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Original Research Paper

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"COMPARE THE PRECISION BETWEEN THE LONG AXIS AND SHORT AXIS APPROACH FOR ULTRASOUND GUIDED RIGHT INTERNAL JUGULAR VEIN VASCULAR CATHETERIZATION IN INTENSIVE CARE UNIT"

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ABSTRACT

Background: Central venous catheterization is a critical procedure frequently performed in intensive care units (ICU) for patients requiring hemodynamic monitoring, medication administration, or hemodialysis access. USG - guidance has been shown to improve the success rate and reduce complications during IJV catheterization. Two primary approaches for ultrasound-guided IJV cannulation are the long axis and short axis approaches. **Aim:** To compare the precision between the long axis and short axis approach for ultrasound guided right internal jugular vein vascular catheterization in intensive care unit **Methodology:** This observational study included 102 ICU patients who required right IJV catheterization. Randomly patients were assigned for short and long axis approach. Primary outcomes measured were Cannulation attempt, cannulation time,. Secondary outcomes included the incidence of complication(atleast one) & need for change of technique. **Results** : Of the 102 subjects, 51 were assigned to the LA and 51 to the SA approach, in terms of cannulation time (p value 0.0575) & attempt (pvalue <0.0001) SA approach showed better results compared to LA approach. Also fewer complication rate in SA group (p value 0.0655) than LA group **Conclusion :** The results of this study indicate that the short axis view approach is more effective than the long axis view for internal jugular vein cannulation using ultrasound guidance. It notably achieves a higher first-attempt success rate, requires fewer needle attempts, lesser time consumption and complication.

KEYWORDS : Usg , ijv cannulation, CVP, SA-OOP, LA-IP, Ultrasound guided intervention, First pass success rate, complications, short axis.

INTRODUCTION

Central venous catheter (CVC) cannulation is routinely used in perioperative and intensive care settings. An ideal technique of CVC cannulation should be easy, safe, and efficient with no or fewer complications [1]. There are two methods of cvc cannulation, one is landmark technique and another is usg guided approach for internal jugular vein cannulation. Traditionally, anatomical surface landmark-guided technique has been used for internal jugular vein cannulation. This approach has many complications like bleeding, hematoma, arterial puncture, and pneumothorax [2]. The use of ultrasound in clinical practice enhances the quick, safe and reliable guidance for needle placement into the internal jugular vein, in elective routine and difficult cases. Practice of using surface anatomy and palpation to identify target vessels before cannulation attempts (landmark technique) is based on the presumed location of the vessel, the identification of surface or skin anatomical landmarks, and blind insertion of the needle until blood is aspirated. Confirmation of successful cannulation of the intended vascular structure relies on blood aspiration of a certain character and color (lack of pulsation and dark color when cannulating a vein or pulsation and a bright red color when cannulating an artery), pressure measurement with a fluid column or pressure transducer, or observation of the intraluminal pressure waveform on a monitor [1]. The internal jugular vein (IJV) is often favored due to its anatomy, and its diameter is also increased in the Trendelenburg position [1]. As per recent guidelines, ultrasound (US) should be utilized to direct the CVC insertion whenever possible to minimize complications. Multiple studies have demonstrated that the US guided technique improves success rate and decrease complication rate of internal jugular vein catheterization [3]. However, there is a controversy regarding which approach is preferable for the ultrasound probe, ie, the short-axis approach or the long-axis approach. Each approach has distinct advantages and disadvantages that may either increase or decrease complications. In the short axis approach, the relationships of the target vessel to the adjacent vessels are visualized, but the needle tip may not be continuously visualized during catheter placement. In the Long axis approach, the needle path including the tip can be continuously visualized during catheterization; however, the relationship of the target vessel to adjacent vessels may be lost.[4]

Methodology

This was a Observational type of study that was conducted in the Intensive care unit of Santosh medical college and hospital, Ghaziabad, U.P over a period of one year from July 2023 to August 2024 . After Ethics Committee approval from our institution ethics committee (F.No.SU/R/2023/2489[6]) & CTRI (REF/2025/03/102792), 102 patients admitted to ICU of Santosh Medical College, Ghaziabad and requiring Central venous catheterization, were included in this observational type of study. After obtaining written consent from the patients or their relatives , all 102 patients were divided into 2 groups according to the random number generated by the computer, group A patients were cannulated by short axis approach , whereas group B were cannulated by long axis . We used an ultrasound machine (Siemens ACUSON) with a high-frequency linear array transducer (5.0-13.0 MHz), as the IJV is a superficial structure. Each patient's IJV was scanned prior to the procedure to ensure its suitability for cannulation. Real-time USG guidance was then used to perform the IJV cannulation in a sterile environment.

Inclusion Criteria :- All critially ill adult individual requiring central line catheterization in Intensive Care Unit within the study period.

Exclusion Criteria: Non cooperative patients.

Materials Required:
Ultrasound machine, linear probe , Central line set , Sterile drapes, Sterile jelly , Local anaesthesia 2% lignocaine, tegaderm dressing

Short-Axis Ultrasound-Guided Internal Jugular Vein Cannulation

1. **Patient Positioning:** The patient is positioned supine with the head turned to the opposite side to distend the IJV.
2. **Ultrasound Probe Placement:** A high-frequency linear transducer (5.0-13.0 MHz) is placed transversely at the clavicle or cricoid cartilage level to provide a short-axis view of the IJV and common carotid artery (CCA).
3. **Identification of Structures:** The IJV appears as an anechoic circle, and the CCA as a pulsatile, hypoechoic structure. The IJV is compressible, while the CCA is non-compressible.
4. **Needle Insertion:** The needle is inserted using the "out-of-plane" technique, directed towards the center of the IJV, with real-time monitoring on the ultrasound screen.
5. **Real-Time Visualization:** The needle is guided carefully to avoid surrounding structures (e.g., CCA), ensuring proper placement within the IJV.
6. **Cannulation:** Once the needle tip is within the IJV, a guidewire is inserted, and the needle is removed, leaving the guidewire in place.
7. **Catheter Insertion:** The catheter is threaded over the guidewire, confirmed with ultrasound, and secured.
8. **Post-Procedure Monitoring:** Vital signs are monitored for complications, and a chest radiograph is taken to confirm catheter placement. A sterile dressing is applied, and data is recorded for analysis.

Long-Axis Ultrasound-Guided Internal Jugular Vein Cannulation: Brief Overview

1. **Preparation And Positioning:** The patient is placed supine with the head slightly turned away and the neck extended to expose the IJV.
2. **Ultrasound Setup:** A high-frequency linear probe (7-12 MHz) is used to visualize the IJV, carotid artery, and surrounding tissues. Gain and depth settings are adjusted for clear imaging.
3. **Ultrasound Imaging:** The probe is placed longitudinally along the neck, typically at the junction of the clavicle and sternocleidomastoid muscle. The IJV appears as an elongated, tubular structure, allowing clear visualization of the needle path.
4. **Needle Insertion:** The needle is introduced at a shallow angle (30-45 degrees) in alignment with the ultrasound beam. Real-time ultrasound monitoring ensures the needle path is accurate and avoids surrounding structures.
5. **Confirmation Of Vein Entry:** Upon entering the IJV, a flash of blood confirms venous access. A guidewire is then inserted through the needle, with real-time ultrasound ensuring correct placement.
6. **Final Steps:** After confirming guidewire placement, the needle is removed, and the catheter is inserted over the guidewire, with ultrasound guidance for accurate positioning. The guidewire is withdrawn, and the catheter is secured.
7. **Post-Procedure Monitoring:** The patient's vital signs are monitored for complications, and a chest radiograph is taken to confirm catheter placement. A sterile dressing is applied to secure the catheter.

Observations And Results

Table 1: Cannulation Time (In Mins)

	Short axis(mean±SD)	Long axis (mean±SD)	p-value
Cannulation time (in mins)	7.14±1.18	7.57±1.08	0.0575

The table and chart below provide a detailed representation of the cannulation time SA vs LA views in ICU

The dataset provided in the table and chart compares the mean cannulation times between two groups: the SA group and the LA group. For the SA group, the mean cannulation time was found to be 7.14±1.18 minutes, while for the LA group, it was slightly higher at 7.57±1.08 minutes.

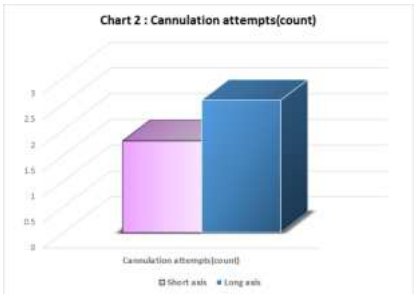
This suggests that, on average, the cannulation procedure took less time in the SA group compared to the LA group. When we conducted a statistical comparison between these two values, we obtained a p-value of 0.0575, it is still considered to be approaching significance. This indicates that, although the difference is not statistically significant at the 0.05 level, there is a trend suggesting that the SA group had a shorter cannulation time compared to the LA group.

Table 2 : Cannulation Attempts (Count)

	Short axis(mean±SD)	Long axis(mean±SD)	p-value
Cannulation attempts(count)	1.78±0.81	2.57±0.70	**<0.0001***

*Significant Value

The table and chart below provide a detailed representation of the cannulation attempts SA vs LA views in ICU



The table and chart above present the mean number of cannulation attempts for both the SA and LA groups. In the SA group, the mean number of attempts was 1.78±0.81, while in the LA group, it was higher at 2.57±0.70. A comparison of the two groups revealed that the number of attempts required for internal jugular vein (IJV) cannulation Was considerably lower in the SA group than in the LA group.

To evaluate the statistical significance of this difference, we performed a statistical analysis on the data. The results yielded a p-value of <0.0001, which is well below the conventional threshold of 0.05, indicating that the observed difference between the two groups is statistically significant. The analysis strongly suggests that the SA group required fewer attempts for successful IJV cannulation compared to the LA group, and this difference is statistically significant. This finding implies that the SA group demonstrated greater efficiency in the cannulation process.

Table 5 : Techinique Change

Group	No change	Technique change	p-value
Short axis	43	8	0.227
Long axis	37	14	

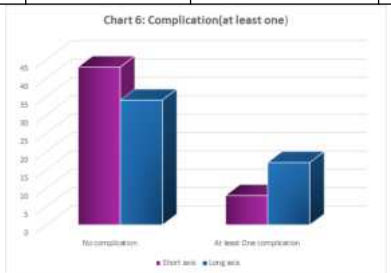
The table and chart below provide a detailed representation of the number of patients requiring change of technique from SA to LA and vice versa.

The dataset in table and chart presented above illustrate the distribution of study subjects based on the need to switch techniques between LA and SA. In the SA group, 8 patients required a change in technique, while 43 didn't. In contrast, in the LA group, 14 patients required a change in technique, and 37 patients didn't required any change.

When comparing these results, it was observed that the SA group had fewer instances where a change in technique was required compared to the LA group. However, When a Chi-square test was conducted to assess the statistical significance of this difference , the resulting p-value was 0.227 , indicating that the observed difference is not statistically significant. although the SA group required fewer changes in technique compared to the LA group, the difference is not statistically significant based on the Chi-square test.

Table 6 : Complication (At Least One)

	No complication	At least One complication	p value
Group			
Short axis	43	8	0.0655
Long axis	34	17	



The table and graph below offer a comprehensive depiction of the number of patients who experienced any complication (hematoma, arterial puncture, pneumothorax)

The table and chart above show the distribution of study subjects based on the occurrence of complication(at least one). In the SA group, 8 patients experienced complications, while 43 patients did not. In the LA group, 17 patients had complication, and 34 patients did not.

Upon comparing the two groups, it was observed that a slightly higher number of complication(at least one), in SA group 8 and LA group 17.

To assess whether this difference is statistically significant, a Chi-square test was performed on the data. The resulting p-value was 0.0655, which is above the commonly accepted threshold of 0.05 for statistical significance. However, the p-value is relatively close to 0.05, indicating that the observed difference between the groups is approaching statistical significance. While the difference in the occurrence of complications between the two groups was not statistically significant, it was worth noting that the SA group showed a slightly higher number of patients without complication than the LA group.

DISCUSSION

This study was conducted with the aim to compare the precision between the long axis and short axis approach for usg-guided right internal jugular vein vascular catheterization in intensive care unit (ICU).

The Primary objective included assessment of cannulation time and number of cannulation attempts using SA vs LA views in intensive care unit. And the Secondary objective included identifying the number of patients requiring change of technique from short axis to long axis and vice versa, and also associated complication(at least one) associated with Long Axis Vs Short Axis. This observational, hospital-based cross sectional study was conducted in Intensive care unit of Santosh Medical College and Hospital over a span of 1year. The study population included all critially ill adult individual requiring central line catheterization in ICU.

In This Study We Compared 2 Groups : Short axis group and Long axis group, each with 51 participants. The analysis focused on demographic distribution including age and gender distribution

The median age of participants in the SA group was 55 years, while the median age in the LA group was slightly lower at 50 years. In terms of age range, the youngest patient in the SA group was 25 years old, while in the LA group, the youngest patient was 20 years old. Both groups had a maximum age of 85 years, indicating that the oldest participant in each group was 85 years old. This distribution highlights the age diversity within both groups, with a broad range of ages spanning from younger adults to older individuals.

Similarly, The gender distribution of study subjects revealed that a higher number of males compared to females in both groups, with males making up a larger proportion of participants overall. Our Finding aligns with the study by Chittoodan et al. (5) conducted a study on 99 patients undergoing cardiac surgery requiring central venous cannulation. The patients were randomized to undergo either long or short-axis ultrasound-guided cannulation of the right internal jugular vein, performed by an experienced anaesthetist. The study revealed a higher proportion of males in both the short-axis and long-axis groups.

However, gender may not considered a major factor influencing the precision of catheterization procedures. Male

patients are generally more likely to have larger vessel diameters, which might theoretically facilitate easier access.

An important aspect of the study was comparing cannulation times between the two approaches. The mean cannulation times for the two groups, SA and LA, were compared. In the SA group, the mean cannulation time was 7.14 ± 1.18 minutes, while in the LA group, it was slightly higher at 7.57 ± 1.08 minutes. A statistical comparison of these values yielded a p-value of 0.0575, which is considered approaching significance. This implies that, although the difference in cannulation times between the two groups was not statistically significant, there is a noticeable trend indicating that the SA group may have had a shorter cannulation time than the LA group. This trend could hold clinical relevance, however, additional research with a larger sample size is necessary to determine whether this difference is statistically significant.

In a comparable study by Blavias et al. (16), the average time for vein cannulation was 2.36 minutes (95% CI = 1.15 to 3.58) for the short-axis (SA) approach and 5.02 minutes (95% CI = 2.90 to 7.13) for the long-axis (LA) approach, with a p-value of 0.03.

In addition, the study by Chittoodan et al. (5) demonstrated that the time to confirm the guidewire placement was 39.6 ± 18.4 seconds for the short-axis approach and 46.9 ± 42.4 seconds for the long-axis approach, with no notable difference in cannulation time between the two techniques.

Another important objective of our study was the Cannulation attempts .The mean number of cannulation attempts(counts) required for successful internal jugular vein (IJV) cannulation was compared between the SA and LA groups. In the SA group, the mean number of attempts was 1.78 ± 0.81, while in the LA group, it was higher at 2.57 ± 0.70. This difference in the number of attempts was statistically significant, with a p-value of <0.0001, the results clearly demonstrate that the SA group required significantly fewer attempts to successfully cannulate the IJV compared to the LA group. This finding highlights the greater efficiency of the SA group in the cannulation process. The statistical significance of this difference suggests that, in terms of technical proficiency, the SA approach may offer a more effective and streamlined procedure for IJV cannulation, potentially leading to quicker patient outcomes and reduced procedural complications.

Results shown by study by Lal et al. (7) echo our study's findings where they reported 32 (88%) patients in short axis achieved cannulation in first attempt while 28 (77%) patients in long axis and it was not statistically significant.

The results were consistent with the findings of Privitera D et al. (8), who conducted a randomized controlled trial on 283 patients with difficult vascular access. In this study, ultrasound-guided catheter insertion was performed using either the short-axis (oop) or long-axis(in plane) approach, with follow-up for up to 96 hours. The study found that the success rate was marginally higher in the short-axis group, though the difference was not statistically significant with a p value of 0.126

In a similar study, Batllori et al. (9) performed a prospective randomized clinical trial at a teaching hospital with 220 patients undergoing usg - assisted IJV cannulation. The patients were randomly assigned to one of three groups: SA, LA, and oblique axis. The results showed a higher first-pass success rate in the SA group compared to the LA group, with the difference being statistically significant (P = 0.005).

In a similar study, Chittoodan et al. (5) compared the SA and LA techniques for ultrasound-guided internal jugular vein cannulation in 99 patients. The first-pass success rate was greater in the short-axis group (98%) than in the long-axis group (78%), with the difference being statistically significant (P < 0.006).

Tammam et al. (10) and Shresta et al. (6) also evaluated the SA and LA approaches for ultrasound-guided IJV cannulation, finding that both groups had the same success rate of 100%.

We have also analysed the change of technique from long to short or vice versa. The comparison between the groups revealed that the SA group required fewer instances of switching techniques during the procedure compared to the LA group. However, when a Chi-square test was conducted to assess the statistical significance of this difference, the resulting p-value was 0.227. Although the SA group demonstrated a trend towards fewer technique switches, the difference did not reach statistical significance, suggesting that the reduced need for technique changes in the SA group may not be robust enough to be considered a significant factor in the overall effectiveness of the procedure. . We were unable to find other study which has taken this variable. This variable may be found useful.

Preventing complications is just as crucial as achieving successful cannulation.

In our study we found that in the SA group, 8 patients experienced complication(at least one), while 43 did not. In the LA group, 17 patients had complication(at least one), and 34 did not. Upon comparing the two groups, it was noted that a slightly higher number of patients in the SA group (8 patients) experience any complication compared to the LA group, where 17 patients had complication(at least one). To determine this difference statistically significant, a Chi-square test was conducted, yielding a p-value of 0.0655. This p-value is relatively close to 0.05, suggesting that the difference is approaching statistical significance.

While the difference in complication rates between the two groups was not statistically significant, it is noteworthy that the SA group had a slightly higher proportion of patients without complications compared to the LA group. This trend, though not statistically significant, may indicate a potential benefit of the SA technique in reducing complications.

The results were also consistent with the study by Chittoodan et al. (5), in which 99 patients were randomized to participate in ultrasound-guided cannulation of the right internal jugular vein using either the long-axis or short-axis approach, performed by a skilled anaesthetist.. Although no statistical significance was found, a clear trend showed a higher incidence of carotid artery puncture with the long-axis approach (4%) compared to the short-axis approach (0%). This may be due to the greater hand-eye coordination and probe alignment required for the long-axis technique.

In their study on central venous cannulation of 60 patients undergoing surgery, Patel P et al. (11)found that the rate of carotid artery puncture was approximately 10% with the long-axis approach, compared to 0% with the short-axis approach. However, the difference between the two groups was not statistically significant. The higher carotid artery puncture rate in the long-axis approach may be due to the greater hand-eye coordination required for internal jugular vein cannulation, making it more prone to errors than the short-axis approach.

Vezzani, A et al. (12) conducted a study on 190 patients who required central venous cannulation after cardiac surgery, carried out by anesthesiologists with a minimum of 3 years' experience in ultrasound-guided central vein cannulation. The study found a complication rate of 3% in the short-axis group, compared to 13% in the long-axis group, although the

difference was not statistically significant (p = 0.028).

In a study by Quan Z et al. (13), 164 patients scheduled for liver surgery were randomly divided into two groups: one group used modified SA (out-of-plane), while the other used LA (in-plane) under ultrasound assistance. The findings revealed a slightly lower incidence of hematoma in the modified SA group, with rates of 15% compared to 18% in the long axis group.

In contrast to our findings, a prospective randomized trial by Berk et al. (14) involving 108 patients, planned for elective surgery under general anesthesia in 2013, showed a significantly lower incidence of hematoma formation in the long-axis group (20%) compared to the short-axis group (56%). This difference can be attributed to the better visibility of the needle tip and shaft in relation to the artery when using the long-axis approach.

Rath A et al. (15), in their randomized trial of 100 patients requiring central venous cannulation in the ICU, they found a significantly reduced rate of complications with the long-axis approach.

However, it appears that both approaches were equally effective in terms of the number of needle passes, reinforcing the notion that operator skill and experience may play a more significant role in determining the outcome than the choice of approach itself.

CONCLUSION

This study aimed to compare the accuracy of two techniques—long axis and short axis approaches—for usg - directed vascular catheterization of the right internal jugular vein (IJV) in the intensive care unit (ICU). After a thorough analysis, the results show that the short axis approach is superior to the long axis method when it comes to precision, ease of use, and a reduced risk of complications. These findings bolster the idea that the short axis approach could be a safer and more effective option for this vital procedure, especially for critically ill patients in the ICU.

The short axis approach comes with a bunch of key advantages that really enhance its precision. One of the standout benefits is that it gives a cross-sectional view of the internal jugular vein (IJV), making it much easier for clinicians to see the vein's edges and align the needle correctly during insertion. This method simplifies the process of pinpointing the target vein, which helps avoid straying off course and ensures that the catheter is placed accurately. With the short axis view, clinicians can have better control over the needle's path, which significantly lowers the risk of accidentally puncturing an artery—a common issue with other techniques, especially the long axis approach.

Moreover, the short axis approach proves to be particularly useful for certain patient groups, especially those with tricky anatomy or tough vascular access. For ICU patients, who might have altered anatomy due to trauma, infections, or past surgeries, this approach offers clearer visualization of the anatomical structures, making it easier to guide the needle safely to the right spot. It also tends to lead to fewer complications, like needle bending, vessel perforation, or accidentally hitting nearby structures, which can happen when using the long axis method in challenging cases. This ultimately results in a lower chance of procedural failures and cuts down on complications like hematomas, pneumothorax, and bleeding.

The short axis approach really helps to ease the learning curve for ultrasound-guided vascular catheterization. By providing a cross-sectional view, it makes it much easier for operators—especially those who might not have a lot of experience with ultrasound—to align the needle with the vein. This simplicity is a big plus in busy ICU environments, where every second counts and making quick, precise decisions is crucial for keeping patients safe.

On the other hand, the long axis approach, which is often the preferred approach, tends to be trickier when it comes to precision. The longitudinal view demands careful needle alignment and frequent adjustments to stay on target with the vein. This method also carries a higher risk of complications, like accidentally puncturing an artery or misdirecting the needle, especially in patients who have challenging access or unusual anatomy. Plus, the longer and more complicated steps involved in the long axis technique can lead to extended catheterization times, which might increase patient discomfort, the chance of procedural complications, and even the risk of infection.

In summary , this study suggests that the short axis approach may offer advantages in terms of cannulation success rate, shorter cannulation time, and a trend toward fewer complications, although further research with larger sample sizes and more controlled variables is necessary to confirm these findings. These findings pave the way for future studies to explore the potential of the SA approach as the preferred technique for ultrasound-guided central venous catheterization in critically ill patients.

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