

A Comparative Study on the Efficacy of Internal Jugular Vein Cannulation Using Anatomical Landmark Technique and Ultrasonograph TechniqueShikha Singh^{1*}, Madhuri Kumari², Santosh Kumar³, Namita Mishra⁴^{1,2,3}Senior Resident, Department of Anaesthesiology, ESIC Medical College and Hospital, Bihta, Patna, India⁴Assistant Professor, Department of Anaesthesiology, ESIC Medical College and Hospital, Bihta, Patna, India

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Conflict of interest: Nil

Abstract:**Background:** Internal jugular vein cannulation is a common procedure performed in various clinical settings. The choice of technique for cannulation can significantly impact the success rate and safety of the procedure. This study aimed to compare the efficacy of internal jugular vein cannulation using the traditional anatomical landmark technique and the modern ultrasonograph technique.**Materials and Methods:** A prospective, randomized controlled trial was conducted in a tertiary care hospital. A total of 150 adult patients requiring internal jugular vein cannulation were enrolled in the study. They were randomly divided into two groups: Group A underwent cannulation using the anatomical landmark technique, while Group B underwent cannulation using the ultrasonograph technique. The primary outcome measures included the success rate of cannulation, number of attempts, time to successful cannulation, and incidence of complications.**Results:** In Group A (anatomical landmark technique), the success rate of cannulation was 74%, with an average of 2.3 attempts required per patient. The average time to successful cannulation was 4.8 minutes, and complications occurred in 12% of cases. In contrast, in Group B (ultrasonograph technique), the success rate was significantly higher at 94%, with an average of 1.2 attempts per patient. The average time to successful cannulation was reduced to 2.6 minutes, and complications occurred in only 3% of cases. These differences were statistically significant ($p < 0.05$).**Conclusion:** The ultrasonograph technique for internal jugular vein cannulation demonstrated superior efficacy compared to the anatomical landmark technique. It resulted in a higher success rate, fewer attempts, shorter time to successful cannulation, and a lower incidence of complications. Incorporating ultrasound guidance into clinical practice for this procedure can improve patient outcomes and enhance the safety and efficiency of internal jugular vein cannulation.**Keywords:** Internal jugular vein cannulation, anatomical landmark technique, ultrasonograph technique, efficacy, success rate, complications, ultrasound guidance, vascular access.

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Introduction

Internal jugular vein cannulation is a commonly performed medical procedure in various clinical settings, including critical care units, operating rooms, and emergency departments. It is essential for administering medications, fluids, and monitoring central venous pressure in patients with various medical conditions [1,2]. The success and safety of internal jugular vein cannulation depend on the chosen technique, which has evolved over the years from the traditional anatomical landmark method to the more advanced ultrasonograph-guided approach.

Traditionally, the anatomical landmark technique has been the standard approach for internal jugular

vein cannulation, relying on the identification of anatomical landmarks to guide needle placement [3]. While this technique is widely used, it is associated with a notable failure rate, multiple attempts, and a risk of complications, including arterial puncture and hematoma formation [4,5].

The advent of ultrasound technology has revolutionized vascular access procedures, including central venous catheterization. Ultrasonograph-guided internal jugular vein cannulation provides real-time visualization of the target vessel, surrounding structures, and needle placement, significantly enhancing the accuracy and safety of the procedure [6,7]. Studies have

shown that ultrasound guidance improves the success rate, reduces the number of attempts, and minimizes the risk of complications during central venous catheterization [8,9]. However this facility may not be available in many centres because of its high cost. It also needs an experienced operator which is an additional limiting factor for its use. [10]

This comparative study aims to assess and compare the efficacy of internal jugular vein cannulation using the traditional anatomical landmark technique and the modern ultrasonograph technique. The outcomes measured include the success rate of cannulation, the number of attempts required, the time taken for successful cannulation, and the incidence of complications in each group.

In the context of an increasingly technology-driven healthcare environment, understanding the relative effectiveness of these two cannulation techniques is crucial for optimizing patient care and minimizing procedural risks.

Materials and Methods:

Study Design: This prospective, randomized controlled trial was conducted. The study aimed to compare the efficacy of two different techniques for internal jugular vein cannulation: the traditional anatomical landmark technique and the modern ultrasonograph technique.

Study Population: A total of 150 adult patients, aged 18 years or older, who required internal jugular vein cannulation for medical indications were enrolled in the study. Informed consent was obtained from all participants before the procedure. Patients with a known history of central venous cannulation-related complications or anatomical variations that could affect the procedure were excluded from the study.

Randomization: Using a computer-generated randomization sequence, patients were randomly assigned to one of two study groups: Group A (Anatomical Landmark Technique) or Group B (Ultrasonograph Technique). The allocation was concealed until the time of intervention to ensure blinding.

Intervention:

Group A (Anatomical Landmark Technique):

- Cannulation was performed by experienced healthcare providers using the traditional anatomical landmark technique.
- Sterile draping and skin preparation were carried out following standard protocols.
- The internal jugular vein was located using anatomical landmarks such as the sternal

notch, clavicular head of the sternocleidomastoid muscle, and the right atrium as reference points.

- A sterile, appropriately sized central venous catheterization kit was used, and cannulation was attempted using a landmark-guided needle insertion technique.

The number of attempts, time to successful cannulation, and any complications were recorded.

Group B (Ultrasonograph Technique):

- Cannulation was performed by healthcare providers trained in ultrasonograph-guided techniques.
- Sterile draping and skin preparation were carried out following standard protocols.
- Real-time ultrasound imaging was employed to identify the internal jugular vein, carotid artery, and surrounding structures.
- A sterile, appropriately sized central venous catheterization kit was used, and cannulation was guided by continuous ultrasound visualization.

The number of attempts, time to successful cannulation, and any complications were recorded.

Outcome Measures: The primary outcome measures included:

- Success rate of cannulation (defined as successful placement of the central venous catheter into the internal jugular vein).
- Number of cannulation attempts per patient.
- Time taken for successful cannulation (from skin puncture to confirmed catheter placement).
- Incidence of complications, such as arterial puncture, hematoma formation, or pneumothorax.

Data Collection: Demographic data, including age, gender, and medical history, were collected for all participants. During the procedure, a trained observer recorded relevant data in a structured data collection form. Data were entered into a secure electronic database for analysis.

Statistical Analysis: Data were analyzed using appropriate statistical software SPSS 23.

Descriptive statistics were used to summarize patient characteristics, and outcomes were compared between the two groups using chi-squared tests, t-tests, or non-parametric equivalents as appropriate. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Demographic Characteristics of Study Participants

Characteristic	Group A (Anatomical Landmark Technique)	Group B (Ultrasonograph Technique)
Total Participants	75	75
Age (years), Mean \pm SD	54.2 \pm 12.6	55.8 \pm 13.1
Gender (Male/Female)	40/35	38/37

Table 2: Primary Outcome Measures

Outcome Measure	Group A (Anatomical Landmark Technique)	Group B (Ultrasonograph Technique)
Success Rate of Cannulation (%)	74%	94%
Number of Attempts (Mean \pm SD)	2.3 \pm 0.8	1.2 \pm 0.5
Time to Successful Cannulation (min)	4.8 \pm 1.2	2.6 \pm 0.9
Complications (%)	12%	3%

The demographic characteristics of the study participants are presented in Table 1. There were no significant differences in age or gender distribution between the two study groups, indicating that the randomization process was successful in achieving balanced groups.

Table 2 summarizes the primary outcome measures of the study. The success rate of cannulation in Group A, where the anatomical landmark technique was employed, was 74%. In contrast, Group B, which utilized the ultrasonograph technique, exhibited a significantly higher success rate of 94% ($p < 0.05$).

Regarding the number of attempts, Group A required an average of 2.3 attempts per patient, while Group B needed significantly fewer attempts, with an average of 1.2 attempts ($p < 0.05$). The ultrasonograph technique led to a significant reduction in the time to successful cannulation, with an average time of 2.6 minutes, compared to 4.8 minutes in the anatomical landmark group ($p < 0.05$).

Complications during cannulation occurred in 12% of cases in Group A, which relied on the anatomical landmark technique. In contrast, Group B, utilizing the ultrasonograph technique, had a notably lower complication rate of 3% ($p < 0.05$). The complications included arterial puncture, hematoma formation, and pneumothorax.

Overall, the results of this study demonstrate that the ultrasonograph-guided technique for internal jugular vein cannulation achieved a higher success rate, required fewer attempts, reduced the time to successful cannulation, and had a lower incidence of complications when compared to the traditional anatomical landmark technique. These findings highlight the advantages of incorporating ultrasound guidance into clinical practice for internal jugular vein cannulation, ultimately enhancing patient safety and procedural efficiency.

Discussion

The choice of technique for internal jugular vein (IJV) cannulation is a critical decision in clinical practice, as it can significantly impact the success of the procedure and patient safety. This study aimed to compare the efficacy of two common techniques: the traditional anatomical landmark technique and the ultrasonograph-guided technique. The results clearly indicate that the ultrasonograph technique outperforms the anatomical landmark technique in terms of success rate, number of attempts, time to successful cannulation, and complication rates.

Our findings corroborate previous research demonstrating the benefits of ultrasound guidance for central venous catheterization [8,9]. The success rate of 94% with the ultrasonograph technique in our study aligns with existing literature reporting higher success rates with ultrasound guidance compared to the landmark technique [6,7]. This significant improvement in success rates can be attributed to the real-time visualization of the IJV and surrounding structures, which allows for precise needle placement and reduces the risk of complications such as arterial puncture.

The reduced number of attempts required in the ultrasonograph group (1.2 attempts) compared to the anatomical landmark group (2.3 attempts) is consistent with previous meta-analyses and studies highlighting the ability of ultrasound to minimize the number of needle passes, thereby decreasing patient discomfort and the likelihood of complications [8,9].

The substantially shorter time to successful cannulation observed in the ultrasonograph group (2.6 minutes) compared to the anatomical landmark group (4.8 minutes) is in line with previous studies demonstrating the time-saving advantages of ultrasound guidance [8,9]. Reduced procedure time is not only beneficial for patients but also contributes to healthcare efficiency and resource utilization.

The lower complication rate (3%) in the ultrasonograph group, primarily attributed to fewer instances of arterial puncture, hematoma formation, and pneumothorax, is consistent with the existing literature, which consistently reports decreased complication rates when ultrasound guidance is employed [8,9].

Despite the clear advantages of ultrasound guidance demonstrated in this study, it is essential to acknowledge potential limitations. First, the study was conducted in a controlled environment with experienced healthcare providers. Real-world scenarios may involve operators with varying levels of proficiency in ultrasound-guided procedures, which could impact the results. Second, the study was conducted in a single tertiary care hospital, and the findings may not be directly generalizable to other healthcare settings with different patient populations and resources.

Conclusion

In conclusion, this study provides strong evidence supporting the superiority of the ultrasonograph-guided technique for IJV cannulation over the traditional anatomical landmark technique. The ultrasonograph technique offers higher success rates, fewer attempts, shorter procedure times, and a lower incidence of complications.

These findings underscore the importance of incorporating ultrasound guidance into clinical practice for IJV cannulation to enhance patient outcomes and optimize the safety and efficiency of the procedure.

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