

A Comparative Study between Right Internal Jugular Vein Cannulation v/s Right Brachiocephalic Vein Cannulation (Supraclavicular Approach) Under Ultrasound Guidance

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Conflict of interest: Nil

Abstract

Background: Central venous cannulation is essential for monitoring hemodynamics, providing inotropic support, delivering total parenteral nutrition, medications, and long-term fluid therapy. Using ultrasound to guide the vein cannulation process has become a standard practice. This shift is primarily due to enhanced visualization, a higher success rate, and a reduction in complications associated with ultrasound compared to the traditional landmark technique.

Aims and Objectives: The main aim of the study was to compare the successful cannulation between the right internal jugular vein v/s supraclavicular approaches to right brachiocephalic vein using ultrasound guidance. Objective of our study was to compare the time taken, number of attempts and incidence of complications during cannulation among them.

Methodology: Study was a comparative study conducted in Fakhruddin Ali Ahmed medical college and hospital. Ethical committee approval for this study was taken from the institute. A total of 50 patients aged between 18 to 60 years, ASA grade 1,2,3, conscious, mechanically ventilated or sedated were enrolled in this study. The patient was randomly allocated into two groups; Group A (n=25) received right internal jugular vein cannulation while group B (n=25) received right brachiocephalic vein cannulation under ultrasound guidance.

Result: The study found that first attempt success rate was significantly higher for group B (80%) than group A (36%) (P=0.0219). Group B achieved faster cannulation time (mean 98.08 secs) than group A (mean 182.68 secs), P=0.022) with few attempts. The incidence of complications was significantly higher for group A compared to group B (P <0.001).

Conclusion: It was found that under ultrasound guidance right brachiocephalic vein cannulation appears to be more successful approach for central venous access because of faster cannulation time, fewer attempts, lesser complication rates and better anatomical visualisation than right internal jugular vein cannulation.

Keywords: Right Internal Jugular Vein, Central Venous Cannulation, Ultrasound, Right Brachiocephalic Vein.

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Introduction

Central venous catheters (CVCs) are medical devices that are placed in the major central veins of the body and play a crucial role in contemporary healthcare [1]. The initial recorded insertion of a CVC dates back to 1733, when English clergyman Stephen Hales attached a glass tube to the left jugular vein of a horse to gauge venous pressure and cardiac output [2]. Nearly two hundred years later, in 1929, German physician Werner

Forssmann made history by inserting a ureteric catheter into his antecubital vein under fluoroscopic guidance, thus becoming the first person to document central venous catheterization in humans [3]. Central venous cannulation is a critical procedure in various medical and surgical settings, enabling the administration of medications, fluids, parenteral nutrition, and the monitoring of central venous pressure [4]. Traditionally, veins were

accessed by locating external surface landmarks and puncturing along the expected path of the veins. However, this approach has been linked to various challenges, including anatomical differences, neck deformities, and previous cannulations.

The landmark technique has frequently resulted in unintentional complications, particularly in patients with coagulopathy [5]. This can lead to multiple attempts and extended time required to successfully cannulate the vein, which may cause patients to become uncooperative.

However, the advent of ultrasound-guided techniques has revolutionized vascular access, offering enhanced visualization that potentially mitigates anatomical challenges and reduces the

risk of complications [6]. With the introduction of USG, supraclavicular BCV cannulation is gaining traction, attributed to the convenience of cannulation with visualizing the complete needle path aided by USG, its superficial location, and the absence of bone covering the vein.

USG cannulation allows real-time visualization of the vein, surrounding structures, and the needle, thereby increasing the success rate of the procedure while minimizing risks such as arterial puncture, hematoma formation, and pneumothorax.

This technique's efficacy and safety profile prompts a reevaluation of the comparative merits of right IJV versus supraclavicular approach to right BCV cannulation when performed under ultrasound guidance [7].

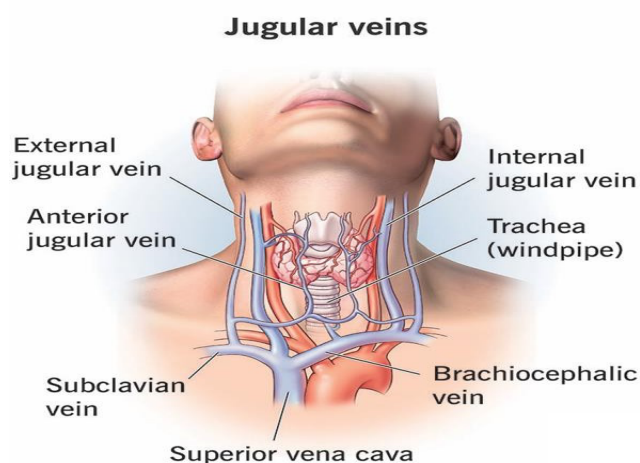


Figure 1: Anatomy of Right internal jugular vein, right brachiocephalic vein.

Aim & Objective: The main aim of the study was to compare the successful cannulation between the right internal jugular vein v/s supraclavicular approaches to right brachiocephalic vein cannulation using ultrasound guidance. Objective of our study was to compare the time taken, number of attempts and incidence of complication of vein cannulation between right IJV and right BCV (supraclavicular approach) using ultrasound guidance.

Material & Methods

Place of Study: Department of Anaesthesiology and Critical Care at FAAMCH, Barpeta.

Duration of Study: One year (from November 2023 to October 2024).

Type of Study: A prospective hospital based comparative study.

Sample Size: 50

Grouping: After obtaining Institutional Ethics committee approval and consent from patient party, those patients who fulfilling the inclusion and

exclusion criteria were randomly allocated into two groups of 25 each by a computer generated random selection; group A (right internal jugular venous cannulation) and group B (supraclavicular approach to right brachiocephalic venous cannulation).

Inclusion Criteria:

1. Patients classified as physical status grades 1, 2, or 3 by the American Society of Anaesthesiologists (ASA)
2. Individuals aged between 18 and 60 years
3. Any gender
4. Valid consent

Exclusion Criteria:

1. A prior history of radiation therapy, burns or neck surgeries
2. Patient with bleeding issues, coagulation disorders
3. Individuals with previous cannulations
4. Presence of infections or tumors at the cannulation site
5. External anatomical deformities at the

cannulation sit

Method of Collection of Data

Study technique: The procedure was done in a sterile environment with an assistant present throughout the procedure. All patients were placed in 30° Trendelenburg position with head rotated about 45° to the left for right side cannulation. Then the site was sterilised with povidine iodine and chlorhexidine as per institution protocol. All the cannulations were done using 7.5MHZ ultrasound transducer probe, which was covered in sterile plastic sheath and connected to a real time USG machine.

For Internal Jugular Vein (IJV): The IJV and common carotid artery were then identified by pulsations, by probe compressibility and by Doppler colour flows. The common carotid artery was identified as anechoic area that was pulsatile and non-compressible with ultrasound transducer probe.

The internal jugular vein similarly seen as an anechoic area but it was non pulsatile and compressible. A 16-gauge needle with syringe containing heparinized saline was used to insert into internal jugular vein under direct real time ultrasound guidance.

For Brachiocephalic Vein (BCV): After preparing the skin and ultrasound probe in a sterile manner, the usg probe was positioned on the supraclavicular fossa or atop the clavicular head of the

sternocleidomastoid muscle.

The Y-shape representing the jugular vein, subclavian vein, and the brachiocephalic vein was then visualized on a single ultrasound image. After the Y-shaped image was visible, the needle was inserted from the lateral side of the ultrasound probe at a 30-45° angle to BCV.

After the needle insertion for both veins:

- Aspiration of blood was done to confirm vein by colour, after which a J-tipped guide wire was inserted.
- The position of the wire in vein lumen was confirmed by ultrasound by long axis and in short axis view.

This was followed by dilator and then triple lumen catheter was inserted and catheter tip position was confirmed by bedside chest X-ray film post procedure.

The data collected for the study included:

- 1) The time taken between the initial skin puncture and the successful guidewire placement in each group.
- 2) The total number of attempts made in each group. (Attempt was considered from the initial skin puncture to the successful placement of guidewire)
- 3) The occurrence of complications in every group.
- 4) The frequency of vein collapse in each group.

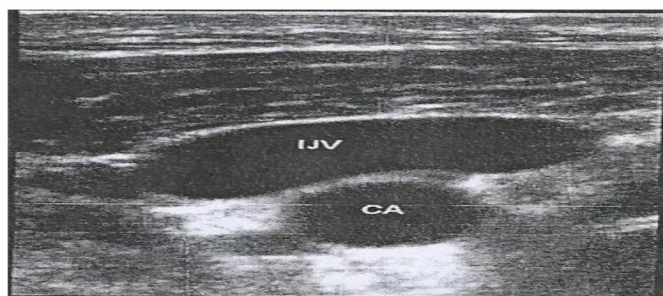


Figure 2: Ultrasound image showing right internal jugular vein completely overlapping the right carotid artery for IJV cannulation.

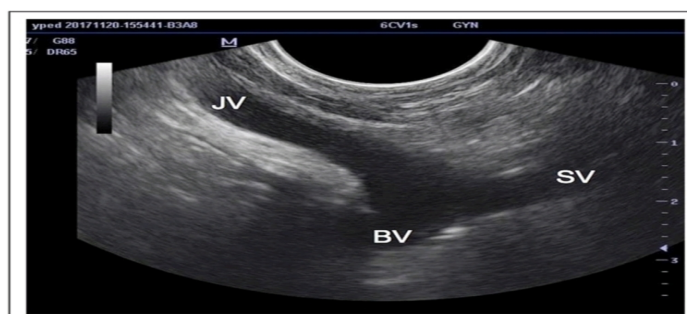


Figure 3: Ultrasound image showing Y-shape visualization of the subclavian vein (SV), internal jugular vein (IJV) & brachiocephalic vein (BCV) for BCV cannulation.

Statistical analysis: The analyses were performed using the statistical software SPSS version 25.0. Descriptive statistics were applied based on demographic details to understand the distribution of study participants. The Shapiro-Wilks and Kolmogorov-Smirnov tests were utilized to check the normality of the variables. Given that the data

showed a normal distribution, an independent t-test or unpaired t-test, chi-square test, Fischer's exact test were planned. A p-value of less than 0.05 was deemed statistically significant, whereas a p-value greater than 0.05 was viewed as statistically insignificant.

Result

Table 1: Inter group comparison of duration of cannulation (in seconds)

Group	No of patients	Mean	Std deviation	Mean difference	p- value
Right IJV	25	182.68	150.83	84.6	=0.022*
Right BCV	25	98.08	94.73		

Values are expressed as mean and SD, the p-value is by independent t-test, p-value less than 0.05 is considered statistically significant.

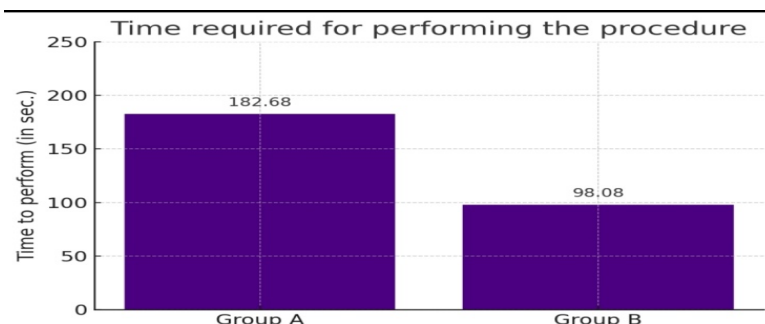


Figure 1: Intergroup comparison of duration of cannulation (in seconds)

The mean duration for cannulation in the Right BCV group was significantly lower at 98.08 seconds with a standard deviation of 94.73 seconds, compared to the Right IJV group, which had a mean duration of 182.68 seconds and a standard deviation of 150.83 seconds. The mean difference of 84.6 seconds between the groups was found to

be statistically significant ($p < 0.05$) based on the independent t-test.

This suggests that cannulation in the Right BCV was associated with a significantly shorter duration compared to the Right IJV, indicating a potential advantage in terms of procedural efficiency.

Table 2: Comparison of the attempts in both groups

No. of Attempts	Right IJV		Right BCV		p - value
	No of patients	%	No of patients	%	
1	9	36.00	20	80.00	0.0219*
2	7	28.00	2	8.00	
3	5	20.00	3	12.00	
4	2	8.00	0	0.00	
5	2	8.00	0	0.00	

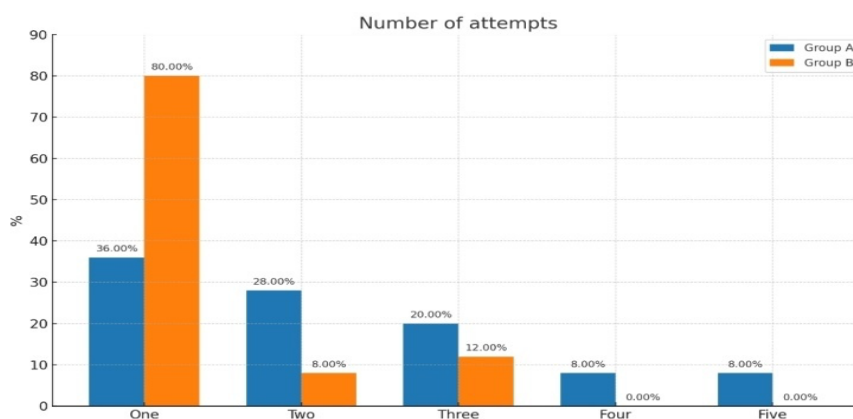


Figure 2: Comparison of the attempts in both the groups

The comparison of the number of attempts for cannulation in both the Right IJV and Right BCV groups is presented in Table 2. The data reveals that in the Right IJV group, 36% of patients achieved successful cannulation on the first attempt, followed by 28% on the second attempt and 20% on the third attempt. Additionally, 8% of patients required four attempts and 8% required

fifth attempts. In contrast, the Right BCV group had 80% of patients succeeding on the first attempt, 8% on the second attempt, and 12% on the third attempt. But no patients needed four or more attempts. The results revealed a statistically significant association (Chi-square test, $p=0.0219$), indicating that the distribution of attempts varied significantly between the groups.

Table 3: Inter group comparison of complications

Complications	Group				p-value
	Right IJV		Right BCV		
	Count	%	Count	%	
Artery puncture	1	4.0	0	0.0	0.5
Catheter-misplacement	4	16.0	1	4.0	<0.001
Hematoma	3	12.0	1	4.0	<0.001
Values are expressed as frequency and percentage. The p-value is by Fisher's exact test.					

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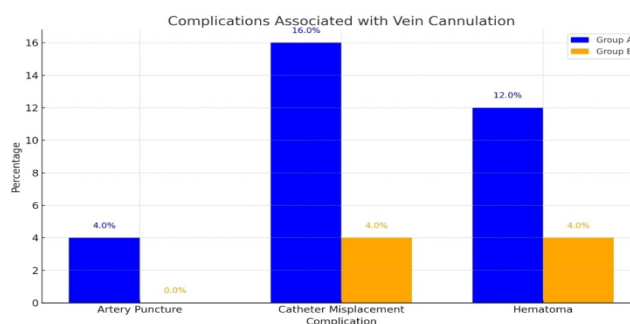


Figure 3: Comparison of the complications in both the groups

The data in Table 3, conducted under ultrasound guidance, indicates a substantial safety advantage associated with cannulation of the Right Brachiocephalic Vein.

Our research identified complications such as arterial puncture, catheter misplacement, and

hematoma formation, with their occurrence being lower in right BCV cannulation than in right IJV cannulation, achieving a significance level of p less than 0.001 in catheter misplacement and hematoma formation but in arterial puncture we did not get statistically significant ($p=0.5$) result.

Table 4: Comparison of the collapsed vein in both the groups

Collapsed vein	Group				p-value
	Right IJV		Right BCV		
	Count	%	Count	%	
No	16	64.00	23	92.0	0.037
Yes	9	36.00	2	8.0	
Values are expressed as frequency and percentage. The p-value is by Fischer's exact test. The incidence of collapsed vein was significantly lower in group B as compared to group A (8% v/s 36%; p=0.037).					

Values are expressed as frequency and percentage. The p-value is by Fischer's exact test. The incidence of collapsed vein was significantly lower in group B as compared to group A (8% v/s 36%; $p=0.037$).

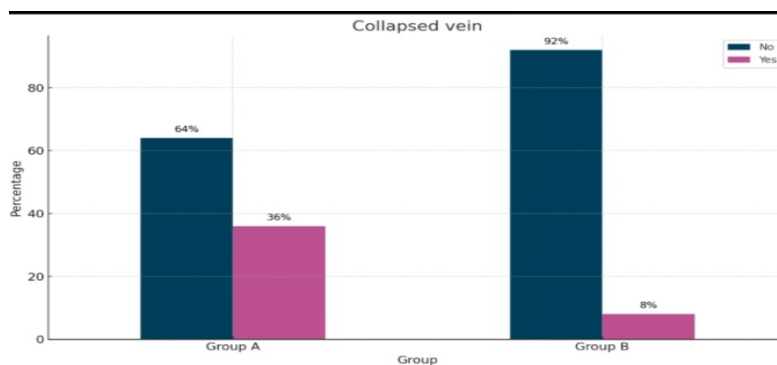


Figure 4: Comparison of the collapsed vein in both the groups

The comparison of the collapsibility of vein after cannulation in both the Right IJV and Right BCV groups is presented in Table 4.

The data reveals that incidence of collapsed vein in the Right IJV group was 36% and in the right BCV was 8%; i.e. higher in right IJV than right BCV cannulation.

The results revealed a statistically significant association (Fischer's exact test, $p=0.037$), indicating that the distribution of collapsibility of veins varied significantly between the groups.

Discussion

The comparative study of right internal jugular vein (IJV) cannulation and supraclavicular approach to right brachiocephalic vein (BCV) cannulation using ultrasound guidance (USG) provides valuable insights into the procedural efficacy, safety, and complications associated with each approach. The use of USG has revolutionized central venous access by enhancing the accuracy of cannulation and reducing the risk of complications traditionally associated with blind techniques [5]. The primary findings of this study indicated that the right BCV cannulation was associated with a higher success rate, fewer complications, and shorter procedure time compared to the right IJV cannulation. These results are consistent with the anatomical advantages of the right BCV, which is typically larger, more superficial, and straighter path to the superior vena cava compared to the right IJV [6].

Primary Objective:

Duration of cannulation: Our study indicated that the average time taken for the procedure was significantly less for the BCV group compared to the IJV group (98.08 ± 94.73 seconds vs. 182.68 ± 150.83 seconds; $p=0.022$). Gowda et al.[8] in 2022 found that the total time for cannulation was longer for group IJV than for group BCV (309.18 ± 87.09 seconds vs. 277.54 ± 116.96 seconds), although this difference lacked statistical significance. Aydin et al.[9] in 2021 also reported no significant difference in cannulation times between the two groups. They noted that the average ease of cannulation score was similar for both BCV and IJV groups (8.78 ± 1.13 vs. 8.67 ± 1.23). We concluded that BCV has several advantages over IJV for cannulation, including larger lumen size, better visibility with ultrasound, and the fact that it does not cross paths with the carotid and brachiocephalic arteries.

Secondary Objectives:

First attempt success rate: Our examination demonstrated that the BCV group achieved successful cannulation on the first attempt in 80% of cases, whereas the IJV had a success rate of

36%. The number of attempts was notably lower in the BCV group in comparison to the IJV group ($p=0.0219$), with percentages of first attempts being 80% vs. 36%, second attempts 8% vs. 28%, third attempts 12% vs. 20%, and fourth and fifth attempts being 0% vs. 8%. The first attempt success rate reported by Gowda et al.[8] in 2022 was 81.81% (45 out of 55) in the BCV group and 76.36% (42 out of 55) in the IJV group, which was not statistically significant.

Complications: Our research identified complications such as arterial puncture, catheter misplacement, and hematoma formation, with their occurrence being lower in group B than in group A, achieving a significance level of p less than 0.001 in catheter misplacement and hematoma formation but in arterial puncture we did not get statistically significant ($p=0.5$) result. A study by Ali et al.[10] in 2024 showed a comparable rate of adverse events like pneumothorax and hemothorax between IJV and SCV groups, noting that arterial punctures were equally present in both groups, while hematomas were more common in the IJV group. This could be attributed to small hematomas in the SCV being concealed by nearby bony structures like the clavicle and first rib. This observation aligns with research conducted by Karpanen et al.[11] in 2019. Earlier reviews suggested that procedures using SCV tend to have a higher incidence of pneumothorax and hemothorax. Additionally, Riaz et al.[12] in 2015 and Tempe et al.[13] in 2013 found that carotid artery punctures happened more frequently when employing the anatomical landmark technique compared to ultrasound guided methods. However, Babu et al.[14] in 2014 noted that utilizing real-time ultrasound guidance for IJV cannulation decreases the risk of carotid artery punctures but does not completely eliminate them.

Our study revealed several notable differences between right IJV and right BCV cannulation. The success rate of first-attempt cannulation was higher for the right BCV compared to the right IJV. This aligns with existing literature suggesting that the right BCV's anatomical positioning makes it a more favorable target. Additionally, the mean time to successful cannulation was significantly shorter on the right BCV cannulation. These findings underscore the advantage of choosing the right BCV for central venous access, particularly in time-sensitive situations. Our analysis of complications revealed a higher incidence of arterial puncture, catheter misplacement and hematoma on the right IJV cannulation.

The proximity of the right IJV to the carotid artery increases the risk of inadvertent arterial puncture. This is a critical consideration, as arterial puncture can lead to significant morbidity. Hematoma

formation was also more common on right IJV cannulation, likely due to the same anatomical challenges. The clinical implications of these findings are significant for practice in critical care and emergency medicine. The preferential use of the right BCV for USG-guided cannulation could improve patient outcomes by reducing the likelihood of complications and enhancing the efficiency of central venous access. Training programs should emphasize the anatomical differences and potential challenges associated with vein cannulation. The duration of cannulation, measured in seconds, is a critical factor in evaluating the efficiency and success of vascular access procedures.

This discussion compares the duration of cannulation between two groups, examines the implications of the findings, and contrasts these results with those reported in various studies. In our study, we compared the duration of cannulation between two groups. The results indicated a significant difference in cannulation times between the two groups, with ultrasound guidance in right BCV demonstrating a shorter duration of cannulation compared to the right IJV. Miller et al conducted a study comparing the duration of cannulation using ultrasound guidance versus the traditional landmark technique. Their findings showed that ultrasound guidance significantly reduced the time required for successful cannulation. Our study aligns with these results, reinforcing the advantage of ultrasound guidance in decreasing cannulation time and enhancing procedural efficiency.

The number of attempts required to achieve successful cannulation is a critical metric in assessing the efficiency and effectiveness of vascular access techniques. This discussion compares the number of attempts between two groups, explores the implications of these findings, and contrasts our results with those reported in various studies.

The results indicated a significant difference in the number of attempts between the two groups, with ultrasound guidance showing a lower number of attempts in right BCV than the right IJV. Gowda et al conducted a study comparing the success rate and number of attempts required for cannulation using ultrasound guidance in both vein cannulation process. Their findings demonstrated that ultrasound guidance significantly reduced the number of attempts needed to achieve successful cannulation.

Our study aligns with these results, reinforcing the advantage of ultrasound guidance in improving first-attempt success rates. Turker et al focused on the impact of operator experience on the number of attempts required for successful cannulation. Their

study found that both novice and experienced operators required fewer attempts when using ultrasound guidance compared to the traditional landmark method. Our findings support this, suggesting that ultrasound guidance can be beneficial for clinicians with varying levels of experience by reducing the number of attempts needed for successful cannulation.

Conclusion

The comparative study of right internal jugular vein cannulation and supraclavicular approach to right brachiocephalic vein cannulation using ultrasound guidance reveals important insights into the efficacy and safety of each approach.

The findings suggest that under ultrasound guidance, cannulation of the Right Brachiocephalic Vein (BCV) demonstrated superior performance characterized by higher first attempt success rates, faster procedural times, enhanced anatomical visualisation, fewer attempts, and a lower incidence of complications, suggesting that right BCV cannulation is the preferred approach and can be an alternative to right IJV cannulation for achieving central venous access in clinical practice

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