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Comparison between anatomical landmark versus ultrasound guided technique for internal jugular vein cannulation

Ghazi Illahi[1], Izhar Faisal[2], Saima Salam[3], Salsabeel Syed[4], Asif Umar[5]
[1](Department of Critical Care, Shri Mata Vaishno Devi Narayana Hospital, katra, Jammu and Kashmir, India)
[2](Department of Anesthesiology and Pain Management, Medeor Hospital, New Delhi, India)
[3](Department of Obstetrics and Gynecology, L.D Hospital, Govt. Medical College, Srinagar, Kashmir, India)
[4](Department of Radiology (Mahajan Imaging), Fortis Flt. Lt. Rajan Dhall Hospital, New Delhi, India)
[5](Department of General and Minimal Access Surgery, SCI International Hospital, New Delhi, India)

Abstract:
Background: *Central venous catheterization of Internal Jugular Vein (IJV) is commonly attempted procedure in anesthesia and intensive care unit. The safe puncture of the IJV is achieved by using anatomical land marks on skin surface, however complications like carotid artery puncture, hematoma, hemothorax, pneumothorax, catheter malposition and even death can occur during the procedure. Some studies have shown thatultrasound guided cannulation could be beneficial in improving the success rate, reducing the number of needle passes, decreasing access time and complications compared to anatomical landmark technique.The purpose of this study was to compare success rate, mean access time and complication rate during internal jugular vein cannulation by using landmark guided (LMG) technique and real time ultrasound guided (USG) technique.*
Material and Methods:*In this Prospective randomized comparative study, 60 patients who required IJV cannulation were randomly assigned to IJV cannulation either by LMG technique (n=30) or by USG technique (n=30). Average access time, average number of attempts, difficulty in cannulation, arising complications and demographics were recorded for each patient.*
Results:*There were no significant differences found in demographic features between the two groups. Cannulation of the internal jugular vein was achieved with 100% success rate for first attempt cannulation in USG technique and in 76.6 % patients in LMG technique. The number of attempts for successful catheterization was statistically lower in USG group of patients compared with landmark group (p=0.007). The mean access time for successful catheterization was significantly reduced in the USG group (141.9 ± 64.79 seconds) compared to LMG group (322.08 ± 125.76 seconds). There was a significant difference found in the total complication of the two groups (30% in LMG group and 6.6% in USG group, p=0.020). Four patients had carotid artery puncture [USG group (n=0) and LMG group (n=4)], technical difficulty of threading the guide wire was encounteredin six patient [USG group (n=1) and LMG group (n=5)] and one patient in USG group had arrhythmia. Carotid artery puncture complication was increased significantly in LMG group (p=0.077 and p=0.038).*
Conclusion: *The findings of this study indicate that ultrasound guided catheterization of the internal jugular vein is superior to the landmark technique with respect to safety, rapidity and comfort to the patient during the procedure and therefore should be the preferred method of choice.*
Keywords: *Central venous cannulation, Internal Jugular Vein, Landmark, Ultrasound.*

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I. Introduction

Central venous catheterization (CVC) is commonly attempted for hemodynamic monitoring such as measurement of central venous pressure, long term fluid administration, antibiotic therapy, chemotherapy, total parental nutrition, hemodialysis and difficult peripheral intravenous (IV) cannulation[1, 2, 3]. Internal jugular vein (IJV), subclavian and femoral veins are the vessels of choice for acquiring central venous access, however cannulation of IJV is usually preferred because of its anatomical position, large diameter and the low risk of complications[2, 3]. The safe puncture ofIJV is accomplished by using anatomical landmarks on skin surface and passing the needle along the anticipated course of the vein. Many anatomical landmark guided techniques for IJV cannulation have been described[4, 5, 6, 7]. Complications including death are influenced by patient factors as well as operator experience[8, 9, 10]. Furthermore, failure to catheterize the IJV may occur in 19.4% of cases [9]. It has been suggested that ultrasound guided central venous catheterization could improve the success rate, reduce number of attempts, decreases cannulation time and complications[11, 12].Also, ultrasound can be used to view the in vivo vascular anatomy of the neck and in asserting the size of IJV and its anatomical relations thereby

identifying the patients with difficult venous access and in whom serious complication can occur[13]. Although ultrasound guided central venous cannulation has been compared favorably to anatomical landmark technique, its widespread use has been restricted by the impracticality of a specially designed ultrasound machine or sterile scanner manipulations, non-availability of equipment and lack of experienced operator[14].Although few prospective studies comparing ultrasound guided CVC versus anatomical landmark technique exists, studies in the Indian context are lacking. Hence, this prospective study was designed to compare classical blind anatomical landmark technique of IJV cannulation with the ultrasound guided approach.

II. Material and Methods

Patients

This prospective randomized comparative study was conducted in the Department of Anesthesiology at Yenepoya Medical College Hospital, Mangalore, Karnataka, from October 2012 to October 2013. A total of 60 patients aged 18 years and above of either sex who required IJV cannulation for various indications such as hemodynamic monitoring, inadequate peripheral venous access, long term infusion of medication, total parenteral nutrition or who needed long term intravenous access were included in the study. Patients with untreated coagulopathy (international normalization ratio > 1.5 and platelets < 50000/mm^3), known vascular abnormalities, infections or burns at the site of cannulation and patients with traumatic injury to neck were excluded from the study.The patients were randomly assigned to one of two groups: LMG group (cannulation was attempted using anatomical landmarks) and USG group (cannulation was attempted using ultrasound guidance). The demographic data of all the patients was recorded. A written, informed consent was obtained from each patient. Institutional ethical committee approval was obtained.

Successful placement of CVC was assessed by chest X-ray obtained after the procedure. Mechanical complications were defined as carotid artery puncture, skin hematoma, pneumothorax, haemothorax, arrhythmia, brachial plexus injury and catheter malposition. Technical problem was defined as difficulty in threading the guide wire after successful puncture of IJV. Carotid artery puncture was identified by forceful pulsatile expulsion of bright red blood from needle. All complications were evaluated clinically, by chest X-ray, and by means of ultrasound where appropriate.

III. Methods

Landmark technique

Patients was placed in the supine position with 15^0 of Trendelenburg position and the head turned at a 30^0 angle to the opposite side, to expose the neck better and to keep the chin away from the procedure. Flexion and extension of the neck were avoided. The operator wore gown, cap, mask and sterile gloves. Theskin at the top of the triangle between the sternal and clavicular head of sternocleidomastoid muscle was cleaned with povidone-iodine before the placement of sterile drapes. Then, the area was anesthetized with 1% lidocaine with a 22-gauge needle and the IJV was located with a 23 gauge "finder" needle connected to 5-ml syringe. The needle was advanced through the skin at 45^0 angle in the direction of ipsilateral nipple. The return of venous blood into the syringe confirmed entry into the vessel, and the finder needle was then used to guide a 18 gauge, 10 cm needle connected to 5-ml syringe. A guide-wire was then placed through the needle into the vein, and the needle was removed. A central venous catheter (Novocent Trio, Poly Medicure Ltd. India) was placed over the wire and advanced into the IJV.

Ultrasound technique

The neck area was prepared and draped with the patient in supine position as described in the landmark technique section above. A 7.5 MHz linear transducer (L14-6S, Mindray, Shenzhen, China) connected to a real-time ultrasound machine (M7, Mindray, Shenzhen, China), wascovered with sterile gel and wrapped in a sterile plastic sheath. Standard two-dimensional (2D) ultrasound imaging was used to measure depth, caliber, patency and compressibility of IJV, and to identify presence of thrombi in the IJV. In case of pre-existing thrombus and/or anatomical anomalies, the IJV on the contralateral side was catheterized. Catheterization procedure was performed with real-time 2D images obtained by placing the transducer parallel and superior to the clavicle, over the groove between the sternal and clavicular heads of the sternocleidomastoid muscle. This facilitated visualization of IJV, external jugular vein and the carotid artery.Vein compressibility and visible pulsations of the artery were used to identify the IJV and carotid artery. After choosing the proper position, the skin was infiltrated with 1% lidocaine, and 18-gauge, 10 cm needle connected to 5-ml syringe was advanced through the skin into the IJV under ultrasound guidance. A guide-wire was then placed through the needle into the vein and the needle was removed. A central venous catheter (Novocent Trio, Poly Medicure Ltd. India) was placed over the wire and advanced into the IJV.To minimize the effect of operator experience on the success rate and mechanical complications, the operator was constant throughout the study. Furthermore, the operator was well-

trained and experienced (5 years of experience in IJV catheter placement and 3 years of ultrasound experience) in performing the procedure.

Data collection and statistical analysis

Demographic characteristics, such as age, gender, physical status (ASA), coagulation profile (such as international normalization ratio and platelet count), and clinical parameters were recorded for all the patients.

The measured outcomes were the access time, the average number of attempts for successful placement, the success of placement, and catheter complication like catheter malposition, carotid artery puncture, skin hematoma, hemothorax, and pneumothorax.

Access time was defined as the time between the first skin puncture and aspiration of venous blood into the syringe. Number of attempts was defined as number of separate skin punctures. When multiple needle passes were attempted, the time from skin contact of the first needle to IJV cannulation was taken into account.Successful placement was defined as the confirmation of catheter in proper position by aspiration of venous blood and post procedural chest X-ray. The access time was measured in seconds by a stopwatch. Complication, if occurred was managed according to the standard protocol.

Data was analyzed using Statistical Package for the Social Sciences (SPSS) software, version 11.5 (SPSS Inc. Chicago, IL, USA). Continuous variableswere expressed as mean ± standard deviation. The student t test was used to compare independent means, and chi-square test was used tocompare categorical variables. A P-value (two-sided in all tests)of <0.05 was considered statistically significant.

IV. Results

Baseline characteristics of the study population are summarized in Table 1.There were no significant differencesbetween the two groups for age, body mass index (BMI), gender, or presence of risk factors for difficult venous cannulation such as prior catheterization, limited sites for access attempts, known vascular abnormalities, untreated coagulopathy and skeletal deformity.

Table 1- Characteristics of the patients

Characteristics	LMG group (n=30)	USG group (n=30)	P value
Age (years)[a]	55.3 ± 10.6	48.17 ± 17.15	0.055
Gender (male/female ratio)	18/12	22/8	0.273
Body mass index (kg/m^2) [a]	25.7 ± 2.6	24.2 ± 5.2	0.163

[a] Values are presented as mean ± standard deviation.

No statistically significant difference was found between the groups in terms of positioning the catheter into right and left IJV (p > 0.05) (Table 2).

Table 2- Right and Left IJV cannulation data

Side of catheterization	LMG group (n=30)	USG group (n=30)	P value
Right IJV	20	16	0.292
Left IJV	10	14	

*p <0.05, statistically significant

With regards to the outcome measures, results using ultrasound guidance are in sharp contrast to those obtained by the landmark technique and are presented in Table 3.

Table 3- Comparison of the outcome measures in the landmark group versus the ultrasound group

Outcome measures	LMG group (n=30)	USG group (n=30)	P value
Access time (seconds)	322.08 ± 125.76	141.9 ± 64.79	< 0.0001
Average number of attempts	1.36 ± 0.718	1 ± 0	0.007
Success rate (cannulation in first attempt)	23 (76.6%)	30 (100%)	0.005
Overall Complications	9 (30%)	2 (6.6%)	0.020
Carotid puncture	4 (13.3%)	0 (0%)	0.038
Difficulty in threading the guide wire	5 (16.6%)	1 (3.33%)	0.087
Arrhythmia	0 (0%)	1 (3.33%)	0.375

Access time and the average number of attempts are presented as mean ± standard deviation. Overall complications, success rate,carotidpuncture, difficulty in threading the guide wire and arrhythmiaare expressed as the absolute number of patients and percentage of their group.

The mean access time and number of attempts for successful placement were both significantly higher in landmark technique compared with the ultrasound guidance (p< 0.0001 and p=0.007 respectively) (Table 3).

The success rate was significantly higher in the ultrasound group as compared to the landmark group (p=0.005) (Table 3). Successful catheter placement was achieved at first attempt in 23 (76.6%) patients in anatomical landmark group and in 30 (100%) patients in the ultrasound guided group. The maximum number of attempts was recorded as 3 in landmark group and 1 in ultrasound group.

The overall complication rate was higher in the landmark group compared to the ultrasound group (p= 0.020) (Table 3). In the landmark group, puncture of carotid artery occurred in 13.3 of patients, which was significantly higher compared with the ultrasound group (p=0.038). Technical difficulty of threading the guide wire was seen in 16.6% of patients in the landmark group and in 3.33% of patients in the ultrasound group, however this difference was not statistically significant(p>0.05). Furthermore, one patient in ultrasound group had arrhythmia, but no such complication was observed in the landmark group.

Complications such as hematoma, pneumothorax, hemothorax, nerve injury, catheter malposition and catheter infection were not observed in any of the groups.

V. Discussion

The use of CVCs is associated with multitude of complications that are hazardous to the patient as well as potentially costly to treat[15]. Mechanical complications have been reported to occur in 5% to 19%, infectious complications in 5% to 26%, and thrombotic complications in 2% to 26% of the patients[16, 17]. Complications vary according to the insertion route, patient anatomy, patient setting, technique used and operator's experience[9, 11, 13].

The use of landmark technique for IJV cannulation was first described in 1966 by Hermosura et al[4]. The traditional method of IJV cannulation includes the use of anatomical landmarks, artery palpation and direct balloting of the vein[18].Ultrasound guided insertion of CVC was first described by Legler and Nugent in 1984[19].Insertion of CVC under ultrasound guidance enables the operator to visualize the IJV directly and evaluate the surrounding anatomical structures prior to and during cannulation. When used, this method appears to improve the success rate and decrease the possibility of anatomical complications associated with central venous cannulation[11, 20, 21]. The present study also demonstrates the superiority of ultrasound guided cannulation of IJV compared to landmark technique.Using ultrasound guided technique, 100% of the patients had successful IJV cannulation on the first attempt versus 76.66% of the patients in the landmark technique. The results obtained in our study are in accordance with the success rates documented in in previous studies [1, 5, 6, 9, 20, 21, 22, 23].

In our study, mean access time, average number of attempts and overall complications showed significant difference between the anatomical landmark group and the ultrasound group, which is in agreement with the previous studies[1, 2, 3].

The maximum number of attempts for IJV cannulation was recorded as 3 in the landmark group versus 1 in the ultrasound group, which is in range with the previous reports[1, 2, 3, 21, 24].

The most commonly observed mechanical complications during CVC placement are arterial puncture, hematoma and pneumothorax[15]. There were no complications such as hematoma, pneumothorax, hemothorax, nerve injuries or catheter infection observed in either group, we only observed carotid artery puncture and arrhythmia.

The incidence of carotid artery puncture was greater(13.3%) with landmark technique than the ultrasound guided technique (0%), which is consistent with the previous reports [1, 25]. Also, ventricular ectopics, a complication related to cannulation rather than technique, was observed in 3.33% of patients in the ultrasound group, which reverted to the sinus rhythm on adjusting the depth of insertion of the guide wire. As reported in earlier studies, this study also demonstrates that the incidences of mechanical complications using ultrasound guided technique arenegligible[7, 21, 23].

VI. Conclusion

The findings of this study indicate that internal jugular vein catheterization using the ultrasound guidanceis superior to anatomical landmark technique in regards to success rate of the first attempt and number of attempts. Also, ultrasound guidance provides advantage of shorter access time and lower rate of mechanical complications.

References

[1]. Karakitsos D, Labropoulos N, De Groot E, et al. Real-time ultrasound-guided catheterisation of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients. Crit Care. 2006; 10(6):R162.
[2]. 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(1):177-182.
[3]. 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 (Sao Paulo)*. 2009; 64(10):989-992.
[4]. Hermosura B, Vanags L, Dickey MW. Measurement of Pressure during Intravenous Therapy. *JAMA*.1966; 195(4):321.
[5]. Daily PO, Griepp RB, Shumway NE. Percutaneous internal jugular vein cannulation. *Arch Surg*. 1970; 101(4):534-536.

[6]. Rao TL, Wong AY, Salem MR. A new approach to percutaneous catheterization of the internal jugular vein. *Anesthesiology*. 1977; 46(5):362-364.
[7]. Hayashi H, Ootaki C, Tsuzuku M, Amano M. Respiratory jugular venodilation: a new landmark for right internal jugular vein puncture in ventilated patients. *J Cardiothorac Vasc Anesth*. 2000; 14(1):40-44.
[8]. Digby S. Fatal respiratory obstruction following insertion of a central venous line. *Anaesthesia*. 1994; 49(11):1013-1014.
[9]. Sznajder JI, Zveibil FR, Bitterman H, Weiner P, Bursztein S. Central vein catheterization. Failure and complication rates by three percutaneous approaches. *Arch Intern Med*. 1986; 146(2):259-261.
[10]. Mansfield PF, Hohn DC, Fornage BD, Gregurich MA, Ota DM. Complications and failures of subclavian-vein catheterization. N Engl J Med. 1994 Dec 29; 331(26):1735-8.
[11]. 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(12):2053-2058.
[12]. Bond DM, Champion LK, Nolan R. Real-time ultrasound imaging aids jugular venipuncture. *Anesth Analg*. 1989; 68(5):700-701.
[13]. Hatfield A, Bodenham A. Portable ultrasound for difficult central venous access. Br J Anaesth. 1999; 82(6):822-826.
[14]. Hayashi H, Amano M. Does ultrasound imaging before puncture facilitate internal jugular vein cannulation? Prospective randomized comparison with landmark-guided puncture in ventilated patients. J Cardiothorac Vasc Anesth. 2002; 16(5):572-575.
[15]. McGee DC, Gould MK. Preventing complications of central venous catheterization. N Engl J Med. 2003; 348(12):1123-1133.
[16]. Kander T, Frigyesi A, Kjeldsen-Kragh J, Karlsson H, Rolander F, Schött U. Bleeding complications after central line insertions: relevance of pre-procedure coagulation tests and institutional transfusion policy. Acta Anaesthesiol Scand. 2013; 57(5):573-579.
[17]. Bowdle A. Vascular complications of central venous catheter placement: evidence-based methods for prevention and treatment. *J Cardiothorac Vasc Anesth*. 2014; 28(2):358-368.
[18]. McGrattan T, Duffty J, Green JS, O'Donnell N. A survey of the use of ultrasound guidance in internal jugular venous cannulation. *Anaesthesia*. 2008; 63(11):1222-1225.
[19]. Legler D, Nugent M. Doppler localization of the internal jugular vein facilitates central venous cannulation. *Anesthesiology*. 1984; 60(5):481-482.
[20]. Mallory DL, McGee WT, Shawker TH, et al. Ultrasound guidance improves the success rate of internal jugular vein cannulation. A prospective, randomized trial. *Chest*. 1990; 98(1):157-160.
[21]. 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; 87(5):1557-1562.
[22]. Schwartz AJ, Jobes DR, Greenhow DE, Stephenson LW, Ellison N. Carotid artery puncture with internal jugular cannulation using the Seldinger technique: Incidence, recognition, treatment, and prevention. Anesthesiology 1979; 51:S161.
[23]. Gordon AC, Saliken JC, Johns D, Owen R, Gray RR. US-guided puncture of the internal jugular vein: complications and anatomic considerations. *J Vasc Interv Radiol*. 1998; 9(2):333-338.
[24]. Hosokawa K, Shime N, Kato Y, Hashimoto S. A randomized trial of ultrasound image-based skin surface marking versus real-time ultrasound-guided internal jugular vein catheterization in infants. *Anesthesiology*. 2007; 107(5):720-724.
[25]. Yeum CH, Kim SW, Nah MY, et al. Percutaneous catheterization of the internal jugular vein for hemodialysis. *Korean J Intern Med*. 2001; 16(4):242-246.

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