation can be performed using either supraclavicular (SC) or infraclavicular (IC) long-axis approach under ultrasound guidance (USG). However, their relative efficacy remains debatable. The aim of this study was to compare these two approaches in terms of safety, ease, success rate, and record the incidence of complications.

Methods: We studied 90 adult patients distributed into two groups of 45 each. Data regarding the time taken for first venous puncture, the time required for inserting the catheter, the total number of attempts, the incidence of guidewire misplacement, and other mechanical complications were compared using Student's t-test for quantitative data and Chi-square test for qualitative value.

Results: Mean puncture time was significantly lesser in group SC than IC (P -value < 0.001). Mean catheter insertion time taken was also significantly less in group SC than IC (P -value = 0.003). The first attempt rate was higher in group SC than IC ($P = 0.013$). Guidewire misplacement was seen in the IC group, $P = 0.001$. No pneumothorax, haemothorax, or arterial puncture were noted in our study in any of the groups. **Conclusion:** We conclude that for right-sided SCV cannulation using USG in the long axis, the SC approach is superior to the IC approach in terms of overall ease of cannulation. It was associated with a relatively shorter procedure time, higher success rate in the first attempt, lesser incidence of guidewire misplacement, and other complications. It should be considered as an alternative approach to the IC approach in patients requiring central line insertion.

Key words: Catheterisation, complications, subclavian vein, ultrasound

Access this article online
Website: www.ijaweb.org
DOI: 10.4103/ija.JJA_1316_20
Quick response code


INTRODUCTION

Central vein catheter (CVC) insertion is necessary for long-term venous access especially in the sick patients and the patients undergoing a major operation. Long-term intravenous support through the subclavian vein (SCV) is preferred due to less restriction of neck mobility and the lesser frequency of thrombosis.^[1] The blind landmark technique of SCV cannulation is associated with certain life-threatening complications such as haemo-pneumothorax ($< 2\%$), catheter malposition (9.3%), and subclavian arterial puncture (0.5%).^[2] So most recent studies advocate the use of ultrasound guidance (USG) for both internal

jugular vein (IJV) and SCV cannulation. CVC under direct vision using USG needs a lesser number of attempts, decreases the time required for insertion, and reduces complications like arterial puncture,

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Mageshwaran T, Singla D, Agarwal A, Kumar A, Tripathy DK, Agrawal S. Comparative efficacy of supraclavicular versus infraclavicular approach of subclavian vein cannulation under ultrasound guidance: A randomised clinical trial. *Indian J Anaesth* 2021;65:69-73.

pneumothorax, and guidewire malposition.^[3,4] The two approaches of SCV cannulation i.e. supraclavicular (SC) and infraclavicular (IC) have been described^[5,6] and successfully attempted under USG for CVC insertion using the long axis (in-plane) approach. However, the relative efficacy of one over the other remains a matter of debate as the studies evaluating the same are few. Therefore, we aimed this study to compare the USG-guided long-axis SC and IC methods of SCV in terms of safety, ease, and success rate.

METHODS

After the Institutional Ethical Committee approval and Clinical Trials Registry- India (CTRI) registration (CTRI/2018/05/013751), this project was undertaken in the department of anaesthesia over 1.5 years from starting of 2018 to late 2019. A total of 90 adult patients aged between 18 and 60 years, of both genders, with American Society of Anesthesiologists (ASA) physical status I–IV listed for elective surgery under general anaesthesia where CVC insertion was indicated, participated in the study. Patients included in the study were posted for neurosurgery, spine surgery, major abdominal surgery. Any patient having an infection at the puncture site, deranged coagulation profile, pneumothorax, uncontrolled hypertension, pulmonary disease, severe cardiac disease, distorted anatomy of the neck or clavicle, previous central line insertions, or not giving consent for the study was excluded.

The specifics of the procedure and risks involved were explained and written consent was taken from each participant. Patients were then randomly allocated to either of the two following groups by sealed envelope technique.

Group SC – Right SCV catheterisation by USG, long-axis SC approach ($n = 45$).

Group IC – Right SCV catheterisation by USG, long-axis IC approach ($n = 45$).

After admission into the operating room, standard monitors including heart rate (HR), pulse oximetry (SpO_2), electrocardiogram (ECG), and non-invasive blood pressure (NIBP) were applied and peripheral venous access was established. After induction of general anaesthesia and before the start of surgery, the right SCV cannulation was performed in all the patients under USG by the same anaesthesiologist who had previously performed at least 30 procedures by both approaches.

For USG-guided SCV cannulation, participants were positioned supine with 10–15° head-down tilt with head turned slightly towards left. Their right arm was fully adducted and shoulders slightly pulled downwards [Figure 1]. Ultrasound Machine Vivid™ iq GE Medical Systems (China) Co. Ltd, with a linear probe 12L-RS at 4-13 MHz was used. The USG machine was positioned on the patient's left side and the anaesthesiologist performing SCV catheterisation was on the right. Another anaesthesiologist was there to record the data.

Under all aseptic precautions, SCV cannulation was done using the modified Seldinger technique. A sterile transducer cover was used to enclose the ultrasound probe and a sterile gel was spread over the tip of the probe. We used 16 G Certrifix[®] trio by B-Braun in all patients for this study. The anaesthesiologist performing the procedure held the probe, located the site of puncture and then performed the SCV puncture under direct vision.

For SC approach, first, the IJV was located with USG probe and, then we moved the probe downwards keeping the IJV under vision until the IJV-SCV junction was located. At this point, the probe was moved 90° to obtain a longitudinal view of the SCV [Figure 2]. So, at the time of initiating the puncture, only the SCV draining into the brachiocephalic vein was visible on the ultrasound display. In the IC approach, by placing the linear USG probe approximately 1.0–1.5 cm below middle and medial one-third of the clavicle, we first located the SCV in the short axis. Then by rotating the probe along the axis of the vein and scanning the area slightly laterally and below the clavicle, the



Figure 1: Position of the patient

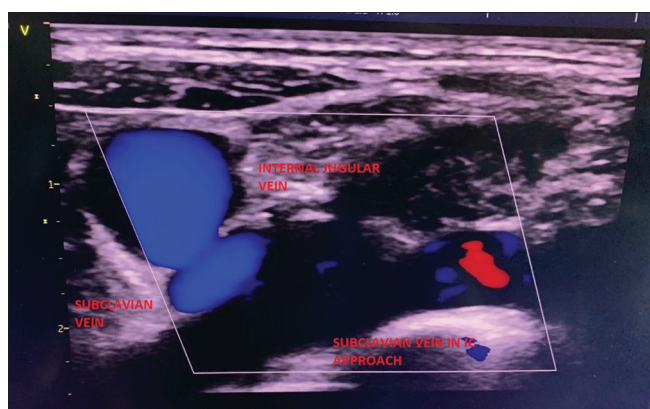


Figure 2: View of SCV in supraclavicular approach

union of the axillary vein and cephalic vein leading to the formation of the SCV was located. By placing the linear USG probe in line with the SCV, only the SCV was evident on the monitor [Figure 3].

The primary objective was to compare the mean puncture time, which was defined as the time taken from introduction of ultrasound probe on skin to aspiration of blood from vein. Secondary objectives were to compare the catheter insertion time, the number of attempts, incidence of complication like guidewire misplacement. Catheter insertion time was taken as time from the successful placement of the needle in SCV to successful catheter insertion (confirmed by aspiration of blood through the catheter). Attempts required, that is single attempt or multiple attempts (maximum three attempts), guidewire misplacement (guidewire not going into the brachiocephalic vein), mechanical complications like pneumothorax, haemothorax, and arterial puncture were recorded. After surgery (which lasted for 3–6 h), a portable chest X-ray was obtained in all patients to confirm the position of the tip of catheter and to rule out any complications as mentioned.

The sample size was estimated based on a similar study done previously,^[6] which included 98 patients. In that study, the mean puncture times in SC and IC groups were 36 ± 60 s and 48 ± 114 s (mean \pm SD), respectively. So, using a confidence level of 95% and power of study of 80% the minimum number of patients required was found to be 44 patients by using Open Epi software version 3.01 (Bill and Melinda Gates Foundation). So, to have better accuracy, we included 45 patients in each group. Descriptive statistics for quantitative variables are presented in terms of minimum, maximum, mean, standard deviation (SD) for each group separately.



Figure 3: View of SCV in infraclavicular approach

International Business Machine Statistical Package for the Social Sciences version 26.0 was used for statistical analysis. For the variables that are of qualitative type, data are presented in terms of frequency/number/percentage under each group separately. The statistical significance of quantitative variables was determined by the Student t-test. And for qualitative data, a Chi-square test was applied. The *P* value of ≤ 0.05 was set as criteria for the level of statistical significance.

RESULTS

No significant difference was observed in the demographic profile of patients in both groups [Table 1]. The mean puncture time was significantly lesser in group SC compared to group IC, it being 29.87 ± 8.89 s and 46.93 ± 12.27 s, respectively (*P*-value < 0.001) [Table 2]. The mean catheter insertion time taken was also significantly less in group SC as compared with group IC, it being 130.49 ± 17.99 s and 140.02 ± 11.26 s, respectively (*P*-value = 0.003) [Table 2]. Similarly, a lower percentage of patients needed multiple attempts for successful cannulation in group SC (4%) compared to group IC (22.2%) (*P* = 0.013) [Table 2]. Guidewire misplacement was not seen in the SC group, 0 (0%) versus 4 (8.9%) in the IC group, *P* = 0.001. No complications like pneumothorax, haemothorax, or arterial puncture were observed in any patients in our study.

DISCUSSION

Our study was aimed to appraise IC and SC approaches of SCV cannulation in terms of ease of catheterisation, that is, puncture time, catheter insertion time, number of attempts, the incidence of guidewire misplacement, and complications. In our study, the USG-guided SC

Table 1: Patient characteristics

Variable (mean±SD)	Group IC (n=45)	Group SC (n=45)	P*
Age (years)	43.27±13.39	43.24±15.20	0.994
Sex (male/female)	29/16	24/21	0.284
Height (cm)	116.38±7.15	160.44±5.06	0.477
Weight (cm)	57.93±9.45	56.93±9.75	0.622
BMI (kg/m ²)	22.22±3.30	22.20±3.82	0.984

BMI: Body mass index; group IC, infraclavicular group; group SC, supraclavicular group. *P<0.05 is considered significant

Table 2: Comparative analysis of the study parameters between the SC and IC groups

Parameter	Group IC (n=45) (mean±SD)	Group SC (n=45) (mean±SD)	P*
Mean puncture time (s)	46.93±12.27	29.87±8.89	<0.001
Catheter insertion time (s)	140.02±11.26	130.49±17.99	0.003
Multiple attempts	10 (22.2%)	2 (4%)	0.013
Guidewire misplacement	4 (8.9%)	0	0.001
Complications	0	0	-

Group IC, infraclavicular group; group SC, supraclavicular group. *P<0.05 is considered significant

approach for SCV cannulation had considerably lesser mean puncture time, mean catheter insertion time, and a lower percentage of patients needing multiple punctures. In the IC approach, SCV not only lies deeper than in the SC area but also is quite close to the clavicle. So acoustic shadow caused by clavicle may interfere in proper visualisation of SCV in the IC area as reported by Byon HJ *et al.*^[6]

Initially, when the landmark approach was used, Anil Thakur *et al.*^[7] comparing IC with SC approach of SVC found that access time which was the time between the first puncture until the successful placement of catheter in SC approach (4.30 ± 1.02 min) was less compared to IC approach (6.07 ± 2.149 min, P = 0.000). Also, the cannulation success rate was better with the SC approach (29 out of 30 vs. 27 out of 30) as compared with the IC approach. They found that the incidence of complications was comparable by both IC and SC methods for SCV cannulation. Further in the study by Czarnik *et al.*^[8] three experienced anaesthesiologists (at least 20 SCV cannulations before starting the study) performed SCV cannulation using the landmark approach. They found the incidence of complications and success rate similar as in other techniques of central vein cannulations in mechanically ventilated patients.

A more recent study by Sidoti A *et al.*^[9] and systematic review by Lalu MM *et al.*^[10] showed a clear advantage of USG-guided technique over anatomic landmark-based technique for SCV cannulation, with lesser complications

and greater success rate. Franco-Sadud R *et al.*^[11] recommended that routine insertion of SCV should be done under USG in real time as it was shown to decrease the threat of mechanical complications, increase the overall procedure success rate and decrease the number of needle punctures compared with landmark technique. We have also used ultrasound in all our patients. None of the patients in either group had any major complications of the procedure like pneumothorax, haemothorax, and arterial puncture, in our study. Similar findings were reported in most studies^[6,12] that had used USG for SCV cannulation.

As far as time to puncture the SCV is concerned we had got a significantly short mean puncture time in SC as compared with the IC approach. The USG-guided visualisation of SCV is better^[13] and easy^[6] in the SC area as compared with the IC area. Byon HJ^[6] also reported faster SCV cannulation by a SC approach in children. Similarly, studies by Prasad R *et al.*^[5] and Raphael PO *et al.*^[12] showed that puncture time was less in the SC approach to SCV cannulation. However, in both these studies time to obtain SCV view and time to puncture it were calculated separately. In our study, anaesthesiologist performing the procedure was not interrupted until successful venous puncture was achieved. Also, the average BMI of patients in both the study groups was around 22.2 kg/m² [Table 1]. Such low BMI could also have contributed to lesser puncture time in our study. Stachura MR *et al.*^[1] have shown that USG visualisation of SCV is affected if BMI is more than 30 kg/m².

In our study, the number of patients requiring multiple attempts was higher in the IC approach. Studies mentioned above^[4,6,12] also reported similar findings. In a study by Stachura MR *et al.*^[1] USG-guided visualisation of the SCV in the long axis is better in the SC area as compared with the IC area. Also, they found that USG-guided views of SC SCV on the right side was slightly better than on the left although the difference was not significant. We have catheterised right SCV by both approaches (SC and IC) in our study. This better visualisation might have resulted in a higher success rate in the first attempt. Similarly, the incidence of guidewire misplacement was also lower in the SC group. Both Byon HJ *et al.*^[6] and Tripathy M *et al.*^[13] in their study reported a significant number of guidewire misplacements in the IC group. In our study, we had four guidewire misplacements into the right IJV with the IC approach and none in the SC approach. A relatively short course of right SC SCV

into the brachiocephalic vein and downward direction of advancing needle-guidewire might be the reason for this difference.

Various modifications of USG-guided techniques for visualisation of SCV have been described in the literature. Zhong X *et al.*^[14] had found that for SCV cannulation by IC route, a multiplanar approach using a combination of transverse, longitudinal, and oblique views along with Doppler is effective and safe. Gaus *et al.*^[15] reported that insertion of central line at the junction of SCV and axillary vein would be technically easier and better for IC SCV cannulation visualisation.

The limitations of our study are that all SCV cannulations were performed on the right side. So, these results might not apply to left SCV cannulation. Secondly, since most participants were adult patients with average BMI, whether these findings apply to patients with higher BMI or special subgroups like infants, children, elderly remains to be seen. A study with much larger sample size may be needed to compare and evaluate these variables.

CONCLUSION

We conclude that for the right-sided SCV cannulation using USG in the long axis, the SC approach is superior to the IC approach in terms of overall ease of cannulation. SC approach was associated with a relatively shorter procedure time, higher success rate in the first attempt, lesser incidence of guidewire misplacement, and other complications. It should be considered as an alternative approach to the IC approach in patients requiring central line insertion.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Stachura MR, Socransky SJ, Wiss R, Betz M. A comparison of the supraclavicular and infraclavicular views for imaging the subclavian vein with ultrasound. *Am J Emerg Med* 2014;32:905-8.
2. Ruesch S, Walder B, Tramèr MR. Complications of central venous catheters: Internal jugular versus subclavian access—A systematic review. *Crit Care Med* 2002;30:54-60.
3. Rastogi A, Agarwal A, Goyal P, Priya V, Dhiraaj S, Haldar R. Ultrasound guided internal jugular vein cannulation in infants: Comparative evaluation of novel modified short axis out of plane approach with conventional short axis out of plane approach. *Indian J Anaesth* 2018;62:208-13.
4. Lal J, Bhardwaj M, Verma M, Bansal T. A prospective, randomised, comparative study to evaluate long axis, short axis and medial oblique axis approach for ultrasound-guided internal jugular vein cannulation. *Indian J Anaesth* 2020;64:193-8.
5. Prasad R, Soni S, Janweja S, Rajpurohit JS, Nivas R, Kumar J. Supraclavicular or infraclavicular subclavian vein: Which way to go—A prospective randomized controlled trial comparing catheterization dynamics using ultrasound guidance. *Indian J Anaesth* 2020;64:292-4.
6. Byon HJ, Lee GW, Lee JH, Park YH, Kim HS, Kim CS, *et al.* Comparison between ultrasound-guided supraclavicular and infraclavicular approaches for subclavian venous catheterization in children—A randomized trial. *Br J Anaesth* 2013;111:788-92.
7. Thakur A, Kaur K, Lamba A, Taxak S, Dureja J, Singhal S, *et al.* Comparative evaluation of subclavian vein catheterisation using supraclavicular versus infraclavicular approach. *Indian J Anaesth* 2014;58:160-4.
8. Czarnik T, Gawda R, Perkowski T, Weron R. Supraclavicular approach is an easy and safe method of subclavian vein catheterization even in mechanically ventilated patients: Analysis of 370 attempts. *Anesthesiology* 2009;111:334-9.
9. Sidoti A, Brogi E, Biancofiore G, Casagli S, Guarracino F, Malacarne P, *et al.* Ultrasound-versus landmark-guided subclavian vein catheterization: A prospective observational study from a tertiary referral hospital. *Sci Rep* 2019;9:12248.
10. Lalu MM, Fayad A, Ahmed O, Bryson GL, Fergusson DA, Barron CC, *et al.* Canadian Perioperative Anesthesia Clinical Trials Group. Ultrasound-guided subclavian vein catheterization: A systematic review and meta-analysis. *Crit Care Med* 2015;43:1498-507.
11. Franco-Sadud R, Schnobrich D, Mathews BK, Candotti C, Abdel-Ghani S, Perez MG, *et al.* Recommendations on the use of ultrasound guidance for central and peripheral vascular access in adults: A position statement of the Society of Hospital Medicine. *J Hosp Med* 2019;14:E1-22.
12. Raphael PO, Simon BP, Thankappan C, Chacko. Comparison between ultrasound-guided supraclavicular and infraclavicular approaches for subclavian venous catheterisation in adults. *J Evid Based Med Healthcare* 2016;3:1774-8.
13. 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;100:21-4.
14. Zhong X, Hamill M, Collier B, Bradburn E, Ferrara J. Dynamic multiplanar real time ultrasound guided infraclavicular subclavian vein catheterization. *Am Surg* 2015;81:621-5.
15. Gaus P, Heß B, Müller-Breitenlohner H. Ultrasound-guided infraclavicular venipuncture at the junction of the axillary and subclavian veins. *Anaesthesist* 2015;64:145-51.