DOI: 10.21276/aimdr.2017.3.4.AN4

Original Article ISSN (O):2395-2822; ISSN (P):2395-2814

Comparison between Ultrasound Guided Techniques and Conventional Anatomical Landmark Technique for Internal Jugular Vein Cannulation: A Clinical Prospective Study.

Geeta Bhandari[1], Subhro Mitra[2], Rahul Saxena[3], K.S Shahi[4], (Col) Gyan Chand[5]

[1]Prof. and HOD, Department of Anaesthesiology and critical care, GMC, Haldwani.
[2]Assistant Professor, Department of Anaesthesiology and critical care, GMC, Haldwani.
[3]Resident, Department of Anaesthesiology and critical care, GMC, Haldwani.
[4]Prof. and HOD, Department of Surgery, GMC, Haldwani.
[5]Associate Professor, Department of Anaesthesiology and critical care, GMC, Haldwani.

Received: May 2017
Accepted: May 2017

ABSTRACT

Background: Ultrasound-guided internal jugular vein (IJV) cannulation is known for increasing success rate and decreasing rate of complications. Aims: The aim of the study is to compared ultrasonography guided techniques namely ultrasound guided real time imaging for right IJV catheter insertion, ultrasound guided prelocation of right IJV catheterization with the classical anatomical landmark technique for right IJV cannulation in terms of success rate, time for cannulation and complications. Settings and Design: A prospective, randomized, observational study was conducted at a tertiy care hospital. **Methods**: One hundred twenty patients 40 in each group requiring IJV cannulation were included in this study and were randomly allocated in three groups. Number of attempts, success rate, venous access time, IJVcatheterization time, and complications were observed in each group. Statistical Analysis Used: All data were analysed by proper statistical test using SPSS-21, with the consultation of institutional statistician. Parametric values were taken as mean (SD), and nonparametric values were taken as median (range). For the inter-group comparison of parametric tests, their distributions were established and Student's t-test was implemented. Mann-Whitney U test was applied in nonparametric measurements. For all tests, p (probability) value of <0.05 was considered significant and p < 0.001 was considered as highly Significant. **Results:** Single attempt catheterization seen in 70% in Group A, 90% in Group B & 87.50% in Group C and it is significant. Failure is seen in 5% cases in Group A only. The time required for venous access was ranging a from 5 seconds to 110 seconds with mean time 24.25 sec in group A, ranging from 5 seconds to 30 seconds with mean time 16.12 sec in group B, time required for venous access was ranging from 5 seconds to 90 seconds with mean time 20.5 sec in group C study population. The result is significant (p-value 0.012). The time required for catheterization was ranging from 150 sec to 1500 sec with mean time 583.12 sec in group A, ranging from 200 sec to 900 sec with mean time 403.75 sec in group B, time required for catheterization was ranging from 200 sec to 1500 sec with mean time 410.0 sec in group C study population. However the result is not significant (p-value 0.123). Carotid artery puncture is seen in 22.5 %(group A), 0% (group B), 12.5% (group C). Pneumotthorax 2.5 % is seen in group A only. Haematoma and catheter malposition is not seen in any group. **Conclusion**: We found that the Real-time ultrasonography guidance provides a faster access, lesser number of attempt, lesser complication.

Keywords: Internal jugular vein, anatomical landmark, ultrasonography prelocation, ultrasonography realtime, central venous cannulation.

INTRODUCTION

Central venous access is defined as placement of a catheter into a great venous vessel. Hermosura et al described right internal juglar vein (IJV) in 1966 and since then it has become one of the most popular route for central venous cannulation.[1,2] Central venous catheter (CVC) is inserted for several reasons, including haemodynamic monitoring, delivery of blood products and drugs, haemodialysis, total parenteral nutrition (TPN), management of perioperative and long term fluids and volume resuscitation.[3]

Name & Address of Corresponding Author
Dr. Subhro Mitra,
Assistant Professor, Department of Anaesthesiology and critical care,
GMC, Haldwani.

The central venous catheter (CVC) is inserted into venous great vessels that include the superior vena cava (SVC), inferior vena cava (IVC), brachiocephalic veins, internal jugular veins (IJV),

subclavian veins (SCV), iliac veins & common femoral vein.[4] The various complications associated with CVC placement are arterial puncture, arteriovenous fistula, pneumothorax, nerve injury and multiple unsuccessful attempts at catheterization. Internal jugular venous access is associated with a lower rate of severe complications like arterial punctures, haematoma, pneumothorax, thrombosis and sepsis in the intensive care unit as compared with other routes like subclavian vein and femoral vein access.

There are various approaches to put central venous catheter. In the Landmark approach central venous access is achieved by using surface anatomical landmarks and by knowing the expected anatomical relationship of the vein to its palpable companion artery.[5] With the coming of ultrasonography guidance even inexperienced medical intensive care unit persons are able to put central venous catheter.[6] Ultrasonography guidance can be either static or dynamic. In static (prelocation) ultrasonography guidance implies that target vein is visualized by ultrasonography prior to puncture, to identify its location, its relation to companion artery. In dynamic (real-time) ultrasonography guidance implies that target vein & its surrounding anatomical structures are visualized in real time prior to as well as during puncture. Dynamic guidance can be either in short axis view (SAX) or long axis view (LAX). SAX visualizes the vessels in cross-section and LAX visualizes them in longitudinal view.[7]

MATERIALS AND METHODS

After institutional ethics committee approval and written informed consent, 120 patients aged 15-65 years, scheduled for elective or emergency surgery or during their stay in the intensivecare unit (ICU); Who required IJV catheterization, were included in this clinical prospective study. Exclusion criteria were patients with previous neck surgery, head and neck mass or cancer, superior vena cava syndrome, coagulopathy, infection at cannulation site, patient or relatives refusal. Patients were randomly allocated to one ofthe three groups using closed envelope method (40 in each group). Patients of the first group had their right IJV catheter inserted by traditional anatomical landmark approach (Group AL).The right IJV was prelocated with the help of an ultrasound probe (Group USG-PL) before catheterization, and in the last group ultrasound-guided real- time imaging was used for their right IJV catheter insertion(Group USG-RT). A 7F × 16 cm, triple- lumen central venous pressure (CVP) catheter was used for catheterization in all patients. A 7.5 MHz transducer (Probe) attached to the 2D image display of the ultrasound machine (Siemens logic 5 alpha machine model). Sterile polyethylene sheath to protect the ultrasound probe and ultrasound gel were used in the study.

Standard monitoring (electrocardiogram, blood pressure, and pulse-oximeter) were applied to patients. Allpatients were positioned in the Trendelenburg (20-30°) position with head turned slightly toward the left side. Anatomical landmarks (sternocleidomastoid muscles, sternal notch, cricoidcartilage, and clavicle) were assessed and marked. Right side of the neck regionwas prepared with an antiseptic solution. 2-3ml of Lignocaine 2% was used for local anaesthesia. Post procedure chest radiograph was done immediately to ensure proper position of catheter tip, and to exclude any pneumothorax/haemothorax.

In group AL, An 22Gfinderneedle attached with a 5 ml syringe was inserted at the apex of the triangleformed by the two heads of the sternocleidomastoid muscle, directed toward the ipsilateral nipple at an angle35□45°anglewith the skin. In ultrasound-guided technique groups, transducer of the ultrasound device was placedat the level of the cricoid cartilage, perpendicular to the skin, on the right side of the neck. Compressibility ofthe vein and visible pulsations of the artery were used to identify the carotid artery and the IJV. Venepuncture site was also determined and marked (Prelocation), and cannulation was performed, and in Group USG-RT cannulation was performed under real-time imaging.

Return of free flowing dark venous blood to the syringe attached to the needle confirms entry into the IJV.This was followed by catheterization of the right IJV. The CVP catheter was secured with sutures, and a sterile dressing was applied.

Following observation were recorded: Number of attempts, success rate, venous access time, catheterization time and complications like accidental carotid artery puncture, haematoma formation, pneumothorax, catheter malposition were also recorded.

Inability to cannulate the vein in three attempts was recorded as a failure.

'Venous access time' was defined as the time from the starting of insertion of the introducer needle to the return of dark colored venous blood into the attached syringe. 'Catheterization time' was defined as the time from the starting of insertion of the introducer needle to the end of catheter placement, not including thesuturing and fixation time.

Position of tip of the CVP catheter and occurrence of pneumothorax was confirmed by performing chestradiograph. Complications, if occurred were managed according to the standard protocol.

Sample size calculation and stastistical analysis

Statistical analysis was performed using SPSS-21software. Parametric values were taken as mean (SD), and nonparametric values were taken as median (range). For the inter-group comparison of parametric tests, their distributions were established and Student's t-test was implemented. Mann-Whitney U test was applied in nonparametric

measurements. For all tests, p (probability) value of <0.05 was considered significant and p < 0.001 was considered as highly Significant.

RESULTS

There are 120 patients in the study. Demographic data of all the three groups of the study are summarized in [Table 1] and it is comparable in all three study groups. Number of attempt for catheterization and success rate for catheterization is summarised in [Table 2,3]. Single attempt catheterization and also the success rate is higher in ultrasound group. The results is found to be significant (p=0.001). Right IJV venous access and catheterization time characteristics are shown in [Table 4]. Venous access time is significant (p=0.012) between the study groups. Catheterization time is not found to be significant (p=0.123) between the study groups. Complications are summarised in [Table 5]. Among the various complications, carotid artery puncture seen in nine patients (22.5%) in the anatomical landmark group, and five patients (12.5%) in ultrasound prelocation groups. Pneumothorax in one patient (2.5%) in anatomical landmark group.

Table 1: Age and Gender distribution of study groups

	Total (n=120)	Group A (n=40)	Group B (n=40)	Group C (n=40)	p-value
Mean age (years)	35.00±13.2 (18-65)	35.00±13.4 (18-65)	35.00±13.7 (18-64)	40.00±13.9 (18-62)	p < 0.000
Male: Female Ratio	1.55:1	1.66:1	1.22:1	1.66:1	

*Statistically significant

Table 2: Number of attempts for catheterization of study groups.

Number of attempts	Group A (n=40)	Group B (n=40)	Group C (n=40)	P value
Cases requiring one attempt	28 (70.00%)	36 (90.00%)	35 (87.50%)	0.023*
Cases requiring two attempts	8 (20.00%)	3 (7.50%)	4 (10.00%)	0.046*
Cases requiring three attempts	2 (5.00%)	1 (2.50%)	1 (2.50%)	0.079
Cases failure	2 (5.00%)	0 (0.00%)	0 (0.00%)	0.009*

*Statistically significant

Table 3: Success rate for catheterization in study groups

Success Rate	Group A (n=40)	Group B (n=40)	Group C (n=40)	P value
Successful	38 (95.00%)	40 (100.00%)	40 (100.00%)	0.001*
Failure	2 (05.00%)	0 (00.00%)	0 (00.00%)	

*Statistically significant

Table 4: Time taken for venous access and catheterization for study group.

Venous access and Catheterization time	Group A (n=40)	Group B (n=40)	Group C (n=40)	P value
Venous access time (sec) Mean (min-max)	24.25 (5-110)	16.12 (5-30)	20.5(5-90)	0.012*
Cathererization time (sec) Mean (min-max)	583.12 (150-1500)	403.75 (200-900)	410.0 (200-1500)	0.123

*Statistically significant

Table 5: Complications in study groups

Age distribution	Group A (n=40)	Group B (n=40)	Group C (n=40)	P value
Carotid puncture	9(22.5%)	0%	5(12.5%)	0.041*
Haematoma	0%	0%	0%	-
Pneumothorax	1(2.5%)	0%	0%	0.047*
Malposition	0%	0%	0%	-

*Statistically significant

DISCUSSION

Anaesthesiologists have been performing diverse interventional procedures using anatomical landmarks over so many years with variable success rates, risks, and consequences of complications. Ultrasonography imaging can play a major role in the field of anaesthesiology, critical care & pain to

perform procedures with precision and reduce complications. In 2001 Agency for Healthcare Research and Quality (AHRQ,USA) and in 2002 National Institute for Health and Care Excellence (NICE, UK) recommended use of USG for CVC placement.[8]

In classical anatomical landmark technique we depend on visual anatomical details and expected anatomical relationship of the vein to its palpable companion artery. Real-time ultrasonography guidance for central venous catheterisation insertion provides the operator with visualization of the desired vein & the surrounding anatomical structures before & during the insertion, either in SAX or LAX view. The image quality offered by 2D ultrasonography allows the user to clearly see variations in anatomy and to assess the patency of a target vein. Ultrasonography also shows the position of the needle relative to the vein and its surrounding structures, which can result in a lower technical failure rate, reduction in complications and faster access.[9]

Gaining required expertise with ultrasonography-guided cannulation requires diligent training and experience and even with the use of real-time ultrasonography guidance complications such as CA dissection has been described.[10] The addition of ultrasonography was not a significant predictor for less procedural complications when used by inexperienced operators. However, when the operator becomes more experienced (>25 insertions) the addition of ultrasonography significantly reduces procedural-related complications. Hence with respect to this learning curve sufficient training and exposure must be provided for trainees to become familiar with the technique of central venous catheterisation insertion itself before a possible benefit of the addition of ultrasonography technique can be observed.[11]

Dynamic ultrasound should always be used when available and static ultrasound should be used only when the operator is unable to perform dynamic guidance single-handedly or when a second person is unavailable to facilitate the two-person technique.[12]

In our study single attempt catheterization seen in 70% in Group A, 90% in Group B & 87.50% in Group C and it is significant. Case requiring two or more than 2 attempt is 25% in Group A, 10% in Group B & 12.5% in Group C. Failure is seen in 5% cases in Group A only. In Group A 95% success and in Group B & C 100% success is seen, which is clinically significant (p= 0.001). Our results were similar to those found in many previous studies which also showed that success rate was better with the USG technique.

The difference in mean number of attempts for catheterization among three groups was also significant statistically, it being 1.43 + 0.81 for group A & 1.07 + 0.26 for group B & for group C 1.15 + 0.42 (p = 0.001)

Time taken for venous access was significantly lower with both real time ultrasonography (16.12 sec) and prelocation (20.5 sec) techniques as compared to landmark (24.25 sec) technique.

Time taken for catheterization was reduced with the use of USG but was not statistically significant. It was 583.12 sec in group A , 403.75 sec in group B, 410.0 sec in group C study population.

The complications experienced in our study groups were:Carotid puncture occured in 9 patients (22.5%) in group A and 5 patients (12.5%) in group C. No carotid puncture was observed in group B. Pneumothorax occurred in single patient (2.5 %) in group A only. Hematoma and malposition were not seen in any patient.

The above studies show that ultrasound guided catheterisation has made the process safer but the drawback with the use of ultrasound in CVC is that resident is not able to perform landmark technique unless trained with it.[13]

There were two cases in our study where cannulation was not successful by landmark technique after initial attempt and ultrasonography guidance was immediately resorted to and successful cannulation of IJV was done. But advocating ultrasonography guided central venous cannulation does have the potential for deskilling in the landmark technique that may be required in emergency situations or when equipment is not available.[14]

The NICE committee also considered that although ultrasonography guidance in central venous catheterisation placement may eventually become the routine method for placing central venous catheterisations, the landmark method would remain important in some circumstances, such as emergency situations, when ultrasonography equipment &/or required expertise is not immediately available. The committee thus thought it important that operators maintain their ability to use landmark method & that the method continues to be taught alongside the ultrasonography guided technique.[8] In emergency situations, where a line needs to be inserted without delay, landmark insertions may still be appropriate. It is important that training in US-guided access allows operators to remain skilled in the landmark methods & must not allow trainers to dispense with teaching the landmark methods.[5]

There are pitfalls in use of ultrasonography guidance as well, by far the greatest difficulty lies in acclimatizing to the additional co-ordination involved in using the ultrasonography probe, stabilizing the hand holding the probe to minimize drift & thus move away from the target vessel. Often at times, the image on the ultrasonography monitor becomes engrossing & attention must be continuously shifted from the screen to the patient.[15]

A small sample size, nonblinded assessment of outcomes, non-measurement of height weight distribution of patients, catheter realated blood

infection (CRBSI), IJV diameter were the limitations of the study.

In conclusion, application of ultrasound-guided techniques increases the success rate of IJV cannulation,decreases complications, and time of catheterization in comparison to anatomical landmark technique.Hence, ultrasound-guided techniques should be used for IJV cannulation when available and ultrasound-guided-prelocation technique can be equally useful as that of real-time imaging technique in allcircumstances.

How to cite this article: Bhandari G, Mitra S, Saxena R, Shahi KS, Chand G. Comparison Between Ultrasound Guided Techniques and Conventional Anatomical Landmark Technique for Internal Jugular Vein Cannulation: A Clinical Prospective Study. Ann. Int. Med. Den. Res. 2017; 3(4):AN13-AN17.

Source of Support: Nil, **Conflict of Interest:** None declared

REFERENCES

1. Hermosura B, Vanags L, Dickey MW. Measurement of pressure during intravenous therapy. JAMA 1966;195(4):321–321.
2. Daily PO, Griepp RB, Shumway NE. Percutaneous internal jugular vein cannulation. Arch Surg Chic Ill 1960 1970;101(4):534–6.
3. Keenan SP et al. Use of ultrasound to place central lines. J Crit Care 2002;17(2):126–37.
4. Rupp SM, Apfelbaum JL, Blitt C, Caplan RA, Connis RT, et al. Practice guidelines for central venous access: a report by the American Society of Anesthesiologists Task Force on Central Venous Access. Anesthesiology. 2012 Mar;116(3):539–73.
5. Calvert N, Hind D, McWilliams RG, Thomas SM, Beverley C, Davidson A. The effectiveness and cost-effectiveness of ultrasound locating devices for central venous access: a systematic review and economic evaluation. Health Technol Assess Winch Engl. 2003;7(12):1–84.
6. Bose N, Patel H, Kamat H. Evaluation of ultrasound for central venous access in ICU by an in experienced trainee. Indian J Crit Care Med. 2014;18(1):26–32.
7. Schroeder RA, Barbeito A, Bar-Yosef S, Mark JB. Cardiovascular Monitoring. In: Miller RD, Eriksson LI, Weiner-Kronish JP, Young WL, editors. Miller's Anesthesia. 7th Ed. USA: Churchill Livingstone Elseveir. 2010; p.1289-90.
8. National Institute for Clinical Excellence. Guidance on the use of ultrasound locating devices for placing central venous catheters. Technology Appraisal Guidance No. 49, 2002 Sept.
9. Palepu GB, Deven J, Subrahmanyam M, Mohan S. Impact of ultrasonography on central venous catheter insertion in intensive care. Indian J Radiol Imaging 2009;19(3):191–8.
10. Parsons AJ, Alfa J. Carotid dissection: a complication of internal jugular vein cannulation with the use of ultrasound. Anesthesia Analogue, 2009; 109:135-6.
11. Lennon M, Zaw NN, Popping DM, Wenk M. Procedural complications of central venous catheter insertion. Minerva Anestesiologica, 2012; 78:11.
12. Wu S, Ling Q, Cao L, Wang J, Xu M, Zeng W. Real-time Two-dimensional Ultrasound Guidance for Central Venous Cannulation: A Meta-analysis. Anesthesiology, 2013; 118:361-75.
13. Maizel J, Guyomarc'h L, Henon P, Modeliar SS, de Cagny B, Choukroun G, et al. Residents learning ultrasound-guided catheterization are not sufficiently skilled to use landmarks. Crit Care 2014;18:R36.
14. Tempe D, Virmani S, Agarwal J, Hemrajani M, Satyarthy S, Minhas HS. The success rate and safety of internal jugular vein cannulation using anatomical landmark technique in patients undergoing cardiothoracic surgery. Ann Card Anaesth 2013; 16:1.
15. Ashrar T. Ultrasound Guidance for placement of Central venous catheters. Isreali Journal of Emergency Medicine, 2007; 7(2).