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Ultrasound-Guided Supraclavicular Brachiocephalic Vein versus Internal Jugular Vein Cannulation in Adults: A Prospective Observational Comparison of Procedural Efficiency and Safety

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ABSTRACT

Background: Ultrasound guidance is recommended as the standard of care for central venous catheterization (CVC) owing to improved first-pass success and reduced mechanical complications. While the internal jugular vein (IJV) remains the most commonly used access site, the supraclavicular brachiocephalic vein (BCV) has emerged as an alternative with favorable anatomical and sonographic characteristics. Prospective comparative adult data remain limited.
Methods: This prospective observational study included 88 adult elective surgical patients requiring central venous access. Patients were alternately allocated to ultrasound-guided in-plane IJV cannulation (n = 44) or ultrasound-guided in-plane supraclavicular BCV cannulation (n = 44). Primary outcomes were vein localization time, puncture time, catheter insertion time, and number of needle attempts. Secondary outcomes included first-pass success and early mechanical complications within 24 hours.
Results: Compared with IJV cannulation, BCV cannulation was associated with significantly shorter vein localization and puncture times, fewer needle attempts, and a higher first-pass success rate. Catheter insertion time was comparable between groups. Two minor hematomas occurred in the IJV group; no arterial puncture, pneumothorax, or hemothorax was observed in either group.
Conclusions: In experienced hands, ultrasound-guided supraclavicular BCV cannulation appears to be an efficient and safe alternative to ultrasound-guided IJV cannulation in adults.

Keywords: *brachiocephalic vein, internal jugular vein, ultrasound guidance, central venous catheterization.*

INTRODUCTION

Central venous catheterization (CVC) is integral to modern anaesthesia and critical care practice, enabling administration of vasoactive drugs, hyperosmolar solutions, parenteral nutrition, renal replacement therapy, and advanced hemodynamic monitoring. Despite its routine nature, CVC insertion is associated with potentially serious complications, including arterial puncture, pneumothorax, haemothorax, and catheter malposition, particularly when landmark-based techniques are employed.

The widespread adoption of point-of-care ultrasound has transformed vascular access practice over the past two decades. Randomized controlled trials, meta-analyses, and large observational studies consistently demonstrate that ultrasound guidance improves first-pass success, reduces the number of needle attempts, and lowers the incidence of mechanical complications compared with landmark-based approaches. Consequently, international guidelines and consensus statements recommend real-time ultrasound guidance as the standard of care for CVC insertion whenever equipment and trained personnel are available.

The internal jugular vein (IJV) is the most frequently used site for ultrasound-guided CVC placement owing to its superficial location and consistent sonographic appearance. However, IJV cannulation has recognised limitations. The close proximity of the carotid artery increases the risk of arterial puncture, particularly during difficult cannulations or repeated attempts. Optimal exposure often requires head rotation, which may be undesirable or contraindicated in patients with cervical spine pathology, raised intracranial pressure, or unstable airways. Furthermore, neck catheter placement may interfere with airway management and is prone to dressing disruption with patient movement.

The supraclavicular brachiocephalic vein (BCV), formed by the confluence of the internal jugular and subclavian veins, represents an alternative access site with several potential advantages. The BCV generally has a larger caliber and a relatively horizontal and predictable course within the supraclavicular fossa. When visualised using a longitudinal in-plane ultrasound approach, the entire needle shaft and tip can be continuously visualized, potentially reducing posterior wall puncture and the need for multiple needle passes.

Although the supraclavicular approach to central venous access was described decades ago, early landmark-based techniques were associated with concerns regarding pneumothorax, limiting widespread adoption. Advances in ultrasound technology and increasing operator experience have renewed interest in this approach. Pediatric studies first demonstrated high success rates and low complication profiles with ultrasound-guided supraclavicular BCV cannulation, and subsequent adult feasibility and cohort studies have reported similarly favorable outcomes. However, most adult data are retrospective or descriptive, and prospective comparative studies remain sparse.

This prospective observational study was therefore undertaken to compare ultrasound-guided supraclavicular BCV cannulation with ultrasound-guided IJV cannulation in adult elective surgical patients, focusing on procedural efficiency and early mechanical safety.

METHODS

This prospective observational study was conducted in the Department of Anaesthesiology at Amala Institute of Medical Sciences, Thrissur, India, between August 2021 and January 2023, after approval by the Institutional Ethics Committee (IEC No. AIMS/2021/ANAES/CR/45). Written informed consent was obtained from all participants prior to enrollment.

Adult patients aged ≥18 years scheduled for elective surgery under general anaesthesia who required central venous access were eligible. Exclusion criteria included infection or hematoma at the planned puncture site, previous ipsilateral neck or thoracic surgery, documented venous thrombosis, recent cervical trauma, anatomical deformity of the neck or supraclavicular region, and significant coagulopathy.

Patients were alternately allocated to ultrasound-guided in-plane internal jugular vein cannulation (Group IJV) or ultrasound-guided in-plane supraclavicular brachiocephalic vein cannulation (Group BCV), with 44 patients in each group. Allocation was not concealed. All procedures were performed on the right side by consultant anaesthesiologists with substantial experience in ultrasound-guided vascular access.

Following induction of general anaesthesia and tracheal intubation, patients were positioned supine with a 10° Trendelenburg tilt to enhance venous filling. A high-frequency linear ultrasound probe (8–18 MHz) was used. Full barrier precautions were employed. (Figure 1) An in-plane long-axis ultrasound technique was used in both groups. After venous puncture, a guidewire was advanced, followed by catheter placement using the Seldinger technique. A post-procedural chest radiograph was obtained to confirm catheter position and exclude pneumothorax.

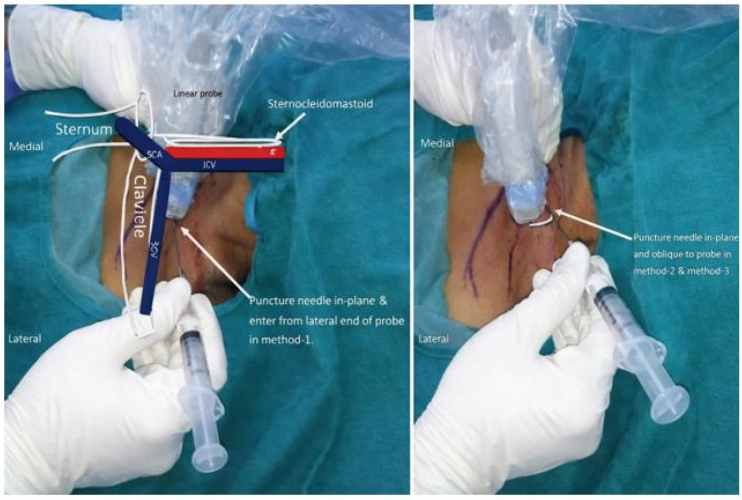

Figure 1

Primary outcomes were vein localization time, puncture time, catheter insertion time, and number of needle attempts. First-pass success was recorded. Secondary outcomes included early mechanical complications within 24 hours. Continuous variables were analyzed using the unpaired Student's t-test and categorical variables using the chi-square or Fisher's exact test. A p-value < 0.05 was considered statistically significant.

RESULTS

Eighty-eight patients completed the study, with 44 patients in each group. Baseline demographic characteristics were comparable.

Vein localization time and puncture time were significantly shorter in the BCV group compared with the IJV group. The number of needle attempts required for successful cannulation was lower in the BCV group, and first-pass success was higher. Catheter insertion time did not differ significantly.

Two cases of minor hematoma occurred in the IJV group and resolved with conservative management. No arterial puncture, pneumothorax, haemothorax, or catheter malposition was observed.

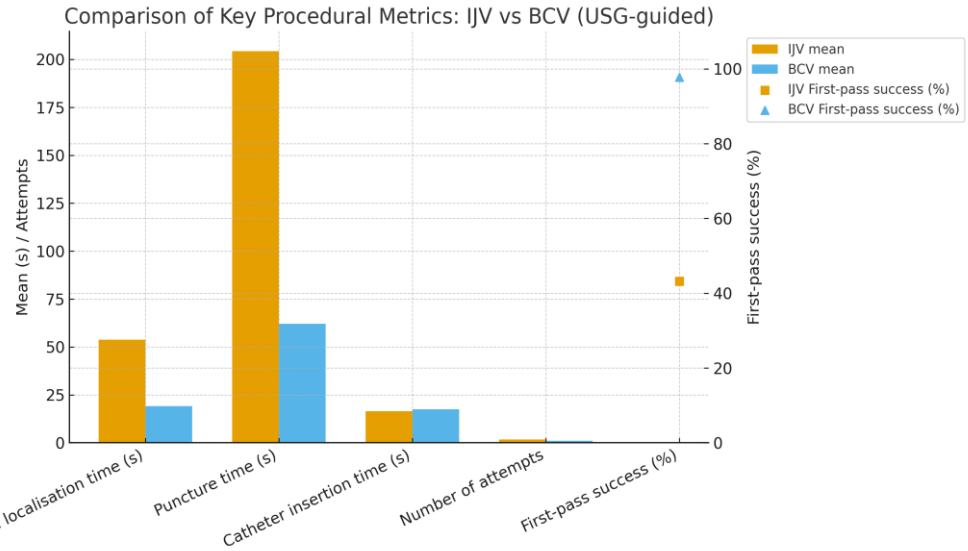

Figure 2. Composite comparison of procedural metrics between ultrasound-guided IJV and BCV cannulation.

DISCUSSION

This prospective observational study demonstrates that ultrasound-guided supraclavicular brachiocephalic vein cannulation is associated with greater procedural efficiency and higher first-pass success compared with ultrasound-guided internal jugular vein cannulation in adult elective surgical patients, without an increase in early mechanical complications.

The improved efficiency observed with BCV cannulation is likely attributable to favorable anatomical and sonographic

characteristics. The BCV generally has a larger diameter and a more horizontal orientation than the IJV, facilitating alignment of the ultrasound beam with the vessel axis and allowing continuous in-plane visualization of the needle tip. These features may reduce posterior wall puncture and the need for repeated needle redirection, translating into shorter procedure times and improved first-pass success.

Our findings are consistent with prior adult cohort studies and feasibility trials reporting high success rates and low complication profiles with ultrasound-guided BCV cannulation. Pediatric studies have similarly demonstrated advantages of the supraclavicular approach, suggesting that the anatomical benefits of BCV access are preserved across age groups. Recent reviews and guideline documents emphasize the importance of ultrasound guidance and support training clinicians in multiple access sites to allow patient-centered site selection.

From a clinical standpoint, the BCV approach may offer several practical advantages. Faster and more reliable vascular access may be particularly valuable in high-acuity settings such as emergency surgery or critical care. The supraclavicular catheter site may be less prone to dressing disruption caused by neck movement, potentially improving catheter stability and patient comfort. In addition, the BCV approach may be advantageous in patients in whom head rotation is undesirable or airway access must be preserved.

Several limitations must be acknowledged. The non-randomized alternate allocation design introduces potential selection bias, and allocation was not concealed. All procedures were performed by experienced consultant anesthesiologists, and outcomes may differ among trainees or clinicians early in the learning curve. Only early mechanical complications were assessed. Long-term outcomes such as catheter-related bloodstream infection, venous thrombosis, and catheter dwell time were not evaluated.

Future research should include multicenter randomized controlled trials comparing BCV and IJV access, with adequate power to detect differences in both short- and long-term outcomes. Studies evaluating the learning curve and training requirements for safe implementation of supraclavicular BCV cannulation are also warranted.

CONCLUSION

In experienced hands, ultrasound-guided supraclavicular brachiocephalic vein cannulation appears to be an efficient and safe alternative to ultrasound-guided internal jugular vein cannulation in adults. It offers improved procedural efficiency and higher first-pass success without an increase in early mechanical complications. Incorporation of this technique into ultrasound-guided vascular access training programs may further enhance the safety and success of central venous catheterization.

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