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## **A COMPARATIVE STUDY OF INTERNAL JUGULAR VEIN CATHETERIZATION IN CRITICAL CARE PATIENTS: ULTRASOUND GUIDED VERSUS CONVENTIONAL METHOD**

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**Abstract:**

**Introduction:**

Ultrasound-guided internal jugular vein (IJV) catheterization is known for improving success rate and reduction in rate of complications. The ultrasound image can be used as a real time image during catheterization or to locate the IJV before attempting catheterization. Various serious complications like carotid artery puncture, haemothorax, pneumothorax or arrhythmias can occur during the procedure. Ultrasound guidance could be beneficial in placing central venous catheters by improving success rate, reducing the number of needle passes, decreasing access time and overall success with reduced incidence of complications.

**Methods:**Total 120 patients were randomly selected for IJV catheterization either by conventional or ultrasound guided technique. Number of attempts, success rate, total venous access time, and complications were observed in each group.**Results:**Successful catheterization (up to 3 attempts) was achieved in all patients of both groups. Total venous access time was found to be significantly less in ultrasound groups than the conventional group. Number of attempts and success in first attempt was higher in ultrasound group. This group also had less number of complications. **Conclusion:**Ultrasound guidance is beneficial in placing central venous catheters by improving success rate, reducing the number of needle passes, decreasing access time and decreasing complications. Ultrasound guided technique improves the catheterization of IJV with respect to safety, rapidity and comfort to the patient during procedure.

**Keywords:** central venous catheterization, internal jugular vein, ultrasonography, conventional

**Introduction:**catheterization

Central venous catheterization has specific indications and should be reserved for patient who has potential to benefit from it. Hermosura et al. described right internal jugular vein catheterization in 1966, and since then it has become one of the most popular routes for central venous catheterization.<sup>[3, 6]</sup>

In conventional technique, internal jugular vein catheterization is performed using external anatomical landmarks and palpation of carotid artery. However, depending on operator's experience and patient's anatomy, this procedure may be difficult or unsuccessful.<sup>[1, 4]</sup>

In the last few years, increased use of ultrasound has improved the success rate of internal jugular vein catheterization, while reducing the time required performing it and the number of complications. It is also helpful in identifying patients in whom catheterization may be difficult. This technique requires understanding of neck anatomy as well as skill in performing and interpreting the results. However, its widespread use has been restricted due to unavailability of equipment and trained personnel.<sup>[9]</sup>

When USG is used for internal jugular vein catheterisation, vessel patency, diameter, degree of collapse with respiration, overlap with internal carotid artery, and depth from skin is noted. This maximizes success rates and reduces complications even with less experienced physicians.

Alternatively, ultrasound imaging can be applied for evaluation of anatomic structures before attempting venous puncture, which helps the clinicians to locate carotid artery and IJV and also determines the direction and site of venepuncture. However, only few studies compared

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IJV catheterization by real-time ultrasound imaging, ultrasound-guided prelocation, and the conventional anatomical landmark technique (central approach). So we decided to conduct this study.

**Aim:**

The aim of our study is to compare success rate, complication rate, and total access time for catheterization during IJV catheterization by using conventional or ultrasound-guided technique.

**Objective:**

- To compare effectiveness of ultrasound guided IJV catheterization with conventional technique.
- To assess whether IJV catheterization using an ultrasound guided technique leads to improvement of procedure.

**Materials and methods:**

Source of data: Patients admitted in intensive care unit (ICU) of our hospital

Study period- from July 2014 To November 2014

Total No. of Patients- 120

Inclusion Criteria- Patient Requiring IJV Catheterization.

Exclusion Criteria- Patients with history of previous neck surgery, head and neck mass or cancer, morbidly obese patient, severe coagulopathy or infection at catheterization site.

Patient selection- patients were randomly allocated to both the groups. In one group (conventional) IJV catheterization done by conventional anatomical landmark technique using central approach and in another group (USG) ultrasound-guided technique is used.

**Preparation:**

- patient and/or relatives were explained about the procedure and informed written consent was taken
- blood coagulation profiles done, if not done recently.
- standard monitoring (electrocardiogram, blood pressure, and pulse-oximeter) was applied.
- patients were positioned in Trendelenburg (20-30°) position with head turned slightly toward left side.
- right side of neck region was prepared with an antiseptic solution.
- inj. Lignocaine 1% 2 ml was infiltrated locally
- if required, sedation provided with Inj. Midazolam 1-2 mg intravenously.

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-procedure was performed by experienced person (performed minimum 5 previously).

### **Equipments:**

Packaged central venous/dialysis catheter kit depending on indication

betadine solution, spirit

Gauze pads

Suture on needle

5 cc syringe with 23g needle for check puncture

2 cc syringe for local anaesthesia

Lignocaine 2% bulb.

Surgical cap and mask, sterile gloves and drape

Tegaderm for probe cover and dressing

### **Procedure:**

#### **In conventional technique group:**

Anatomical landmarks (sternocleidomastoid muscles, suprasternal notch, cricoid cartilage, and clavicle) were assessed and marked (figure-1). The carotid artery is palpated and its course determined. An introducer needle attached with 10 ml syringe filled with 2-3 ml normal saline was inserted at apex of triangle formed by two heads of sternocleidomastoid muscle, directed towards ipsilateral nipple at an angle 20-30° with skin.

#### **In ultrasound-guided technique group:**

Conducting jelly was applied on probe and the probe was covered with sterile tegaderm dressing or glove (figure-2). Transducer of ultrasound device was placed on right side of the neck, at the level of cricoid cartilage, perpendicular to the skin. Carotid artery and internal jugular vein were located. Visible pulsations were used to identify carotid artery and compressibility for internal jugular vein. Catheterization was performed under real-time imaging.

#### **In both groups:**

Return of free flow of dark blood in syringe attached to needle confirmed entry into internal jugular vein. Guide wire introduced, needle removed, vein dilated and catheterization done. Position of catheter in internal jugular vein was confirmed by USG at the end of procedure and X-ray chest later on within 2-3 hours. The catheter position was secured with suture, and a sterile dressing was applied.

#### **Observation:**

Following observation were recorded: number of attempts, success rate and total venous access time. Complications like local swelling, hematoma, arterial puncture, arrhythmia, pneumothorax, hemothorax, and catheter malposition were recorded. Inability to cannulate internal jugular vein in 3 attempts was recorded as a failure.

‘total access time’ was defined as duration of time from skin puncture to completion of skin suturing.

Position of catheter tip and occurrence of pneumothorax was confirmed by performing chest radiograph. If haemothorax suspected USG of chest was done and managed accordingly. Complications were managed accordingly.

Statistical analysis was performed using MS office.

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### **Results:**

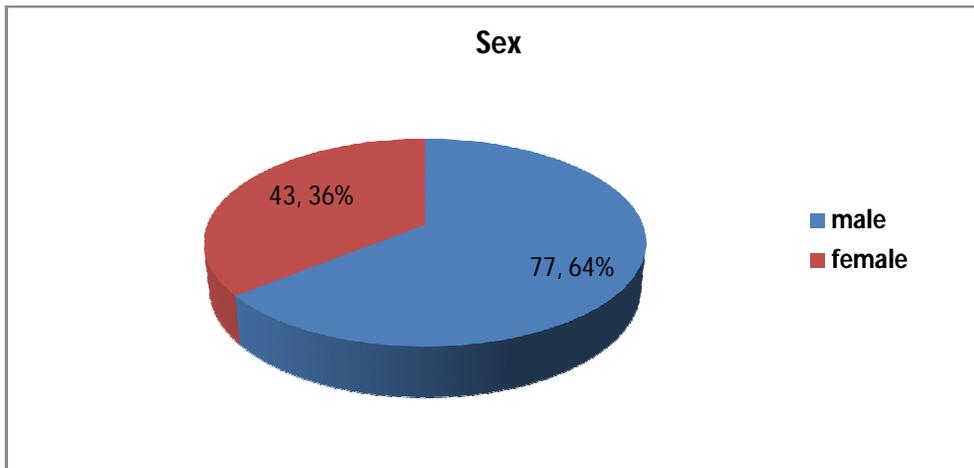
For all patients in our study, right IJV catheterization was attempted for maximum of 3tries, after which procedurewas abandoned. Demographic data is summarized in table 1& 2.

**Table-1 Age Distribution**

<b>Age group (years)</b>	<b>USG group</b>	<b>Conventional group</b>	<b>Total Number</b>	<b>Total percentage</b>
<25	9	10	<b>19</b>	<b>15.8</b>
25-<50	14	18	<b>32</b>	<b>29.1</b>
50-<75	21	41	<b>62</b>	<b>51.6</b>
>75	5	2	<b>7</b>	<b>5.8</b>
<b>Total</b>	<b>49</b>	<b>71</b>	<b>120</b>	<b>100.0</b>

Table-1 shows age wise distribution in both patients, indicates that maximum no. of patients are in the age of 50-75 years.

**Table-2 Sex Distribution**



**Table-3 technique for catheterization**

<b>Group</b>	<b>Number</b>	<b>Percentage %</b>
USG guided	70	58.3
Conventional	50	41.6
<b>Total</b>	<b>120</b>	<b>100</b>

The above table shows no. of patients in whom both the technique was used.

**Table-4 Total Venous Access Time**

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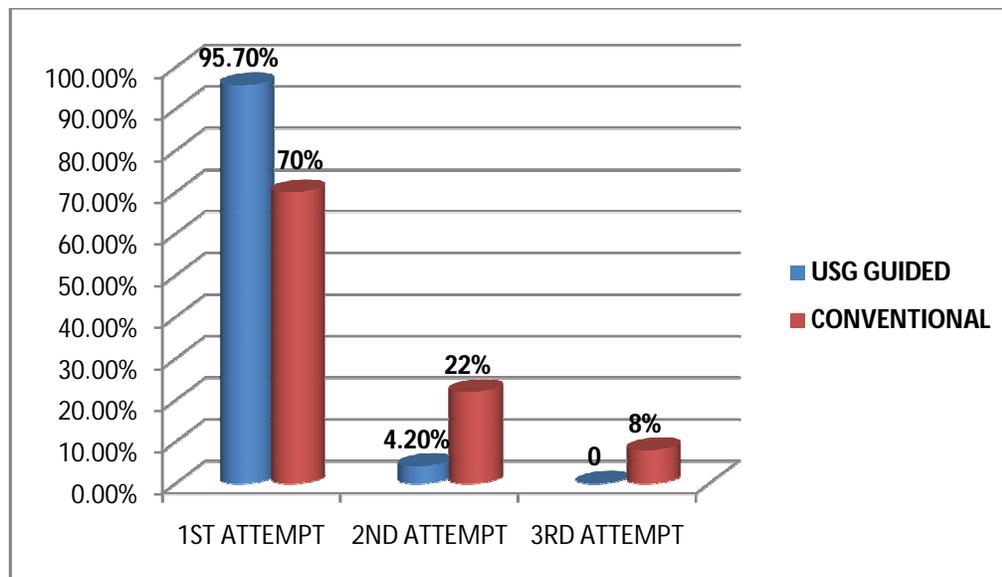
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Group	Time in minutes			
	Minimum	Maximum	Mean	Median
USG guided	1.0	4.95	2.25	2.135
Conventional	3.2	9.00	4.90	4.425

Table-4 shows minimum as well as maximum time required to perform the procedure. Median time was significantly short (2.135 v/s 4.425 min) in USG guided group

**Table-5 Number of Attempts**



Percentage of successful catheterization in 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> attempts is summarized in table-5. In USG guided group more than 95% patients are cannulated in 1<sup>st</sup> attempt while 8% in conventional group required 3 attempts for the same.

In both groups successful catheterisation was achieved in all the patients, may be due to performance by experienced person.

**Table-6 Complications**

Technique	USG Guided		Conventional	
	No of patients	%	No of patients	%
Local haematoma	-	-	4	8
Carotid puncture	-	-	3	6
Catheter malposition	1	2	1	2
Pneumothorax	-	-	1	2
Haemothorax	-	-	1	2

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The above table shows incidence of complications in both groups showing minimum in USG guided group. The commonest complications in conventional group are local haematoma (8%) and carotid puncture (6%).

### **Discussion:**

Real-Time ultrasound guidance may be provided either through the external application of an ultrasound probe to visualize the vessels or with doppler probe for identifying needle entry into the vein. National Institute Of Clinical Excellence (NICE) guidelines, recommend that 2D ultrasound should be considered in most clinical circumstances where central venous catheterization is indicated.<sup>[8]</sup>

In our study IJV catheterization was possible in all of the patients in this study. However, successful IJV catheterization in 2 attempts was achieved in 97% of patients in USG guided group while in conventional landmark technique it was around 92%, which is in accordance with the success rate reported in previous studies using anatomical landmarks (85-99%).<sup>[4]</sup>

Most of the studies have not specified the definition of successful catheterization, and it varied from <3 attempts without carotid artery puncture to <7 attempts and some investigators have defined it as access time less than 4 minutes.<sup>[2]</sup>

Success rate with real-time ultrasound imaging in our study is also similar to results of previous study (94-100%).<sup>[5]</sup> Most of the previous studies have not found any significant difference in success rate while comparing different techniques of IJV catheterization. This is mainly due to, requirement of a large sample size, varying definition of success or failure of catheterization and different study population. However, Mallory and Denys et al. found a significant difference in success rate while comparing anatomical landmark technique with ultrasound guided real-time imaging technique.<sup>[7]</sup> Similarly, Chuan et al. found statistically significant difference in success rate between anatomical landmark and ultrasound guided pre-location technique (80% v/s 100%) in their study.<sup>[2]</sup>

The median of total venous access time in USG group of our study was found to be significantly low, which is in accordance with previous studies. Various studies shown variation in time for puncture and catheterization, but the definition also varied considerably. Hence, it is difficult to compare data from different studies.

Incidence of carotid artery puncture in conventional group of our study are comparable with previous studies using same technique. Hematoma formation occurred in 4 patients belonged to the conventional group, which was managed by external compression. As reported in earlier studies, our study also demonstrates usefulness of ultrasound technique for placement of IJV catheters, and decreasing the incidence of complications.<sup>[4,5]</sup>

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The ultrasound guided techniques not only clarifies relative position of vein and its surrounding structures, but also helps in identifying course of the vein and artery and their calibre and thereby infuses confidence to the operator.

Cost is one of the limiting factors in the availability of ultrasound device in many clinical setups but it is only a one time investment and can be used for other purpose also. A further cost is incurred while using the real-time imaging technique, as specific sterile cover (tegaderm or glove) and jelly are used but it is not that much effective.

Ultrasound machine available in operation room or ICUs for other purposes can be used for ultrasound-guided IJV catheterization, thereby increasing successful catheterization, effective utilization of available equipment and avoiding purchase of additional equipment.

**Limitations:**Ultrasound image does not necessarily confirm location of the tip, so we have to look for return of blood in syringe.

Maintenance of sterile field while using USG probe.

Requirement for an experienced staff but with minimal training anyone can do it.

A small sample size, non-blinded assessment of outcomes, and non-measurement of the IJV diameter were the limitations of our study.

### **Conclusion:**

In conclusion, application of ultrasound guided techniques increases the success rate of IJV catheterization, reduces time of catheterization as well as rate of complications compared to conventional landmark technique. Hence, ultrasound-guided techniques should be used for IJV catheterization whenever available. Ultrasound guided pre-location technique can equally useful as that of real-time imaging technique in all circumstances.

As the number of users for USG guided technique are increasing , it may replace anatomical landmark technique as conventional technique.

### **Acknowledgment:**

I am very thankful to my department for helping me in preparing my study.

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Figure-1 Anatomical Landmark for Conventional Technique



Figure- 2Aseptic USG Transducer Preparation

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Figure-3 Skin Puncture under USG Guidance



Figure-4USG Image Showing IJV and Carotid Artery

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