

Original Research Article

LANDMARK GUIDED SUPRACLAVICULAR VERSUS INFRACLAVICULAR SUBCLAVIAN VEIN CANNULATION A RANDOMIZED CONTROL TRIAL

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ABSTRACT

Background: Subclavian vein cannulation is a widely performed procedure for obtaining central venous access in critically ill and perioperative patients. Both supraclavicular and infraclavicular approaches are commonly used; however, the optimal technique remains controversial. The present study compared the efficacy and safety of these two landmark-guided approaches.

Materials and Methods: This prospective randomized controlled trial was conducted in a tertiary care center and included 50 adult patients requiring subclavian vein catheterization. Patients were randomly allocated into two groups: Group S (supraclavicular approach, n = 25) and Group I (infraclavicular approach, n = 25). The primary outcome was the time from skin puncture to successful guidewire insertion. Secondary outcomes included overall success rate, first-attempt success, number of attempts, and procedure-related complications.

Results: Baseline demographic characteristics and indications for catheterization were comparable between the groups ($p > 0.05$). Successful cannulation was achieved in all patients (100%) in both groups. The mean procedural time was significantly shorter in Group S than in Group I (20 ± 18 seconds vs. 133 ± 35 seconds; $p < 0.001$). First-attempt success was achieved in 23 (92%) patients in Group S and 20 (80%) patients in Group I ($p = 0.21$). Transient arrhythmias occurred in two patients (8%) in Group S and three patients (12%) in Group I. Two patients (8%) in Group I experienced arterial puncture, and one patient (4%) had catheter malposition into the internal jugular vein. No pneumothorax was observed in either group.

Conclusion: The supraclavicular approach was associated with significantly shorter procedural time and a higher first-attempt success rate while maintaining an equivalent overall success rate. It also demonstrated fewer mechanical complications, suggesting that it is a safe and effective alternative to the infraclavicular approach for landmark-guided subclavian vein cannulation.

Keywords: Central line, subclavian vein, cannulation, critical care.

INTRODUCTION

Central venous catheterization (CVC) is an essential procedure in modern anesthesiology, emergency medicine, and critical care. It provides a very good venous access for administration of drugs, intravenous fluids, parenteral nutrition, blood products, chemotherapy, hemodynamic monitoring and dialysis. Sometimes such venous access can be a lifesaving for critically ill patients. Among the

available central venous access sites, the subclavian vein remains one of the preferred choice because of its consistent anatomy, lower rates of catheter-related infection and thrombosis, and improved patient comfort compared with other venous access.

The subclavian vein can be cannulated by two different approaches: the infraclavicular (IC) approach and the supraclavicular (SC) approach. The infraclavicular technique is the conventional method and has been widely practiced for several decades

because of its familiarity among clinicians. However, this approach may be technically challenging due to the narrow needle trajectory beneath the clavicle, difficulty in needle visualization during ultrasound guidance, and the potential risk of complications such as arterial puncture, pneumothorax, catheter malposition, and multiple needle passes which may lead to discomfort to the patient.

The supraclavicular approach, first described by Yoffa in 1965, provides a straighter and shorter path to the brachiocephalic-subclavian venous junction.^[1]

This approach offers several anatomical advantages, including easier identification of the vein, better ultrasound visualization, wider needle insertion angle, and potentially higher first-attempt success rates. Improved visualization may also reduce procedural time and minimize mechanical complications associated with central venous catheterization. One should always understand that the peripherally inserted catheter are not superior than the central line catheters.^[2]

The widespread adoption of ultrasound guidance has significantly improved the safety and success of central venous catheterization. Current international guidelines recommend real-time ultrasound guidance whenever feasible because it increases first-pass success while reducing complications such as arterial puncture, hematoma formation, and pneumothorax. Ultrasound guidance is particularly advantageous for subclavian vein cannulation, where anatomical variations and limited landmark reliability may contribute to procedural difficulty. However, the limited resource critical care units face challenges during the emergency situation while securing central line. In such cases the landmark techniques can be a life saving although complications are unavoidable in some cases.^[3]

Despite the increasing use of ultrasound, there remains ongoing debate regarding the optimal approach for subclavian vein cannulation. Several randomized controlled trials have compared the supraclavicular and infraclavicular routes with respect to procedural success, cannulation time, visualization time, number of needle passes, and complication rates.^[4] Many studies have demonstrated that the supraclavicular approach offers superior needle visualization, shorter access time, and higher first-attempt success, whereas others have reported comparable outcomes between the two techniques, indicating that operator experience and patient characteristics continue to influence procedural success.^[5]

Mechanical complications associated with subclavian vein cannulation, although infrequent with ultrasound guidance, remain clinically important because they can result in increased morbidity, prolonged hospitalization, and additional healthcare costs. Evaluating techniques that improve procedural success while minimizing complications is therefore of considerable clinical relevance. Identifying the superior approach may facilitate

standardization of practice and enhance patient safety across operating rooms and intensive care units.

Although various studies are conducted for the comparison of supraclavicular versus infraclavicular subclavian vein cannulation under ultrasound guidance, very few studies are conducted such comparison with landmark guided blind technique. This study was conducted to compare both approaches in critical care patients.

MATERIALS AND METHODS

This prospective randomized controlled trial was conducted in a tertiary care center. Written informed consent was obtained from all patients or, where applicable, from their legally authorized representatives prior to enrolment. The sample size was calculated using the formula for comparison of two independent means using previous study conducted by Ram Prasad et al.^[6]

$$n = \frac{2(Z_{\alpha/2} + Z_{\beta})^2 \sigma^2}{(\mu_1 - \mu_2)^2}$$

where, $Z_{\alpha/2}=1.96$ (95% confidence level), $Z_{\beta}=0.84$ (80% power), $\mu_1=177.92$ seconds, $\mu_2=199.66$ seconds and difference between means (Δ) = 21.74 seconds. The minimum required sample size was 9 participants per group. Considering the small calculated sample size, potential dropouts, and the need to improve the precision and reliability of the study findings, 25 patients were included in each group, resulting in a total sample size of 50 participants.

All 50 patients were included in the study were randomly allocated into two equal groups of 25 patients each using a computer-generated randomization sequence. Patients undergoing subclavian vein cannulation via the supraclavicular approach were assigned to Group S, while those undergoing cannulation via the infraclavicular approach were assigned to Group I. Adult patients aged more than 25 years, irrespective of gender, who required subclavian venous catheterization were eligible for inclusion in the study. All eligible patients and, whenever applicable, their relatives were counseled regarding the procedure, its benefits, and the potential risks and complications. Only those patients or their legally authorized representatives who provided written informed consent and agreed to participate were included in the study.

Patients with known bleeding diathesis or coagulopathy and those who had an existing central venous catheter inserted through a site other than the subclavian vein were excluded from the study. In addition, patients in whom the planned site of central venous catheterization was changed at the time of the procedure due to clinical or technical reasons were also excluded. Following randomization, subclavian vein cannulation was performed using the standard anatomical landmark technique through either the

supraclavicular or infraclavicular approach, according to the allocated study group. A 7 Fr triple-lumen central venous catheter was inserted in all patients. Following successful catheterization, a post-procedure chest radiograph was obtained as per the institutional protocol to confirm catheter tip position and exclude procedure-related complications such as pneumothorax. All procedures were performed by an operator who had previously completed at least 25 successful landmark-guided subclavian vein cannulations, thereby ensured procedural competence and minimized operator-related variability.

The primary procedural variables recorded included the time required for successful guidewire insertion, measured from the initial skin puncture until successful placement of the guidewire, the number of cannulation attempts. Procedure-related complications, including inadvertent arterial puncture, pneumothorax, catheter malposition into the internal jugular vein, and cardiac arrhythmias occurring during guidewire insertion, were also documented and analyzed.

RESULTS

A total of 50 patients were enrolled in the study, with 25 patients each in the supraclavicular group (Group S) and the infraclavicular group (Group I). Baseline demographic characteristics were comparable between the two groups. [Table 1]

In Group S, 13 (52%) patients were male and 12 (48%) were female, whereas Group I comprised 17 (68%) males and 8 (32%) females. The difference in gender distribution between the groups was not statistically significant (Chi-square test, $p = 0.248$). The mean age of patients in Group S was 46 ± 2 years, compared with 48 ± 8 years in Group I. The difference in mean age was not statistically significant (Independent t-test, $p = 0.28$).

The indication for central venous catheterization was elective in 18 (72%) patients and emergency in 7 (28%) patients in Group S, while in Group I, 19 (76%) patients underwent elective cannulation and 6 (24%) underwent emergency cannulation. There was no statistically significant difference between the groups regarding the indication for catheterization (Chi-square test, $p = 0.74$).

Successful subclavian vein cannulation was achieved in all patients in both groups, resulting in an overall success rate of 100%. The mean time required from skin puncture to successful guidewire insertion was 20 ± 18 seconds in Group S and 133 ± 35 seconds in Group I. This difference was highly statistically significant, with Group S demonstrating a substantially shorter procedural time than Group I (Independent t-test, $p < 0.001$).

First-attempt cannulation was successful in 23 (92%) patients in Group S, while the remaining 2 (8%) patients required a second attempt. In Group I, needle reinsertion was required in 5 (20%) patients, indicating a comparatively lower first-pass success rate. However, all patients were successfully cannulated. Although Group S demonstrated a higher first-attempt success rate, the difference did not reach statistical significance (Fisher's exact test, $p = 0.21$). Procedure-related complications were infrequent in both groups. In Group S, transient ventricular premature complexes (VPCs) occurred in 2 (8%) patients, with no cases of arterial puncture, catheter malposition, or pneumothorax. In Group I, transient cardiac arrhythmias occurred in 3 (12%) patients, inadvertent arterial puncture was observed in 2 (8%) patients, and catheter malposition into the internal jugular vein occurred in 1 (4%) patient. No patient in either group developed pneumothorax. Although complications were numerically more frequent in Group I, the overall difference in complication rates between the groups was not statistically significant (Fisher's exact test, $p > 0.05$).

Table 1: Comparison of study variables

Variable	Group S (n=25)	Group I (n=25)	Statistical test	p value	Inference
Gender (Male/Female)	13/12	17/8	Chi-square	0.248	Not significant
Age (years)	46 ± 2	48 ± 8	Independent t-test	0.280	Not significant
Indication (Elective/Emergency)	18/7	19/6	Chi-square	0.740	Not significant
Successful cannulation	25 (100%)	25 (100%)	Fisher's exact	1.000	Not significant
Procedure time (seconds)	20 ± 18	133 ± 35	Independent t-test	<0.001*	Highly significant
First-attempt success	23 (92%)	20 (80%)	Fisher's exact	0.221	Not significant
Transient arrhythmia	2 (8%)	3 (12%)	Fisher's exact	0.637	Not significant
Arterial puncture	0	2 (8%)	Fisher's exact	0.149	Not significant
IJV malposition	0	1 (4%)	Fisher's exact	0.500	Not significant
Pneumothorax	0	0	NA	-	None observed

* p value <0.05 is considered to be significant.

DISCUSSION

The present prospective randomized controlled study compared the supraclavicular (SC) and infraclavicular (IC) landmark approaches for subclavian vein cannulation with respect to procedural success, cannulation time, number of attempts, and procedure-related complications. The

baseline demographic characteristics, including age, gender distribution, and indication for central venous catheterization, were comparable between the two groups, indicating that the study population was homogeneous and that the observed differences in procedural outcomes were attributable to the technique employed rather than patient-related factors.

In the present study, successful subclavian vein cannulation was achieved in all patients in both groups, resulting in an overall success rate of 100%. Although both techniques were equally successful in achieving venous access, the supraclavicular approach demonstrated superior procedural performance. Similar findings were reported by Ram Prasad et al., who observed a comparable overall success rate between the two approaches while concluding that the supraclavicular route was technically easier and more efficient under ultrasound guidance.^[6]

The most important finding of the present study was the significantly shorter time required from skin puncture to successful guidewire insertion in the supraclavicular group (20 ± 18 seconds) compared with the infraclavicular group (133 ± 35 seconds; $p < 0.001$). This suggests that the supraclavicular approach provides easier anatomical access to the subclavian vein, allowing rapid venous puncture and guidewire advancement. Similar observations were reported by Jaiswal et al, who found that the supraclavicular approach was associated with significantly shorter visualization time, puncture time, catheter insertion time, and total procedural time than the infraclavicular approach. The authors concluded that the supraclavicular route was quicker, technically easier, and associated with fewer complications.^[4]

Our findings are also consistent with those of Sharma et al., who compared landmark-guided supraclavicular and infraclavicular subclavian vein catheterization and reported significantly shorter access times with the supraclavicular approach (4.30 ± 1.02 minutes versus 6.07 ± 2.14 minutes). They attributed this advantage to the straighter course of the brachiocephalic vein and easier needle trajectory offered by the supraclavicular route.^[7]

First-attempt success is an important determinant of procedural safety because repeated needle passes increase patient discomfort and the risk of mechanical complications. In the present study, first-pass success was achieved in 92% of patients in the supraclavicular group compared with 80% in the infraclavicular group, although this difference was not statistically significant ($p = 0.21$). Nevertheless, fewer patients required repeat needle insertion in the supraclavicular group, suggesting easier venous access. Similar findings have been reported by Ram Prasad et al., who observed a higher first-attempt success rate with the supraclavicular approach than with the infraclavicular approach.^[6]

Procedure-related complications were infrequent in both groups. In the supraclavicular group, only transient ventricular premature complexes were observed in two patients, whereas no arterial puncture, catheter malposition, or pneumothorax occurred. In contrast, the infraclavicular group demonstrated a higher incidence of transient arrhythmias, arterial puncture, and catheter malposition into the internal jugular vein, although these differences were not statistically significant

because of the relatively small sample size. The absence of pneumothorax in either group may be attributed to careful patient selection, adherence to standard procedural techniques, and the experience of the operators.

The lower incidence of complications with the supraclavicular approach observed in the present study is supported by the large randomized controlled trial conducted by Kim et al., involving 401 patients. They reported significantly fewer catheterization-related complications and catheter malposition in the supraclavicular group compared with the infraclavicular group, while maintaining similar overall success rates. The supraclavicular approach also required a shorter time for venous puncture, leading the authors to recommend it as the preferred approach for right subclavian vein catheterization.^[8-10]

The anatomical characteristics of the supraclavicular approach may explain its favorable performance. The needle follows a shorter and straighter path toward the brachiocephalic-subclavian venous confluence, facilitating easier guidewire passage and reducing the likelihood of catheter malposition. In contrast, the infraclavicular approach requires a longer and relatively narrower needle trajectory beneath the clavicle, making venous access technically more demanding and increasing the possibility of repeated needle passes. These anatomical advantages have been consistently highlighted in previous comparative studies.

Although the present study employed the landmark technique, the observed advantages of the supraclavicular approach are in agreement with contemporary ultrasound-guided studies. Both Ram Prasad et al. and Jaiswal et al. demonstrated that the supraclavicular approach offers superior visualization, shorter procedural time, improved first-pass success, and fewer complications when ultrasound guidance is used. These findings suggest that the inherent anatomical benefits of the supraclavicular route remain advantageous irrespective of the cannulation technique employed.

Limitation of the study:

The present study was conducted at a single tertiary care center with a relatively small sample size, which may limit the generalizability of the findings. All procedures were performed by experienced operators using the landmark technique, and therefore the results may not be applicable to less experienced clinicians or ultrasound-guided cannulation. The patient comfort was not assessed in this study which is one of the important variables. In this study we have used only 7 fr triple lumen catheter, the use of hemodialysis catheter may affect the study outcome. The study assessed only immediate procedural outcomes and did not evaluate long-term catheter-related complications or operator-related factors. Larger multicenter studies with longer follow-up are required to further validate these findings.

CONCLUSION

The supraclavicular approach for subclavian vein cannulation was associated with a significantly shorter procedural time compared to the infraclavicular approach while maintaining a comparable overall success rate. It also demonstrated a higher first-attempt success rate and fewer procedure-related complications, although the differences in complications were not statistically significant. Both techniques were found to be safe and effective for achieving central venous access. The findings suggest that the supraclavicular approach may offer technical advantages over the infraclavicular approach when performed by experienced operators. Further large-scale multicenter randomized controlled trials are recommended to confirm these findings and establish the optimal approach for routine clinical practice.

REFERENCES

1. Tomar GS, Chawla S, Ganguly S, Cherian G, Tiwari A. Supraclavicular approach of central venous catheter insertion in critical patients in emergency settings: Re-visited. *Indian J Crit Care Med.* 2013 Jan;17(1):10-5
2. Turcotte S, Dubé S, Beauchamp G. Peripherally inserted central venous catheters are not superior to central venous catheters in the acute care of surgical patients on the ward. *World J Surg.* 2006;8:1605–19
3. Scholten HJ, Ten Bloemendal E, Botter B, Korsten HHM, Bouwman RA. Barriers to ultrasound guidance for central venous access: a survey among Dutch intensivists and anaesthesiologists. *J Clin Monit Comput.* 2019 Dec;33(6):1023-1031
4. Jaiswal P, Saini S, Chhabra PH. Subclavian Vein Cannulation via Supraclavicular or Infraclavicular Route Which is Better? A Prospective Randomized Controlled Trial. *Indian J Crit Care Med* 2024;28(4):375–380
5. Saini V, Vamsidhar A, Samra T, Sethi S, Naik BN. Comparative evaluation of ultrasound guided supraclavicular and infraclavicular subclavian venous catheterizations in adult patients. *J Anaesthesiol Clin Pharmacol.* 2022 Jul-Sep;38(3):411-416
6. 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(4):292–298
7. Thakur A, Kaur K, Lamba A, Taxak S, Dureja J, Singhal S, Bhardwaj M. Comparative evaluation of subclavian vein catheterisation using supraclavicular versus infraclavicular approach. *Indian J Anaesth.* 2014 Mar;58(2):160-4
8. Kim YJ, Ma S, Yoon HK, Lee HC, Park HP, Oh H. Supraclavicular versus infraclavicular approach for ultrasound-guided right subclavian venous catheterisation: a randomised controlled non-inferiority trial. *Anaesthesia.* 2022 Jan;77(1):59-65
9. Parienti JJ, du Cheyron D, Timsit JF, Traoré O, Kalfon P, Mimoz O, et al. Meta-analysis of subclavian insertion and non tunneled central venous catheter-associated infection risk reduction in critically ill adults. *Crit Care Med.* 2012;40(5):1627–1634
10. 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(1):12248.