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Original Research Article

Comparative Study between Ultrasound Guidance and Anatomical Landmark Technique for Internal Jugular Vein Cannulation in Adult Patients

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Conflict of interest: Nil

Abstract:

Background: The study compares landmark vs ultrasound-guided internal jugular vein cannulation in elective surgery and ICU patients, evaluating success rates, access time, attempts, and complications.

Materials and Methods: After Institutional Review Board approval, this Prospective randomized study (n=60, ASA I–IV) comparing US-guided vs landmark IJV cannulation. Anterior approach (AL) vs short-axis out-of-plane (US); Seldinger technique used in both. Placement confirmed by chest X-ray (PA view).

Result: Overall success is similar for both techniques, but ultrasound guidance improves first-pass success, reduces attempts, shortens access time, and lowers mechanical complications.

Conclusion: Ultrasound-guided IJV cannulation improves success, reduces time, attempts, and complications, and is preferred in high-risk or difficult access cases.

Keywords: Internal jugular vein cannulation, Anatomical Landmarks, Seldinger Technique, Ultrasound Guidance, Intensive care units.

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Introduction

Central venous access is the placement of a catheter in a major vein for monitoring, drug/fluid administration, hemodialysis, pacing, and rapid resuscitation, especially when peripheral access is inadequate. [1]

Landmark-guided CVC insertion is a traditional method but carries risks such as bleeding, arterial injury, pneumothorax, arrhythmias, failed access, and catheter malposition. [1,3]

Ultrasound-guided CVC (introduced in 1978) improves success rates and reduces attempts and procedure time, but its use is limited by cost, equipment availability, and need for trained staff. [4,5]

The purpose of our study was to compare the traditional anatomical landmark technique with an ultrasound guidance technique for cannulation of the IJV.

Materials and Methods

After Institutional Review Board approval, this prospective, randomized observational study was conducted in 60 adult patients aged ≥18 years having ASA physical status I, II, III, or IV, who underwent elective major surgeries and patients admitted in intensive care unit requiring central venous access. The patients were randomly assigned to two groups on an one is to one ratio randomly.

a) Ultrasound guided technique (US group)
b) Anatomical Landmark technique (AL group)

Exclusion Criteria

- Patients who do not give consent
- Skin infection at insertion site
- Altered coagulation profile (platelet count<50,000 per cu mm; INR > 1.5)
- Patients with known bleeding disorders
- Prior IJV catheterization
- Subcutaneous emphysema
- Patients underwent radiation therapy

Pre-anaesthetic Assessment: All the patients

underwent a thorough pre anaesthetic check-up. Local part was examined and written informed consent was taken from all patients. For mechanically ventilated/sedated ICU patients, written informed con-sent was taken from patients relative.

Preparation: On the arrival in the operation theatre or ICU, all the standard monitors (electrocardiogram, non-invasive blood pressure and pulse-oximetry) were attached to the patient and baseline vitals were noted. A peripheral venous line was secured with 18 or 20 G intravenous cannula and intravenous fluid started.

Equipments Prepared: A portable sterile tray containing:

- Disposable syringes of 5,10 ml.
- Disposable 23G 1.5-inch block needle
- Povidone iodine, spirit and normal saline solutions
- Sponge holding forceps
- Sterile towel and towel clip
- Drug injection Lignocaine 2% 5 ml
- Four lumens central venous catheter 8fr 15 cm
- Tegaderm
- Needle holding forceps
- Artery forceps
- Ethilon 2-0 suture

Emergency resuscitation equipment was prepared, and the ultrasound machine with its linear probe was cleaned and aseptically ready for use.

Position for IJV Cannulation: The patient's position for internal jugular vein (IJV) cannulation was identical for both landmark-guided and ultrasound-guided techniques. A ring under the head and a shoulder sandbag were used to enhance landmark visibility. Patients were placed supine in a 15–20° Trendelenburg position to distend the vein and reduce air embolism risk. The head was slightly turned 45° to the left to expose the IJV without overlapping the carotid artery. The operator's position during ultrasound-guided insertion ensured a clear line of sight to the insertion site, needle, and ultrasound screen. [10]

The sterile field was prepared identically for both techniques. The skin from the neck, clavicle, and anterior chest to below the ipsilateral nipple was painted with antiseptic, then draped with sterile towels. Local anesthesia (5 ml of 2% Lignocaine) was administered at the puncture site. [10]

Seldinger Technique [14]: We had used the Seldinger technique (Catheter over wire) to facilitate the cannulation. First, the right IJV was punctured using a hollow needle. A soft, curved tip guidewire was then inserted through the trocar and advanced into the lumen.

The guidewire was held secured in place whilst the introducing needle was removed. A central venous catheter was passed over the guidewire into the lumen. The guidewire was then withdrawn, leaving the central venous catheter in situ.

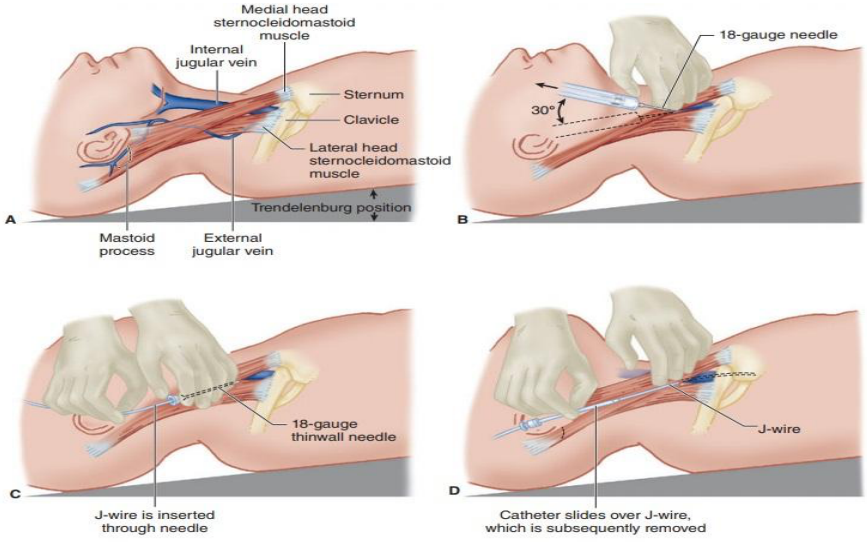

Figure 1:

Landmark Guided Method [8]: In our study, the anterior approach was used for landmark-guided right-sided IJV cannulation. The triangle formed by the sternocleidomastoid heads and the clavicle was identified, and the carotid artery at its medial edge was palpated. An 18-gauge introducer needle was inserted at a 30° angle toward the ipsilateral nipple, past the triangle's apex, with continuous aspiration. After confirming venous blood flow, the syringe was removed, and a guidewire was advanced into the vein. The catheter was then inserted using the Seldinger technique and secured with sutures. Proper catheter placement was confirmed via a chest X-ray (PA view).

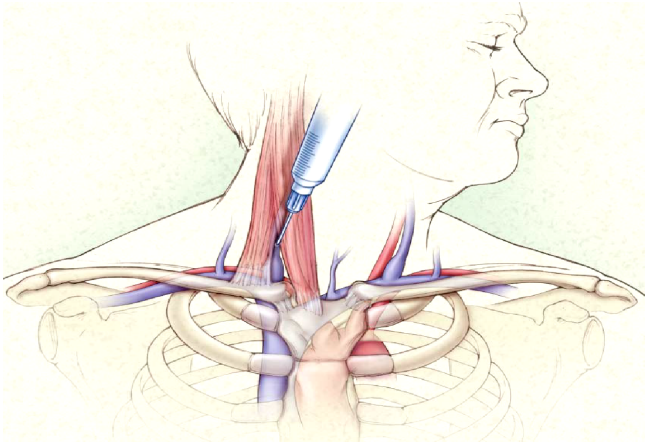

Figure 2:

Ultrasound Guided Method [15]: The potential catheter site was evaluated with ultrasonography, confirming vein patency by compressibility. A 7.5 MHz linear probe with sterile cover provided real-time 2D B-mode imaging using the out-of-plane short-axis technique. An 18-G needle punctured the skin at 45°, with tip position monitored via ultrasound. After venous blood aspiration, a guidewire was inserted, followed by the catheter. Guidewire placement was visualized in cross-sectional and longitudinal views. Catheter position was confirmed with ultrasound and a chest X-ray (PA view).

Figure 3:

Parameters:

Ultrasound Guidance / Anatomical Landmark

1. The Access time:
2. First attempt success rate:
3. Number of attempts for successful cannulation:
4. Overall success rate:
5. Complications:

All mechanical complications were evaluated clinically by chest X-ray and ultrasound when appropriate and managed according to the standard protocol.

Statistical Analysis: Data are expressed as mean ± SD. Unpaired t-test was used for quantitative data, and Z-test or Chi-square test for qualitative data. P < 0.05 was considered significant.

Observations and Results

Our study was carried out in 60 patients (30 in each group) posted for elective major surgeries and in intensive care units. Observations and results were summarized in the tabulated form and described below.

The mean access time was 9.16 ± 2.19 seconds in the ultrasound guidance group and 19.9 ± 8.28 seconds in the anatomical landmark group. P value < 0.0001, so this difference was highly statistically significant.

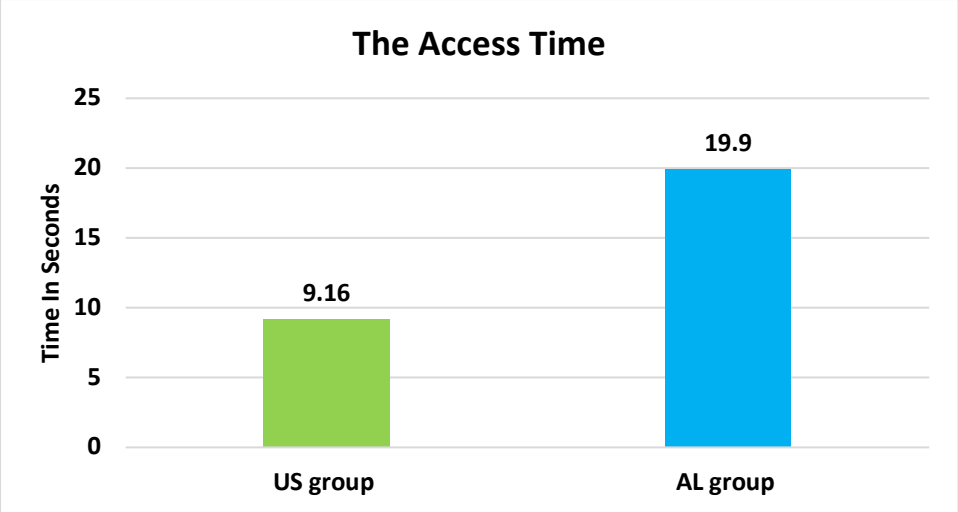

Figure 4: The Access Time

In ultrasound guidance group, 29 (96.67%) patients out of 30, IJV cannulations were done at first attempt, 1 (3.33%) at second attempt and 0 (0%) at third attempt. While in anatomical landmark group 19 (63.33%) patients out of 30, IJV cannulations were performed at first attempt, 9 (30%) at second attempt, 2 (6.67%) at third attempt which was statistically significant ($P < 0.05$).

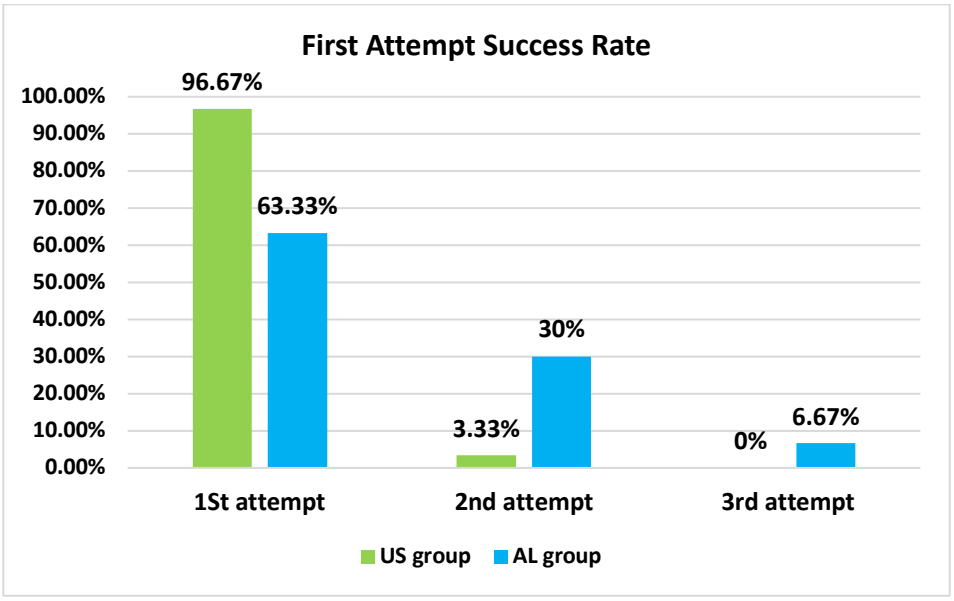

Figure 5: First Attempt Success Rate

The average number of attempts for catheterization in the ultrasound guidance group was 1.03 ± 0.18 and the anatomical landmark group was 1.43 ± 0.62. It was a statistically significant difference ($P < 0.05$).

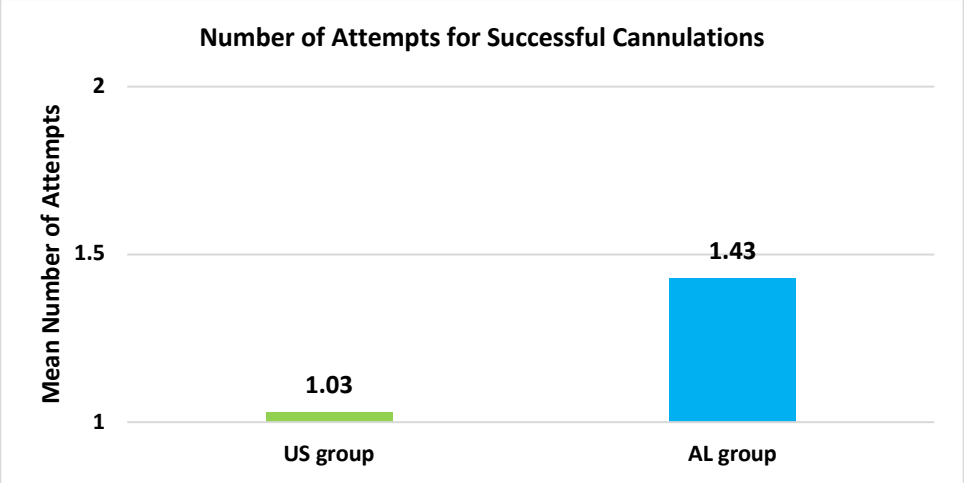

Figure 6: Number of Attempts for Successful Cannulations

There were total 13 complications, in which 10 (33.33%) complications occurred in the AL group and 3 (10%) in the US group. In the US group, out of 30 patients, 1 had hematoma (3.33%) and 2 had double wall puncture (6.67%). In the AL group, out of 30 patients, 3 had hematomas (10%), 2 had carotid artery punctures (6.67%), 1 had pneumothorax (3.33%), and 4 had double-wall punctures (13.33%) which was statistically significant ($P < 0.05$).

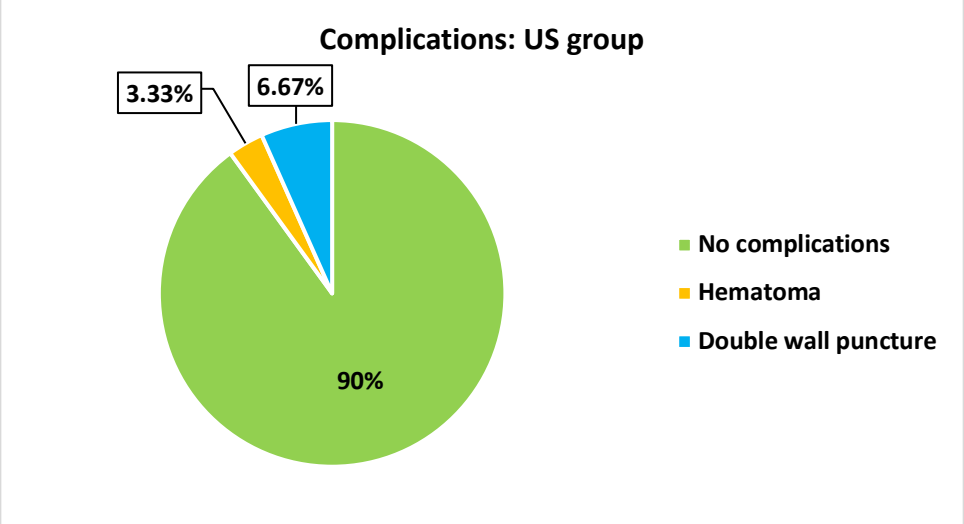

Figure 7: Complications: US group

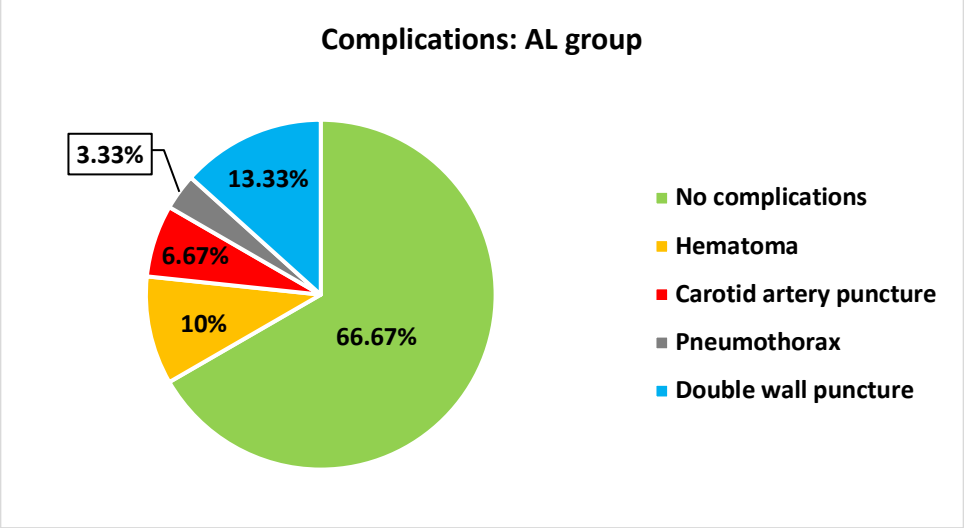

Figure 8: Complications: AL group

Discussion

For decades, anaesthesiologists have performed interventional procedures using only anatomical landmarks, resulting in variable success rates and notable risks and complications. [1] Traditional internal jugular vein (IJV) cannulation relies on landmarks, arterial palpation, and vein balloting, but is associated with multiple potentially serious and costly complications. [16]

Over the past three decades, ultrasound guidance has gained widespread acceptance in vascular access due to its ability to enhance success rates and minimize complications. Unlike landmark methods, it permits direct visualization of vascular anatomy, detection of thrombus, and verification of vein patency, helping prevent arterial injury and failed cannulation. Ultrasound is especially beneficial in clinical situations where pulse-guided techniques are ineffective or impractical. [9,11]

Ultrasound has proven useful in rescuing failed landmark-guided vascular access and is now widely integrated into routine clinical practice, facilitated by the development of portable, lightweight systems for venous procedures. [2,7]

Variations in surface landmarks and vascular anatomy can complicate landmark-guided cannulation. Ultrasound guidance allows direct visualization of the internal jugular vein and adjacent carotid artery, reduces complications, shortens procedure time, confirms venous patency, and lowers infection risk by minimizing repeated attempts. [15] Ultrasound-guided cannulation decreases procedure time, number of venepunctures, early compli-cations, and failure rates. Despite comparable overall success with landmark techniques, it provides superior first-attempt success, requires fewer attempts, enables faster access, and reduces mechanical complications.[6]

Conclusion

In conclusion, real-time ultrasound guidance significantly improves the safety and efficiency of internal jugular vein cannulation, supporting its use in high-risk patients and situations with anticipated peripheral access difficulty.

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