

# Comparison of Landmark v/s USG Guided Technique for Internal Jugular Vein Cannulation in Adult Patients Undergoing Cardiac Surgery

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## ABSTRACT

**Background:** Obtaining central venous access is the basic requirement in patients undergoing cardiac surgery. Use of ultrasound (USG) for accessing IJV cannulation, improves the success rate and reduces the number of complications that may arise due to blind approach. Through this study we aimed to compare landmark vs real time USG guided IJV cannulation techniques.

**Methods:** 190 adult patient's undergoing cardiac surgery were randomly divided into two groups of 95 each. Patients in Group A (Landmark based approach) were being compared to Group B (USG based) in terms of – success rate, first attempt success rate, total cannulation time, number of attempts, complications and success rate among residents and consultants.

**Results:** Success rate obtained in Group A was 89.4% compared to 100% in group B ( $P = 0.001$ ). First attempt success rate was 67.36% in group A and 91.57% in group B ( $P < 0.001$ ). Group B showed less number of attempts. Total cannulation time in group A ( $252.2 \pm 66.4$ ) sec was significantly higher ( $P < 0.001$ ) than group B ( $182.5 \pm 40.39$ ) sec. Rate of complications such as hematoma formation and carotid artery puncture were also significantly higher in group A.

**Conclusion:** The real time USG guided IJV cannulation is better technique than Landmark guided approach as it has significantly higher success rate, reduces the number of attempts, reduces the total time for cannulation and decreases the rate of complications. Also, success rate even increases among junior residents with the use of USG.

## Introduction

Although obtaining central venous access is a routine practice in adult cardiovascular surgeries but the traditional methods for cannulating IJV by anatomical landmarks is at risk of complications from even expert hands such as hematoma, carotid artery puncture, pneumothorax, hemothorax, venous air embolism, thrombosis & infections [1]. In addition to these, left sided IJV cannulation is more time consuming

and is associated with thoracic duct injury [2-4]. Although, according to guidelines by National Institute of Clinical Excellence (NICE), 2002 – ultrasound (USG) should be used as a preferred method for elective IJV cannulations in both adults and children [5]. Despite these recommendations, the use of USG for routine IJV cannulation is still very low [6]. Real time IJV cannulation yields added benefits such as faster procedure times and lower complication rates [7]. Availability of USG machine & expertise always poses constraints. In centers such as cardiac operations theaters,

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where IJV cannulation is a routine procedure USG machine may not be available in all setups but Transesophageal Echocardiography (TEE) machines are usually readily available, the use of their vascular probe can be taken for IJV cannulation.

Therefore, we conducted a prospective, randomized control trial for comparing the use of vascular probe of TEE machine for real time IJV cannulation with the anatomical landmark-based approach for IJV cannulation in adult patients undergoing cardiac surgeries. Simultaneously, we also compared the success rate among junior residents and consultants in anatomical landmark technique and evaluated any improvement in that after the introduction of real time guidance of USG.

## Methods

After obtaining approval from institutional ethics committee (953/MC/EC/2021) and informed written consent, study was carried out on 190 patients undergoing cardiac surgery. Patients with altered coagulation parameters, arrhythmias, pacemaker in-situ, neck burn contracture, cervical spine injury, neck swelling, surgical scar, local site infection were excluded from study.

The patients were allotted either of the groups using sealed envelope method into

Group A: patients in whom IJV was cannulated using landmark approach and

Group B: patients who were cannulated by real time USG technique using vascular probe of TEE machine.

Before the induction of general anesthesia and endotracheal intubation, patients were placed in 10-200 Trendelenburg position with head turned to left side in order to cannulate right IJV. After application of 2% lignocaine injection, all cannulations were performed under aseptic precautions using 7.5F triple lumen central venous catheter. Most of the cannulations in either group were performed by junior residents and few by consultants & rest unsuccessful attempts by residents required help by consultants. After the insertion of central venous catheter, patient was induced with routine intravenous (i/v) anesthetic drugs and vitals were monitored throughout surgery till the completion of surgery and patients were shifted intubated to the ICU's.

Group A:

Triangle formed between two heads of sternocleidomastoid and clavicle was identified. Through the apex of this triangle, a 22- gauge finder needle attached to a 5ml syringe was inserted at an angle of 45° directed towards the ipsilateral nipple. After the flash of dark coloured venous blood, finder needle was removed and 18- gauge puncture needle was inserted in the same direction immediately lateral to it. Under constant aspiration cannulation was performed using Seldinger's technique. All the three ports were checked and flushed with heparinized saline and three-way were attached at respective ports.

Group B:

A standard vascular probe of TEE machine with a frequency of 8 MHz was used to visualize the structures of neck starting from the middle and tracing laterally towards right side till a thin-walled structure with a collapsible lumen was identified lying just lateral to pulsating carotid artery. Further confirmation was done by using pulse wave doppler, which reveals a venous waveform. Vein was visualized in both longitudinal and transverse sections. After visualizing the entire course of vein, cannulation was performed using Seldinger's technique under real time Ultrasound (US) scanning.

Success was defined as localizing the IJV with the finder needle within 2 attempts. First attempt success rate was defined as locating the IJV in the very first attempt. Total time for cannulation was defined as time taken from insertion of finder needle till the de-airing and flushing of all three ports of triple lumen catheter in case of landmark technique. In case of USG technique, after the localization of vein on the USG screen time starts from the insertion of locator needle directly till flushing of all three ports of triple lumen catheter. Number of attempts were counted as each successive attempt taken to locate the IJV with a new skin puncture. Complications encountered were recorded and their rate was calculated with respect to total sample size.

A sample size of 190 (95 in each group) was taken to ensure the power of study as 80% with a confidence interval of 95%.

## Statistical Analysis

After the collection of data, it was summarized in the form of mean and standard deviation. Difference in mean of two groups was analyzed using student t-test. Categorical data was expressed in the form of proportions and the difference in proportions was analyzed using chi square test. Statistical analysis was performed using SPSS, version 22 for windows statistical software package (SPSS inc., Chicago, IL, USA).

## Results

Study was carried out in cardiothoracic OT over a period of one year, till the completion of sample size (n = 190). Out of these 190, 95 patients were allocated Group A (Landmark-guided Technique) and 95 were allocated Group B (USG-guided Technique). Both the groups were comparable (P > 0.05) in terms of demographic profile of the patients involved (Table1).

**Table 1- Demographic profile**

Parameters	Group A	Group B	P value
Age* (years)	45.032 ± 12.09	46.81 ± 11.5	0.304
Height * (cm)	165.19 ± 8.18	163.07 ± 8.99	0.092
Weight* (Kg)	57.49 ± 13.64	56.96 ± 11.69	0.771

BSA* (m2)	1.62 ± 0.17	1.60 ± 0.18	0.477
Sex* (M/F)	67/28	63/32	0.640

\*Data were presented as mean ± Standard deviation  
(No significant difference was observed in this data)

Most commonly performed surgery in group A was MVR (Mitral Valve Replacement) and in group B was CABG (Coronary Artery Bypass Graft). All technical parameters for IJV cannulation were noted (Table 2).

Success was achieved in 95 patients in group B yielding a success rate of 100% which was significantly higher (P= 0.001) than Group A where 85 patients were successfully cannulated yielding a success rate of 89.4%. The first attempt success rate was 91.57% (87 out of 95 patients) in group B which was significantly higher (P <0.001) than Group A with 67.36% (64 out of 95 patients).

In group B 91.57% (87 out of 95) patients were successfully cannulated in the first attempt and rest 8.42% (8 patients) were cannulated in second attempt whereas in group A 67.36% (64 out of 95) patients were successfully cannulated in first, 22.10% (21 patient's) in second, 8.42% (8 patients) in third and 2.10% (2 patients) in fourth attempt respectively. Group B showed significantly less (P < 0.001) number of additional attempts and majority were cannulated within first attempt. Total cannulation time was also significantly higher (P < 0.001) in group A (252.2 ± 66.4) sec as compared to group B (182.5 ± 40.39) sec.

**Table 2- Technical Parameters.**

Parameter	Group A	Group B	P value
Success rate (%)	89.4	100	0.001
First attempt success rate (%)	67.36	91.57	<0.001
Total cannulation time	252.16 ± 66.44	182.51 ± 40.39	<0.001
Number of attempts taken (%) (2/3/4)	(22.10/8.42/2.10)	(8.42/0/0)	<0.001

Rate of complications such as hematoma formation in group A was 9.47% (9 out of 95), which was significantly higher (P = 0.023) than in group B 1.05% (1 out of 95). Also, the occurrence of carotid artery puncture in group A was 14.75% (14 out of 95), which was significantly higher (P = 0.011) than 3.15% (3 out of 95) in group B (Table 3).

**Table 3- Complication's Rate.**

Complication's	Group A	Group B	P value
Hematoma (%)	9.47	1.05	0.023

Pneumothorax	-	-	-
Catheter	-	-	-
Malposition (%)			
Difficulty Negotiating Guidewire	7.36	1.05	0.071
Right IJV can't be Cannulated	2.10	1.05	1.00
Carotid Artery puncture	14.74	3.15	0.011

74.73% Residents from group B were successful in cannulating IJV alone as compared to 71.58% residents from group A performed successful cannulation on their own. Only 2.10% residents from US group required additional assistance from consultant whereas 17.89% residents needed additional help from consultant in order to successfully cannulate IJV via landmark approach thus showing a significant difference in the improvement after cannulating under USG guidance. (Table 4)

**Table 4- Performed by Resident/ Consultant**

Performed by	Group A (%)	Group B (%)
Consultant Individually	17.89	23.15
Consultant after failed attempts by resident	10.53	2.10
Resident's Individually	71.58	74.73
Result (p value)	0.049 (S)	

## Discussion

We conducted this study with the aim to compare Right Internal Jugular vein cannulation by Landmark versus Real time USG techniques in relation to success rate, first attempt success rate, number of attempts taken, total cannulation time and if any complications like carotid artery puncture, hematoma, pneumothorax, difficulty negotiating guidewire.

In our study, all the patients from each groups were comparable in terms of demographic profile (Age/Sex/Height/Weight/BSA) to avoid confounding factors.

### Success Rate

Our study showed a success rate of 89.4% in group A (landmark guided technique) while in group B (USG guided technique) was 100%. Kunhahamed et al. [8] showed a success rate of 100% in USG guided group and 91.4% success rate in landmark guided group. Karakitsos et al. [9] also obtained 100% success rate in USG group and 94.4% in landmark guided group. Shrestha & Gautam [10] observed 97% success rate in USG guided group while 88% in landmark based group. Karimi et al. [11] obtained success rate of 100% in USG and 88% in landmark guided group. Similarly, Sazdov et al. [6] and Slama et al. [12] obtained 98% & 100% success rate in

USG group while 90.5% & 76% success in landmark based group respectively. All these studies showed a significantly higher success rate in USG guided approach, as obtained in our study. Improved success rate with USG guidance could be attributed to 2D visualization of the patency of target vein along with the anatomical variations seen among different people. Real time cannulation has even better success rate than Static USG as the latter requires pre-location of vein under USG, marking its whole course and then cannulating it afterwards. Although, Turker et al. [13] obtained a success rate of 99.47% in USG group while 97.36% in landmark group but the difference was not observed to be significant, this could be attributed to their level of expertise in landmark approach. 100% success obtained via landmark approach in a study by Tempe et al. [14] could be attributed to their definition of success (within five attempts) and the fact that all the cannulations were performed by senior residents/consultants.

#### Attempt Rate

In our study, 67.36% patients in group A were group B 91.57% patients were successfully cannulated in first attempt. 32.63% patients of group A and 8.42% patients of group B required additional successive attempts. Denys et al. [15] obtained first attempt success rate of 78% in USG and 38% in landmark group. Leung et al. [16] got 82% success rate in USG while 70.6% in landmark group during first attempt of cannulation. Palepu et al. [17] & Kunhahamed et al. [8] obtained first attempt success rate of 84.4% & 91.4% in USG and 72.7% & 48.6% in landmark based group respectively. All these studies showed a higher first attempt success rate (as in our study) obtained via USG as compared to landmark-based approach indicating that the use of real time USG improves the first attempt success rate, as it provides the operator real time visualization of desired vein and surrounding structures lying in proximity prior to and during the insertion of catheter.

Also, our study showed in group A 22.10% patients were cannulated in second, 8.42% in third and 2.10% in fourth attempts respectively. Also, in group B 91.57% patients were cannulated in the first attempt and rest 8.42% patients were cannulated in the second attempt. None required third or fourth attempt. Turker et al. [13], Karimi et al. [11] showed a lesser number of attempts required in Ultrasound group (similar to our study). In studies by Vucevic et al. [18] & Choraria et al. [19] showed that there existed no significant difference between the two groups in terms of number of attempts at cannulating the IJV. This might be attributed to less sample size in their study groups compared to our study.

#### Total Cannulation Time

Our study showed an average time taken for IJV cannulation in group A was (252.16 ± 66.44) sec and group B was (182.51 ± 40.39) sec. Our study showed similar results with studies by Shrestha et al [10] (8min.

in landmark vs 5min. in USG), Karimi et al. [11] (63.42 ± 35.19 sec in landmark vs 37.12 ± 17.33 sec in USG), Turker et al. [13] (236 ± 110 sec. in landmark vs 95 ± 136 sec. in USG), Ray BR et al. [20] (225sec in landmark vs 165 sec in USG), Bhandari et al. [21] (583.12 in landmark vs 410 sec in USG), which also showed that mean cannulation time was decreased in USG guided group. Less time required for localizing followed by puncture of vein via USG is because of direct puncture under real time view of the vein.

#### Complications

Our study showed that hematoma occurred in 9.47% patients of group A (landmark) and 1.05% patients of group B (USG- guided). Similar to ours, rate of hematoma formation in studies by Denys et al. [15] (3.3% in landmark vs 0.2% in USG), Shrestha et al. [10] (8% in landmark vs 2% in USG group), Karakitsos et al. [9] (8.4% in landmark vs 0.4% in USG group), Turker et al. [13] (4.73% in landmark vs 0.5% in USG group) was found to be more in landmark based approach.

Carotid artery puncture was most common complication that occurred in 14.74% patients of group A and 3.15% patients of group B. Similarly, rate of carotid artery puncture in studies by Karakitsos et al. [9] (showed 10.6% in landmark & 1.1% in USG group), Turker et al. [13] (4.73% in landmark vs 0.5% in USG group), Shrestha et al. [10] (10% in landmark vs 3% in USG group), Karimi et al. [11] (10% in landmark vs 2% in USG group), Hayashi H. [22] (13% in landmark and none in USG group), showed similar to the results in our study showing higher carotid artery puncture rate in landmark group.

Overall complication's rate observed in a systemic review by Hassan S. et al. [23] and studies by Leung et al. [16] (16.9% in landmark group vs 4.6% in USG group) and Palepu et al. [17] (9.8% in landmark vs 4.9% in USG group) were higher in landmark based approach. Also, in a study by Gordon et al. [24] observed an increased success rate and reduction in overall complications by USG guidance. Lesser number of complications were as a result of real time visualization of anatomical structures and actual localization of vein and artery followed by appropriate direction of needle insertion into the vein avoids the unnecessary arterial punctures and overall damage to nearby structures such as puncturing pleura/brachial plexus injury. Apart from these complications, we also encountered difficulty in negotiating guidewire and in few cases unable to localize right side IJV but their incidence was not statistically significant between both the groups.

#### Success Rate Among Residents

In group A, out of 95 patients 68 (71.58%) were cannulated by residents independently, 17 (17.89%) were cannulated by consultants & in 10 (10.53%) cases residents required additional help from consultants. Whereas in group B, with the help of ultrasound guidance

71 (74.73%) patients were cannulated independently by residents, 22 (23.15%) were cannulated by consultants & in only 2 (2.10%) cases residents required additional help from consultants for successfully IJV cannulation. As evident from the data, number of patients cannulated by the residents independently were more & also the residents required less help from the consultants when attempting for cannulation under ultrasound guidance. Our study showed similar results with studies by Bose N. et al. [25], Dodge KL et al. [26] which also showed higher success rate, decreased time for cannulation and lesser complications by inexperienced junior residents after the use of Ultrasound guidance.

### Conclusion

In conclusion, application of USG increases the success rate, first attempt success rate, decreases the risk of complications & total time required for cannulation in comparison to landmark based technique. Real time IJV cannulation is even better than the static approach and should always be performed when available. While the latter approach could be used only when the operator is unable to perform real time IJV cannulation single handedly and unavailability of second person around. Training of residents in performing this procedure also improves the success rate and thus should be considered as standard of care in cardiac patients.

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