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## Original article

# Ultrasound guided versus land mark technique for internal jugular central venous catheterization in cardiac surgical patients- a randomized trial

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### Abstract

**Background:** Catheterization of internal jugular vein can be achieved by either anatomical landmark technique or the ultrasound guided technique. The objective of our study is to find out if ultrasound guided technique could be beneficial in placing central venous catheters by improving the success rate by reducing the number of attempts, decreasing the access time and decreasing the complications rate in comparison to the landmark technique.

**Methods:** Fifty patients scheduled for cardiac surgery requiring central venous cannulation of the right internal jugular vein were divided into two groups: ultrasound guided group 'U' and the landmark group 'L', each consisting of 25 patients with age more than 15 years. The outcomes were compared in terms of success rate, time taken for successful cannulation and rate of complications.

**Results:** The two groups were comparable in terms of age, weight, heart rate and blood pressure. The mean number of attempts for successful cannulation was  $1.08 \pm 0.277$  and  $1.40 \pm 0.764$  ( $p=0.055$ ), the time taken in seconds for successful cannulation was  $108.56 \pm 27.822$  and  $132.08 \pm 72.529$  ( $p=0.137$ ) and the overall complication rate was 0% (0 out of 25) and 32% (8 out of 25) ( $p=0.02$ ) in the ultrasound guided and the landmark technique group respectively.

**Conclusion:** Ultrasound guided central venous catheterization of internal jugular vein is comparable to the landmark technique in terms of number of attempts and the time required for successful cannulation. Ultrasound guided technique is much safer than the landmark technique to reduce the overall complications rate during central venous cannulation.

**Keywords:** anatomic landmark; central venous catheterization; ultrasound.

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## Introduction

Central venous catheterization (CVC) is being done for various purposes like volume resuscitation, central venous pressure monitoring, transvenous pacing, hemodialysis access and hypertonic or irritant substance infusion. Central lines are typically introduced into the internal jugular, subclavian, or femoral veins. During the past few years central venous catheterization has become an important aid in the management of critically ill patients.<sup>1</sup>

Cannulation of the internal jugular vein (IJV) was first described in 1969. However, minimizing complications such as multiple puncture attempts, arterial puncture, pneumothorax, or hematoma as well as minimizing patient discomfort and overall procedure time has been a great challenge.<sup>2</sup>

The traditional anatomic landmark technique to guide cannulation of the IJV has yielded various rates of successful access and complications. Moreover, central venous catheterisation requires considerable expertise.

First described in 1984, ultrasound-guided placement of central venous catheters has proved beneficial in most settings, including the intensive care unit and the operating room. Available evidence suggests that fewer needle passes are required for successful venous cannulation when two-dimensional ultrasound guidance is used. In addition, most investigators have shown that ultrasound guidance reduces the time required for catheterization, increases overall success rates, and results in fewer complications.<sup>3,4</sup>

However the facility of ultrasound may not be available in many centers because of its high cost. It also needs an experienced operator which is an additional limiting factor for its use.

The potential impact in utilizing USG to guide CVC placement is to increase first-attempt success rate, decrease procedural complications, and decrease procedural time and patient discomfort. In a meta-analysis published in 1996,<sup>5</sup> use of ultrasound guidance versus traditional landmark approach for internal jugular (IJ) and subclavian (SC) vein cannulation resulted in significant decrease in complications without any difference in procedural time.

The purpose of this study was to see the reproducibility of the previous findings on the USG guided to blind technique in insertion of central venous catheter in reducing the number of attempts and other complications in a developing country setup.

## Methods

This was the prospective, randomized comparative study performed at an operation theatre of a Heart Center. Fifty patients scheduled for cardiac surgery requiring central venous cannulation of the right IJV were divided into two groups by lottery withdrawn by an assistant from a

sequentially numbered container which was revealed after patient received general anesthesia so that patient was blind about the group : USG guided group 'U' and the landmark guided group 'L', each consisting of 25 patients with age more than 15 years. Informed written consent was taken from the patients and/ or relatives. Clearance from the institutional review board was taken for the study. The exclusion criteria included patients' refusal, previous catheter placement, bleeding disorders, clotting abnormalities (platelets < 75,000, INR > 2), emergency venous access requirement and local site of infection.

In the USG guided group (group U), an ultrasound scanner with linear vascular probe (Philips Diagnostic ultrasound system Model number HD11) was used. Under all aseptic precautions, the puncture site was infiltrated with 1 % lignocaine or without local anaesthetic infiltration in anaesthetized patients. On linear probe of the ultrasound, ultrasonic gel was applied which was then covered with a sterile transparent plastic sheath or sterile glove and was fixed with sterile rubber bands and about upto half meter distal from the tip of the probe was draped by sterile sleeve. The patient was positioned in the supine and the head turned to the other side. The depth in ultrasound machine was adjusted 2-3 cm to optimize the view of the vessel. The view was adjusted either with inplane or out of plane technique to guide the needle insertion. The transducer was placed perpendicular or parallel to the vessels at the apex of the triangle formed by the two heads of sternocleidomastoid (SCM) muscle and clavicle. The IJV was identified as an oval thin walled hypoechoic compressible structure lying lateral and superficial to non-compressible pulsating carotid artery or longitudinal compressible structure just above and slight lateral to carotid artery. The IJV picture was centered in the USG window. An introducer needle with an attached syringe was inserted under the probe at an angle of 45 degrees by inplane or out of plane technique. The movement of the needle tip and the change of the shape of the vein were carefully observed. The tip of the needle lying intravascularly was visualized clearly on the image and the free flow of blood upon aspiration was taken as confirmation of correct position of the needle. The guide-wire was then passed and the catheter was rail-roaded over it after dilatation of the tissue plane.

The time to successful completion of the cannulation in the study was the time from the skin puncture to blood aspiration via the catheter immediately following the guide-wire removal. An attempt was considered unsuccessful if complete withdrawal of the puncturing needle out of skin surface was required. The procedure was regarded as a failure if the operator was unable to cannulate the vein in three attempts.

In Group L, CVC was performed by the conventional landmark approach. The patient was placed supine. The neck was turned slightly to the contralateral side and the apex of the triangle formed by the two SCMs was palpated

for ICA pulsations. Once palpable, the ICA was pressed slightly medially with fingers of the left hand so that it did not overly the IJV. A puncture needle was then inserted just lateral to the point of ICA pulsations, directed toward the ipsilateral nipple at an angle of 20°–30° with the skin. After successful aspiration of blood, rest of the procedure was similar to that in Group U. In case of an unsuccessful cannulation after three attempts, it was rescued by ultrasound-guided cannulation.

Local site hematoma and carotid artery puncture if present were noted. Pneumothorax if present was confirmed by USG after completion of the procedure and before sternotomy/thoracotomy was done. Hemothorax if present was confirmed by direct visualization of any blood collection in the thoracic cavity after the sternotomy/thoracotomy was done in the patients. The complications were managed by placing a chest tube (which was a regular practice in the cardiac surgery patients) and by other medical interventions as per the hospital protocol.

Taking alpha error as 1.96, beta error as 1.282, standard deviation (SD) as 0.58 and difference between two proportions, or effect size 0.33 from previous study done by Hrics P, Wilber S, Michelle P, Blanda and Gallo UGO<sup>6</sup>, it was calculated that 22.04 patients in each group would be required to have 95% confidence interval and power of 90%. So, the sample size taken was 25 in each group. Collected data were analyzed by means of statistical software SPSS-16 and Chi-square test was used to compare the number of attempts, duration of successful cannulation and complications between the land mark technique and ultrasound guided methods of central venous cannulation of internal jugular vein. We used Student's t-test for continuous parametric data like age, height and weight. A p-value less than 0.05 was taken as significant.

### Results

All together fifty patients were enrolled in the study with 25 patients in each group. Demographic datas in terms of age group, gender and body weight were comparable in both groups. The mean number of attempts for successful cannulation in the USG guided group was 1.08±0.277 and for the Landmark technique group was 1.40±0.764 (p=0.055). The mean time in seconds from skin prick to blood aspiration after successful cannulation for USG guided group was 108.56±27.822 and for Landmark technique group was 132.08±72.529(p=0.137). However, the overall complication was 32% (8 out of 25) in Landmark technique group and there were no any complication in the USG guided group (p=0.002) as shown in table below.

**Table 1: Demographic variables**

Variables	Group U	Group L	p-value
Gender male:female	16:9	12:13	0.254
Age in years mean±SD	37.28±14.453	38.20±17.224	0.839
Weight in kg mean±SD	51.60±8.986	57.08±13.988	0.106

**Table 2: Outcome variables**

Variables	Group U	Group L	p-value
Number of attempts mean±SD	1.08± 0.277	1.40± 0.764	0.055
Time to successful cannulation in seconds mean±SD	108.56± 27.822	132.08± 72.529	0.137
Carotid artery puncture n(%)	0	2 (8)	0.490
Hemothorax n (%)	0	0	0.00
Hematoma n (%)	0	4 (16)	0.110
Pneumothorax n (%)	0	1 (4)	1.00
Arrhythmias n (%)	0	1 (4)	1.00
Overall complications n (%)	0	8 (32)	0.002

### Discussion

There are several techniques of CVC. In this study two different techniques were employed, but the approach was constant throughout, which was the apical approach of central venous cannulation of IJV. In our study, in the USG guided group 92% of the study population (23 out of 25 study population) were successfully cannulated in first attempt and 8% (2 out of 25 study population) were successfully cannulated in the second attempt. However in the Landmark technique group only 76% (19 out of 25 study population) of the study population were cannulated in the first attempt, 8% (2 out of 25 study population) required second attempt and remaining 16% (4 out of 25 study population) required third attempt for successful cannulation. Our success rate of cannulation in first attempt by the use of USG was comparable with the findings of Shrestha BR and Gautam B whose success rate with USG was 97%.<sup>7</sup>

In our study, the mean±standard deviation for the number of attempts for successful cannulation in the USG guided group was 1.08±0.277 and for the Landmark technique group was 1.40±0.764 ( $p=0.055$ ) which was comparable to the study done by Agarwal A, et al.<sup>8</sup>

The time for successful cannulation was variable in various studies which could be because of the number of cases and the expertise of the performer. In our study the time of successful cannulation was comparable between both of the groups with the mean time±standard deviation in seconds from skin prick to blood aspiration after successful cannulation for USG guided group being 108.56±27.822 and for Landmark technique group being 132.08±72.529 ( $p=0.137$ ). Our result obtained was similar to that of the previous studies done by Agarwal A et al.<sup>8</sup> In their study the mean time to successful insertion was 145 and 176.4 seconds in USG guided and landmark technique groups respectively ( $p = 0.08$ ). The results regarding the assess time obtained by other studies done by Shrestha BR and Gautam B ( 4.9 ± 1.7 minutes in the ultrasound approach and 8.0 ± 2.8 minutes in the landmark approach group ( $p = 0.001$ ) showed that the use of USG significantly decreased the time for successful cannulation.<sup>7</sup>

In our study, among the complications in the two study group accidental carotid artery puncture was done in 8% (2 out of 25) of study population in Landmark technique group whereas in the USG guided group there was no any carotid artery puncture. Hemothorax was not observed in both groups. Hematoma was seen in 16% (4 out of 25) of study population in Landmark technique group whereas there was no case of hematoma formation in USG guided group. Pneumothorax was seen in 4% (1 out of 25) of study population in Landmark technique group whereas there was no case of pneumothorax in USG guided group. Arrhythmia was seen in 4% (1 out of 25) of study population in Landmark technique group whereas there was no case of Arrhythmias in USG guided group. Hence, the overall complication rate in the landmark technique group was higher (32% 8 out of 25) in comparison to the USG guided technique (0%) ( $p=0.002$ ). In other studies as well, the use of USG showed significant reduction in complications rate. Agarwal A et al witnessed 10% arterial puncture and 2.5% pneumothorax in landmark technique group and none in USG guided group.<sup>8</sup> Dimitrios Karakisos et al witnessed carotid artery puncture in 10.6%, haematoma in 8.4%, pneumothorax in 2.4% in landmark technique group and no any complication noted in USG guided group.<sup>9</sup>

However the limitation of our study was that we didn't considered factors like body mass index, neck thickness and length and tricuspid valve status.

### Conclusion

Our study has found that the use of ultrasound in central venous cannulation of the internal jugular vein requires similar number of attempts and almost similar time for successful cannulation with that of the landmark

technique. However the overall complications rate is markedly decreased by the use of ultrasound than by the landmark technique for the central venous cannulation. Hence, we conclude that ultrasound guided technique is much safer than the landmark technique to reduce the inadvertent complications during central venous cannulation.

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**Conflict of interests:** None

### References

1. Andrew R. Webb, Marc J. Sharpiro, Meryn Singer. In: Oxford textbook of Critical Care, Oxford Medical Publications, 1990;1090-4.
2. McGee DC, Gould MK. Current concepts: preventing complications of central venous catheterization. *N Engl J Med* 2003;348:1123-33. <http://dx.doi.org/10.1056/NEJMra011883> [PMID:12646670]
3. Legler D, Nugent M. Doppler localization of the internal jugular vein facilitates central venous cannulation. *Anesthesiology* 1984;60:481-2. <http://dx.doi.org/10.1097/00000542-198405000-00016> [PMID:6711857]
4. Wigmore TJ, Smythe JF, Hacking MB, Raobaikady R, MacCallum NS. Effect of the implementation of NICE guidelines for ultrasound guidance on the complication rates associated with central venous catheter placement in patients presenting for routine surgery in a tertiary referral centre. *Br J Anaesth* 2007;99:662-5. <http://dx.doi.org/10.1093/bja/aem262> [PMID:17872936]
5. Randolph AG, Cook DJ, Gonzales CA, Pribble CG. Ultrasound guidance for placement of central venous catheters: a meta-analysis of the literature. *Crit Care Med* 1996;24:2053-8. <http://dx.doi.org/10.1097/00003246-199612000-00020> [PMID:8968276]
6. Hrics P, Wilber S, Michelle P, Blanda, Gallo UGO. Ultrasound-Assisted Internal Jugular Vein Catheterization in the Emergency Department. *Am J Emerg Med* 1998;16:401-3. [http://dx.doi.org/10.1016/S0735-6757\(98\)90140-1](http://dx.doi.org/10.1016/S0735-6757(98)90140-1) [PMID:9672463]
7. Shrestha BR, Gautam B. A prospective randomized comparative study of internal jugular vein cannulation in an intensive care unit. *J Nepal Med Assoc* 2011;51:56-61. [PMID:22916513]
8. Agarwal A, Singh DK, Singh AP. Ultrasonography: A novel approach to central venous cannulation. *Indian J Crit Care Med* 2009;13:213-6. <http://dx.doi.org/10.4103/0972-5229.60174> [PMID:20436690] [PMCID:PMC2856149]
9. Karakitsos D, Labropoulos NDe Groot E, Patrianakos AP, Kouraklis G, Poularas J, et al. Real time ultrasound guided catheterisation of internal jugular vein; A prospective comparison with the landmark technique in critical care patients. *J Critical Care* 2006;10:843-63. <http://dx.doi.org/10.1186/cc5101> [PMID:17112371]