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A COMPARATIVE STUDY OF INTERNAL JUGULAR VEIN CANNULATION BY ANATOMICAL LANDMARK AND ULTRASOUND GUIDED TECHNIQUE IN OPERATION THEATRE AND INTENSIVE CARE UNIT

Anaesthesiology

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KEYWORDS

INTRODUCTION

In surgery, the implantation of a central venous catheter through the internal jugular or subclavian vein is crucial.[1] Typically, fluids, blood, or inotropic medications are delivered through the catheter's numerous passageways. In addition, monitoring of central venous pressure and pulmonary artery pressure is accomplished via central veins. [2] The indirect measurement of venous pressure (VP) by the physical examination of blood arteries in the neck is one of the most important components of assessment, but it is not without its problems. The jugular vein is difficult to palpate in more than 20% of patients; hence, measures of normal, low, and high levels of VP are erroneous, particularly in critically ill patients. [3] These difficulties also occur in individuals who are scheduled for surgery; sometimes, even dramatic changes in VP are not identified. Consequently, the direct assessment of VP is frequently necessary for patients with hemodynamic instability and those undergoing major surgery. [2,3]

On the other hand, the use of central venous cannulation can be associated with adverse effects that are both hazardous to patients and can increase costs. Mechanical complications have been observed in 5% to 9% of patients, infectious complications in 5% to 26%, and thrombotic complications in 2% to 26% of patients. Several factors, such as the patient's anatomy and health or the operator's experience, relate to these adverse effects.[4] Several studies have shown that the use of ultrasonography in central venous cannulation can lower the risk of problems and decrease the time required to access the vein, as well as the associated costs. [5-10]

Central venous catheterization CVC is performed for several reasons, including volume resuscitation, central venous pressure monitoring, transvenous pacing, hemodialysis access, and hypertonic or irritating chemical administration. The internal jugular, subclavian, or femoral veins are frequently used to insert central lines. In recent years, central venous catheterization has emerged as a crucial tool for the management of critically ill patients. [11]

In 1969, internal jugular vein (IJV) cannulation was first described. Nevertheless, limiting complications such as multiple puncture attempts, artery puncture, pneumothorax, or hematoma, as well as decreasing patient discomfort and overall operation duration, has proven to be a formidable issue. [8,10]

The use of traditional anatomic landmarks to guide IJV cannulation has resulted in varying success rates and problems. Moreover, central venous catheterization takes great competence. Ultrasound-guided placement of central venous catheters has proven useful in most situations, including the intensive care unit and the operating room. [12] Evidence suggests that when two-dimensional ultrasound guidance is utilized, fewer needle passes are necessary for effective venous cannulation. In addition, most researchers have demonstrated that ultrasound guidance decreases the time necessary for catheterization, improves the overall success rate, and minimizes the incidence of problems. [5-7,9,12]

The aim of the study was to comparing the internal jugular vein cannulation by anatomical landmark and ultrasound-guided approach in the Operating Room and intensive care unit.

Methodology

Study Design And Setting:

A Prospective Observational Study was conducted in the operation theatre and post-operative care units of various departments under the guidance of the Department of Anaesthesiology, King George's Medical University, Lucknow from 2022-23 after getting ethical committee approval [ref.no. VIII -PGTSC-IIA/P5]

Study Participants:

Adults aged 18 years or above presented to the ED were required central venous access through Internal Jugular Vein as part of their treatment and consented to be part of the study. Those who were Patients <18 years with a suspected cervical spine injury or penetrating injury to the neck or with coagulopathy or local site infections or burns and head and neck cancer and those non-willing patients were excluded from the study.

Sample Size: Total 50 cases. 25 cases in each group. Calculated from the study, Dolu H et al, 2015. [13]

The sample size formulae used are as follows: (Bernard, 5th edition)

$$\frac{(\sigma_1^2 + \sigma_2^2/\kappa)(z_{1-\alpha/2} + z_{1-\beta})^2}{\Delta^2}$$

n= Sample Size, σ= Standard Deviation, = Difference of means, = Ratio

$Z_{1-\alpha/2}$= Two side Z value, $Z_{1-\beta}$=Power

Confidence Interval (2-sided)- 95%, Power- 90%

Number of needles passes [13]	AL group	USG group	Difference
Mean	2.2	1.1	1.1
Standard Deviation	1.6	0.5	
Variance	2.56	0.25	
AL-Anatomical landmark, USG-Ultrasonography			

Total sample size calculated- 50, with 25 in each group.

Data Collection:

50 patients were included in the study after informed written consent. The ED physician solely decided the need for central vein access and the appropriate method (Ultrasound guided or Anatomical landmark) according to the patient's clinical condition. The participants were followed up till 12 hour of central line insertion for any acute complications.

GROUP-USG	Internal Jugular Vein Cannulation by Ultrasound-Guided Technique.
GROUP-AL	Internal Jugular Vein Cannulation by Anatomical Landmark.

Procedure
Patients of both the groups were shifted to operation theatre or intensive care unit where standard ASA monitors were attached. Patients were positioned in a Trendelenburg position with a rolled towel under the shoulder and turned head opposite to site of insertion. The neck area was prepared and draped as per our institution protocol.

Anatomical Landmark Technique
In this technique, the triangle's apex was formed by the two heads of the sternocleidomastoid muscle, and the clavicle serves as a landmark. The IJV runs deep to the sternocleidomastoid muscle and then through this triangle before joining the subclavian vein to become brachiocephalic. After the landmarks were identified, sterile precautions were taken, and local anaesthesia was administered. An 18g introducer needle is advanced past the triangle's apex, in the direction of the ipsilateral nipple, at an angle of 20°. Once the blood was freely aspirated, the syringe was removed from the needle. The guide wire was then advanced through the needle into the vessel, and the catheter was placed using the Selinger technique and secured in place using sutures, and apply tegaderm over it and advise for chest Xray stat.

Ultrasonography-Guided Technique
The skin was then damped with sterile saline solutions and a 13-6mhz linear ultrasound transducer was placed over the groove of triangle covered with sterile towel, ultrasonic gel and wrapped with a sterile tegaderm patch and connected to real time ultrasonography machine. A 18gauge long needle inserted, guided by ultrasonography in short axis view. When blood was freely aspirated insert guide wire and completed procedure as per anatomical landmark.

At the end of each procedure, the operator recorded the data, including patient demographics, operator details, method of insertion, indication for central line insertion, number of attempts, success or failure, time to completion (flash time and cannulation time), and acute complications.

Operational Definitions
Flash Time is the time interval between skin puncture and observing blood at the syringe hub. Cannulation Time is taken as the time interval between observing blood at the syringe hub and confirming the backflow of blood at all three ports in the triple-lumen catheter.

Attempt was defined as the introducer needle's entry into the skin and removal from the skin. The procedure was successful if the IJV was cannulated, resulting in the successful aspiration of blood. A procedure was considered a "failure" if the operator was unable to perform cannulation of the IJV after a maximum of three attempts. Acute complications, such as skin hematoma, arterial puncture, pneumothorax, hemithorax, and catheter malposition, were observed for 12 h.

Outcome:
Safety, efficacy, and successful cannulation of IJV. The flash time, cannulation time, number of cannulation attempts, acute complications.

Statistical Analysis:
Data were entered in Microsoft Excel and analysed using statistical software SPSS version 26 (SPSS Inc., Chicago, IL, USA). The continuous variables were evaluated by mean (standard deviation) or range value when required. The dichotomous variables were presented in number/frequency and were analysed using Chi-square. Analysis by Student t-Test was used to compare the means between the two groups. A p-value of < 0.05 or 0.001 was regarded as significant.

RESULTS
25 patients in each group were studied. The mean age of the USG group was higher [42.24± 14.59] compared to AL group [39.88± 13.96]. Most of the patients belonged to the age group of 40-51 years [8, 32%] in group AL, while in group USG, the majority were aged between 28-39 years [8, 32%]. Statistically, a non-significant difference was observed among the groups. Male preponderance was observed in both AL [13, 52%] and USG group [18, 72%]. Statistically, a non-significant difference was observed in gender among groups [p=0.1452]. A statistically non-significant difference was observed in mean cannulation time and mean flash time among both groups [p=0.586 and 0.129 respectively]. The mean flash time and mean cannula was higher in group AL compared to group USG. In the AL group, most of the patients had a catheter placed on the first attempt [17, 68%] whereas, in group USG, all the patients had a catheter placed at the first attempt [25, 100%]. Statistically, a significant difference was observed in attempts among groups [p=0.0085]. [Table 1]

Table-1- Comparison Of Age, Gender And Time Of Cannulation And Attempts Across Both Groups

Variables		GROUP-AL	GROUP-USG	P-Value
		N (%)	N (%)	
AGE (In years)	MEAN±SD	39.88± 13.96	42.24± 14.59	0.5617
	18-27	5 (20.00%)	4 (16.00%)	0.9074
	28-39	6 (24.00%)	8 (32.00%)	
	40-51	8 (32.00%)	6 (24.00%)	
	52-63	5 (20.00%)	5 (20.00%)	
	64-75	1 (4.00%)	2 (8.00%)	
GENDER	MALE	13 (52.00%)	18 (72.00%)	0.1452
	FEMALE	12 (48.00%)	7 (28.00%)	
Mean Of Cannulation [Sec]		304.97± 67.18	294.17± 72.17	0.5865
FLASH TIME (sec)	MEAN±SD	7.20± 2.71	5.40± 5.16	0.1291
	3-12	24 (96.00%)	24 (96.00%)	0.3679
	13-22	1 (4.00%)	0 (0.00%)	
	23-32	0 (0.00%)	1 (4.00%)	
ATTEMPT	1	17 (68.00%)	25 (100.00%)	0.0085
	2	7 (28.00%)	0 (0.00%)	
	3	1 (4.00%)	0 (0.00%)	

Most patients had no complications after the procedure in the AL group [22(88.00%)], while 3 patients had skin hematoma. In the USG group, all the patients were normal and had no complications [25,100%]. These results showed that the USG technique was better than AL. Statistically, a non-significant difference was observed in complications among groups. Most of the patients in the AL group [23(92.00%)] and all patients in the USG group [25(100.00%)] had no adverse effects. The fewer the adverse effects, the better the technique. Statistically, a non-significant difference was observed in adverse effects among groups [p=0.1489]. In group AL, most of the patients showed a high success rate [21(84.00%)], while in group USG, all the patients showed a high success rate [25(100.00%)]. A high success rate in the USG group than group AL signifies that group USG was better than group AL, which was statistically significant among groups [**p=0.0371**]. [Table 2]

Table-2- Comparison Of Complications, Adverse Effects And Success Rates Across Both Groups

VARIABLES		**Group-AL**	**Group-USG**	**P-Value**
		N %	**N%**	
COMPLICATION	NO	22(88%)	25(100%)	0.0740
	SKIN HEMATOMA	3(12%)	0(0%)	
ADVERSE EFFECT	NO	23(92%)	25(100%)	0.1489
	YES	2(8%)	0(0%)	
SUCCESS RATE	Success	21(84%)	25(100%)	0.0371*
	Fail	4(16%)	0(0%)	

DISCUSSION
Implantation of a central venous catheter via the internal jugular or subclavian vein is essential in surgery. Fluids, blood, or inotropic medicines are typically administered through the catheter passages. [3] CVC is performed for a variety of purposes, including volume resuscitation, central venous pressure monitoring, transvenous pacing, haemodialysis access, and delivery of hypertonic or irritant chemicals. In most cases, central lines are inserted through the internal jugular, subclavian, or femoral veins. In recent years, central venous catheterization has become an indispensable technique in the treatment of critically ill patients. [7]

Although there are a lot of studies comparing real-time USG-guided IJV cannulation with the AL technique in diverse contexts, few of these studies have been verified in emergency rooms in India. The present study aimed to compare the effect of efficacy and incidence of complications in USG guided IJV central venous catheter insertion versus anatomical land mark IJV central venous catheter insertion. Our study helps to determine the USG guided CVC catheter cannulation learning curve and provide a protocol for residents and learner for improve patient safety and efficacy. With the advancement of

technology USG machine is a easily available in operation theatre and intensive care unit, it is essential to know the technique and technology, How to use safely on patients.

In the present study, the mean cannulation time (sec) was higher in the AL group [304.97± 67.18] compared to the USG group [294.17± 72.17]. The mean flash time was higher in group AL [7.20± 2.71] compared to group USG [5.40± 5.16]. The majority of the patients had a flash time of 3-12 mins in both AL [24, 96%] and USG groups [24, 96%]. Similarly, Kunhahamed MO et al. [14] showed a higher mean cannulation time in the AL group [305.88± 66.84] compared to the USG group [293.03± 71.15]. They also noted a higher mean flash time in the AL group [16.59± 10.67] than in the USG group [4.86± 2.18]. Statistically, a non-significant difference was observed in mean cannulation and flash time.

Once a flash of blood is detected at the hub of the syringe, the method for either technique is likely comparable. Prior studies have also shown that independent of expertise, USG guidance reduced the time to blood flash and the number of attempts to obtain a central venous catheter. [60] Further, Turker G et al. [12] observed a higher mean time in the AL group [236± 110] compared to the USG group [95± 136], and this was statistically significant.

In the present study, in the AL group, most of the patients had a catheter placed on the first attempt [17, 68%], followed by the second attempt [7, 28%]; compared to group USG, all the patients had a catheter placed at the first attempt [25, 100%]. The number of attempts showed that the USG group with minimum attempt was way better than group AL. The expertise of the individual inserting the central venous catheter is key to the success rate. According to prior findings, the US-guided method provided for a significant reduction in access time. [15-17]

Central venous catheters were inserted in all patients within 3 minutes using ultrasound guidance. [61] Similarly, Kunhahamed M et al. [14] showed that the catheter was inserted on the first attempt in [49, 70%] patients, of which [17, 48.6%] patients were in group AL and [32, 91.4%] in USG group. Thirteen patients were cannulated on the second attempt, of which [10, 28.6%] in the AL group and [3, 8.6%] in the USG group. In research by Denys et al, IJV cannulation with USG guidance was successful on the first attempt in 77.8 per cent of critically ill patients. [15] Several prior research indicates that the incidence of complications increased with the number of CVC insertion attempts. [16,18]

In the present study, most patients had no complications after the procedure in the AL group [22, 88%], except skin hematoma in 3 patients. In the USG group, all the patients were normal and had no complications [25, 100%]. These results showed that the USG technique was better than AL. As mentioned in previous research, this study reveals that both ultrasonography procedures are superior for IJV catheter placement and reducing problems. Both ultrasonic techniques clarify the relative position of the vein and its surrounding tissues and aid in identifying the vein's and artery's course and diameter, instilling the operator with confidence. [19]

In the present study, the majority of the patients in the AL group [23, 92%] and all patients in the USG group [25, 100%)] had no adverse effects. The fewer the adverse effects, the better the technique. In contrast to the present study, Kunhahamed M et al. [14] observed complications in both groups, i.e., in the AL group, one hematoma, three carotid artery punctures, and one catheter malposition occurred, while in the USG group, two hematomas were observed.

The rate of complications varies depending on the physician's level of expertise. In a study by Sznajder et al, [20] a success rate of 14.3% was recorded for a group of novices. A study by Ray B et al, [21] observed 3 patients (7.5%) in the AL group and 1 patient (2.5%) in each of the USG groups had a carotid artery puncture. In only 1 patient in the AL, group developed a hematoma at the puncture site. Yeum et al, [22] retrospectively evaluated 150 patients who required IJV catheterization and found that 11.3% of instances involved arterial puncture of the common carotid artery. According to the McGee and Gould [18] study of central venous catheter complications, the incidence of complications after three or more insertion attempts increased considerably. Therefore, the number of successful venipuncture and catheter insertion attempts is crucial.

In the present study, in group AL, the majority of the patients showed a high success rate [21, 84%], while in group USG, all the patients showed a high success rate [25, 100%]. A high success rate signifies that group USG was better than group AL. Similarly, Kunhahamed MO et al, [14] noted the success rate of USG-guided IJV catheterization in the ED was 100% (35/35) compared to 91.4% (32/35) in the AL group. In contrast, the success rate did not differ substantially in their study. However, Hrics et al., Mallory et al. and Denys et al. found a significant difference in success rate while comparing the anatomical landmark technique with the ultrasound-guided real-time imaging technique. [15,23,24]

Many studies showed a success rate of 85-99% using AL, like the present study. [15,25] Before and during catheter insertion, real-time ultrasound guidance of CVC insertion gives the operator visualisation of the intended vein and adjacent anatomic features. This technique appears to increase the success rate and reduce the incidence of complications associated with CVC installation [15,24,25]. The current data indicate the superiority of ultrasound-guided IJV cannulation over the landmark technique in mechanically ventilated, intensive-care patients.

REFERENCES

1. Deere M, Singh A, Burns B. Central Venous Access of The Subclavian Vein. InStatPearls [Internet] 2022 May 4. StatPearls Publishing.
2. Merchaoui Z, Lausten-Thomsen U, Pierre F, Ben Laiba M, Le Saché N, Tissieres P. Supraclavicular approach to ultrasound-guided brachiocephalic vein cannulation in children and neonates. Frontiers in Pediatrics. 2017 Oct 5;5:211.
3. Mendenhall BR, Wilson C, Singh K, Dua A, O'Rourke MC. Internal jugular vein central venous access. InStatPearls [Internet] 2021 Apr 19. StatPearls Publishing.
4. Giordano CR, Murtagh KR, Mills J, Deitte LA, Rice MJ, Tighe PJ. Locating the optimal internal jugular target site for central venous line placement. Journal of Clinical Anesthesia. 2016 Sep 1;33:198-202.
5. Caffery T, Jagneaux T, Jones GN, Stopa E, Freeman N, Quin CC, Long AC, Zatarain L, Musso MW. Residents' Preferences and Performance of Three Techniques for Ultrasound-Guided Central Venous Cannulation After Simulation Training. Ochsner Journal. 2018 Jun 20;18(2):146-50.
6. Augoustides JG, Horak J, Ochroch AE, et al A randomized controlled clinical trial of real time needle guided ultra sound for internal jugular vein cannulation in a large university anaesthesia dept.J cardiothoracic vasc anest 2005;19:310-315
7. Zitek T, Busby E, Hudson H, McCourt JD, Baydoun J, Slattery DE. Ultrasound-guided placement of single-lumen peripheral intravenous catheters in the internal jugular vein. Western Journal of Emergency Medicine. 2018 Sep;19(5):808.
8. Bhutta ST, Culp WC. Evaluation and management of central venous access complications. Techniques in vascular and interventional radiology. 2011 Dec 1;14(4):217-24.
9. Kayir S, Ozyalcin S, Dogan G, Diken AI, Turkmen U. Internal jugular vein catheterization: The landmark technique versus ultrasonography guidance in cardiac surgery. Cureus. 2019 Feb 7;11(2).
10. Kornbau C, Lee KC, Hughes GD, Firstenberg MS. Central line complications. International journal of critical illness and injury science. 2015 Jul;5(3):170.
11. Maecken T, Grau T. Ultrasound imaging in vascular access. Critical care medicine. 2007 May 1;35(5):S178-85.
12. Turker G, Kaya FN, Gurbet A, Aksu H, Erdogan C, Atlas A. Internal jugular vein cannulation: an ultrasound-guided technique versus a landmark-guided technique. Clinics. 2009;64:989-92.
13. Dolu H, Goksu S, Sahin L, Ozen O, Eken L. Comparison of an ultrasound-guided technique versus a landmark-guided technique for internal jugular vein cannulation. J Clin Monit Comput. 2015;29:177–82.
14. Kunhahamed MO, Abraham SV, Palatty BU, Krishnan SV, Rajeev PC, Gopinathan V. A Comparison of Internal Jugular Vein Cannulation by Ultrasound-Guided and Anatomical Landmark Technique in Resource-Limited Emergency Department Setting. J Med Ultrasound. 2019 May 13;27(4):187-191. doi: 10.4103/JMU.JMU_2_19. PMID: 31867192; PMCID: PMC6905261.
15. Denys BG, Uretsky BF, Reddy PS. Ultrasound-assisted cannulation of the internal jugular vein. A prospective comparison to the external landmark-guided technique. Circulation. 1993 May;87(5):1557-62.
16. Troianos CA, Jobes DR, Ellison N. Ultrasound-guided cannulation of the internal jugular vein. A prospective, randomized study. Anesthesia & Analgesia. 1991 Jun 1;72(6):823-6.
17. Koski EM, Suhonen MA, Mattila MA. Ultrasound-facilitated central venous cannulation. Critical care medicine. 1992 Mar 1;20(3):424-6.
18. McGee DC, Gould MK. Preventing complications of central venous catheterization. New England journal of medicine. 2003 Mar 20;348(12):1123-33.
19. Tada M, Matsumoto T, Takeda C, Yamada N, Furukawa TA, Watanabe N. Ultrasound guidance versus landmark method for peripheral venous cannulation in adults. Cochrane Database Syst Rev. 2019 Sep 30;2019(9):CD013434. doi: 10.1002/14651858.CD013434. PMCID: PMC6768290.
20. Sznajder JI, Zveibil FR, Bitterman H, Weiner P, Bursztein S. Central vein catheterization: failure and complication rates by three percutaneous approaches. Archives of internal medicine. 1986 Feb 1;146(2):259-61.
21. Ray BR, Mohan VK, Kashyap L, Shende D, Darlong VM, Pandey RK. Internal jugular vein cannulation: A comparison of three techniques. Journal of anaesthesiology, clinical pharmacology. 2013 Jul;29(3):367.
22. Yeum CH, Kim SW, Nah MY, Ma SK, Ko JH, Kim NH, Choi KC. Percutaneous catheterization of the internal jugular vein for hemodialysis. The Korean Journal of Internal Medicine. 2001 Dec;16(4):242.
23. Hrics P, Wilber S, Blanda MP, Gallo U. Ultrasound-assisted internal jugular vein catheterization in the ED. The American journal of emergency medicine. 1998 Jul 1;16(4):401-3.
24. Mallory DL, McGee WT, Shawker TH, Brenner M, Bailey KR, Evans RG, Parker MM, Farmer JC, Parillo JE. Ultrasound guidance improves the success rate of internal jugular vein cannulation: a prospective, randomized trial. Chest. 1990 Jul 1;98(1):157-60.
25. Randolph AG, Cook DJ, Gonzales CA, Pribble CG. Ultrasound guidance for placement of central venous catheters: a meta-analysis of the literature. Critical care medicine. 1996 Dec 1;24(12):2053-8.