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INTERNAL JUGULAR VEIN CATHETERIZATION: A COMPARISON BETWEEN ULTRASOUND GUIDED TECHNIQUE WITH LANDMARK GUIDED TECHNIQUE

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ABSTRACT

Introduction: *Central venous cannulation is frequently performed procedures to gain access to the central vein. With increased use of ultrasonography to guide cannulation, the success rate has improved and it has decreased the time required for cannulation and complications. The aim of the study was to compare ultrasound guided technique (USG) and landmark technique (LMG) in Internal jugular vein.*

Materials and Methods: *This study was conducted in National Medical College and Teaching Hospital, Birgunj from July 2019 to July 2020. Ethical clearance (NMC/420/075/076) was obtained from institutional review committee of NMC Birgunj. Total of 60 patients were randomly allocated into two groups; ultrasound group (USG) landmark group (LMG) underwent landmark guided catheterization. Access time, number of attempts for successful cannulation and incidence of various complications were compared between groups. Data analysis was done with Statistical Package for Social Science version 22.*

Result: *The study was conducted on 60 patients, divided randomly into two groups with 30 patients in each group. The mean age for LMG was 48.57±16.08 years and for USG was 50.03±13.36 years. Out of 60 patients, 61.7% were male and 38.3% were female. The mean of neck dimension for LMG and USG was 35.95±6.327 and 35.67±6.194 cm respectively. The mean distance under LMG and USG was 19.07±1.780 and 18.33±2.368 cm respectively. The mean access time taken for LMG and USG was 403.10±98.111 and 217.57±75.408 seconds respectively (p<0.001). LMG technique showed total 5 cases (16.7%) of carotid artery puncture during procedure whereas there were no cases seen in USG (p value 0.05).*

Conclusion: *This study has shown better result of ultrasound guided internal jugular cannulation when compared with landmark guided internal jugular vein cannulation technique by decreasing number of needle passes, access time, complication and giving least discomfort to the patient.*

Keywords: *Internal jugular vein cannulation; Landmark guided catheterization; Ultrasound guided catheterization.*

INTRODUCTION

Central venous catheterization is defined as the process of insertion of an indwelling catheter into a central vein for a purpose of administering fluid, medications and for the measurement of central venous pressure (CVP).[1] Traditionally, CVC placement was performed using landmark technique on the basis of anatomic structure relating the arteries and veins. This technique does not account for anatomic variations at the CVC insertion

site. However anatomic variation to the normal anatomy has been described in relevant proportion of patient for Internal jugular vein (IJV). In addition to the anatomic variation, venous thrombosis which is especially common in oncologic and ill patients can make CVC placement almost impossible or dangerous for patients. Complications including death are influenced by patients factor such as body mass index, site of attempted access and operator experience in case of anatomical landmark.[2] So, ultrasound (US) can be used for easily visualizing anatomic structures and patency of the vein and also helps to avoid unintended arterial puncture or unsuccessful cannulation and related complications.[3]

MATERIALS AND METHODS

A cross-sectional study was done at National Medical College, Department of Anesthesiology and critical care, Birgunj from July 2019 to July 2020. Total of 60 cases were included in the study who needed internal jugular catheterization. Informed consent was obtained from the cases that were included in the study. Ethical clearance (NMC/420/075/076) was obtained from institutional review committee of NMC Birgunj. Patient who were allocated for surgery undergoing major surgical procedures or admitted in Intensive care unit (ICU) who needed central venous cannulation were included in the study.

On the basis of study done by Parajuli SS.et al[4] sample size was calculated.

Using the formula for estimating sample size:

$$N = \frac{2\sigma^2}{(m_1 - m_2)^2} \times f(\alpha,\beta)$$

Where,

N = Number of patients in each group,

m_1 = assumed proportion of USG guided

m_2 = assumed proportion of landmark guided

σ = standard deviation of the response group

f (α,β) :10.5 (from the table)

from the article[68],

$m_1 = 108.56$

$m_2 = 138.08$

$\sigma = 27.822$

$$N = \frac{2\times(27.822)^2}{(108.56-132.08)^2} \times 10.5 \text{ (from table)}$$

N = 29.384

N ≈ 30 in each group

Hence, we will take 30 patients in each group with total patient of 60.

LMG group: land mark guided internal jugular cannulation.

USG group: ultrasound guided internal jugular cannulation.

Patients were randomly allocated into two groups (USG group or LMG group) by lottery withdrawn by assistant from sequentially numbered container which was revealed after patient received general anesthesia in operation theater or in ICU cases. In the procedure room, non-invasive blood pressure, electrocardiogram and pulse oximeter were attached and pre-procedure baseline vitals were measured and a peripheral venous access were obtained via an 18/20 Gauze cannula. IV set was joined and the isotonic fluid was attached to the cannula. Seven French triple lumen central venous cannula with 18 gauze transducer needles was used. In the USG guided group (USG group), an ultra sound scanner with linear probe (Samsung medison Diagnostic ultrasound system model no PT60A) was used. Under all aseptic precaution, the puncture site was infiltrated with 1% lignocaine or without local anesthetic infiltration in anesthetized patients. The patient was kept in the Trendelenburg's position and the head turned to the other side by 15 degrees. The probe was placed at the apex of the triangle formed by the two heads of sternocleidomastoid muscle and clavicle. The depth in ultrasound machine was adjusted 2-3 cm to optimize the view of the vessel. The IJV was identified as an oval thin walled hypo echoic 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 45degrees. The movement of needle tip and the change of the shape of the vein were carefully observed. The tip of the needle lying intravascular was visualized clearly on the image and the free flow of the blood upon aspiration was taken as confirmation of correct position of the needle. In LMG group 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 SCM's was palpated for right carotid artery pulsation. Once palpable, the right carotid artery was pressed slightly medially with fingers of the left hand so that it was not over the IJV. A puncture needle was then inserted just lateral to the point of carotid artery pulsations, directed towards the ipsilateral nipple at angle of 20degree-30 degree with skin. The needle was withdrawn holding the guidewire in place and the catheter was railroaded over it after dilatation of the tissue plane in both the cases.

Number of attempts, access time and complication during procedure were noted in the data collection sheet. The collected data was entered in Microsoft-excel 2007 sheet. Entered data was verified and converted in statistical package for social sciences (SPSS) 22 version for statistical analysis. Data was analyzed by descriptive statistics (frequencies, percentage, mean, median and standard deviation) and student t test was used to compare mean. A p-value< 0.05 was considered significant.

RESULTS

The study was conducted on 60 patients, divided randomly into two groups with 30 patients in each group. Maximum number of cases were seen between 55-64 years of age with total number of 17 cases (figure 1). The mean age for LMG was 48.57±16.08 years and for USG was 50.03±13.36 years (table 1).

Figure 1: Bar diagram showing age distribution among the study population

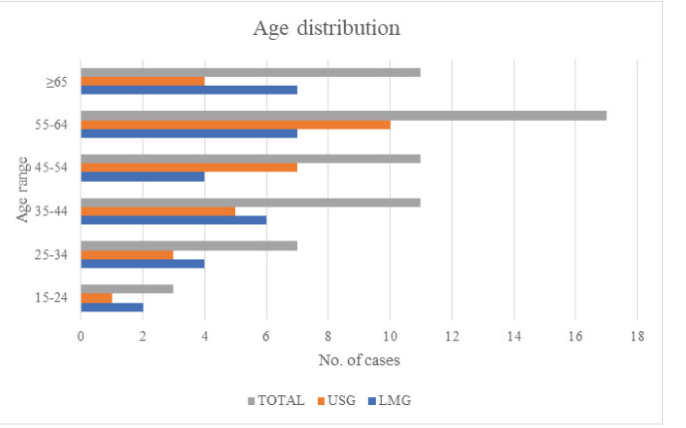

Table 1: Mean age of study populations

Methods	No.	Mean age	SD	Min. age	Max.age
LMG	30	48.57	16.08	19	70
USG	30	50.03	13.36	22	75

Out of 60 patients, 37 (61.7%) patients were male and 23 (38.3%) were female (figure 2).

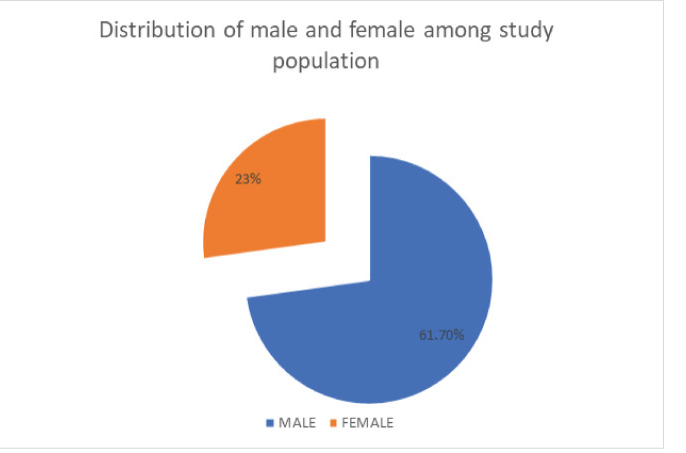

Figure 2: Pie chart showing percentage of male and female among study population

Table 3: Distribution of mean neck dimensions among study populations

	Method	No. of patients	Mean	SD
Neck circumference (cm)	LMG	30	35.97	6.327
	USG	30	35.67	6.194
Distance (cm)	LMG	30	19.07	1.780
	USG	30	18.33	2.368

The mean value of neck dimension for LMG and USG was 35.95±6.327 and 35.67±6.194 cm respectively. The mean distance under LMG and USG was 19.07±1.780 and 18.33±2.368 cm respectively (table 3).

Table 4: Mean access time in seconds among study population

Method	No. of patients	Mean access time in seconds	SD	MIN	MAX	P VALUE
LMG	30	403.10	98.111	245	645	<0.001
USG	30	217.57	75.408	120	400	

The mean access time taken for LMG and USG was 403.10±98.111 and 217.57±75.408 seconds respectively. The study showed statistically significant difference between LMG and USG with p value <0.001 (table 4)

Table 5: Distribution of no. attempts among study populations

No. of Attempts	Method		Total	P Value
	LMG (n=30)	USG (n=30)		
1	24 (80%)	28 (93.3%)	52 (86.7%)	0.254
2	6 (20%)	2 (6.7%)	8 (13.3%)	

Out of 60 total cases, in landmark technique, 24 cases (80%) were successful. Whereas in ultrasound technique 28 cases (93.3%) were done in single attempt. There is no significance (P=0.254) in number of attempts in cannulation between LMG and USG (table 5).

Table 6: Distribution of complication among study groups

COMPLICATIONS	METHOD		TOTAL	P VALUE
	LMG	USG		
Carotid artery puncture	5 (16.7%)	0	5 (8.3%)	0.05
Arrythmias	1 (3.3%)	0	1 (1.7%)	0.313
Pneumothorax	1 (3.3%)	0	1 (1.7%)	0.313
Hematoma	4 (13.3%)	1 (3.3%)	5 (8.3%)	0.161
Total	11 (36%)	1 (3.3%)	12 (20%)	

The overall complication rate was higher in LMG technique than in USG technique. Most common complication seen was carotid artery puncture. LMG technique showed total 5 cases (16.7%) of carotid artery puncture during procedure whereas there were no cases seen in USG technique. It showed statistically significance with p value 0.05 (table 6).

Table 7: Distribution of chest X-ray among study population

Chest X-ray	Method		Total
	LMG	USG	
Normal	29 (96.7%)	30 (100%)	59 (98.3%)
Pneumothorax	1 (3.3%)	0	1 (1.7%)

Out of 60 cases 1 patient developed pneumothorax after cannulation by LMG technique. Remaining patients showed normal chest X-ray (table 7).

DISCUSSION

Central venous catheterization is commonly used procedure and is performed in patients needed for monitoring of central venous pressure or long-term intravenous access.

The right IJV is usually preferred because superior venacava can be reached directly from the right avoiding injuries to the ductus thoracicus.[5] It is the first choice in patients with coagulopathy. Traditionally IJV cannulation was done by palpation and using anatomical landmarks.[6] Then the procedure of using ultrasound guidance has been described.[7,8]

The use of CVCs may be hazardous to patients when complication occurs and also increases the expense to treat. To prevent complication appropriate catheter, appropriate position of the patient, appropriate vein and care should be given. The total complication rate was found to be 36% in LMG group while it is 3.3% in USG group. There was 32.7% decrease in overall complication rate by USG technique in comparison to LMG technique. In the literature, the mechanical complication rates were 5%-19%, thrombotic complication rates were 2%-26% and infection complication rates were 5%-26%.[9,10]

These complications are usually associated with several characteristics. The leading factors are morbid obesity, cachexia, local scarring from surgery or radiation treatment, patients receiving mechanical ventilation comorbidities and operator's experience.[11]

In this study maximum number for internal jugular vein cannulation was seen in age group of 55-64 years. The mean age for ultrasound group was 50.03±13.36 and land mark group was 48.57±16.08 years. Similar study was done by Hasan Dolu et.al[60] where mean age group for ultrasound group was 53.6±5.8 years and landmark guided group was 53.2±9.10 years. Similarly, other studies done by Kunhahamed et.al,[5] Karakitosis et.al[13] showed mean age of USG group as 46.74±16.36 and landmark group was 50.41±17.93 years; USG group 49±15.9 and LMG group 45±13.5 years; USG group 58.3±10.3 and LMG 59±9.5 years respectively.

In this study maximum intervention was done in male with 60% under landmark group and 63.3% under ultrasound group. Similarly, in the study done by Kunhahamed et al[5] 60% male and 40% female underwent USG technique and through landmark technique 49% were male and 51% were female. Similarly, male preponderance was seen in other studies; Dolu et al[14] (65% were male and 35% were female), Turker et al[12] (male 62.63% and female 64).

The access time was shorter in USG technique with a mean of 217.57±75.408 seconds compared with LMG technique mean of 403.10±98.11 seconds ($p<0.001$). Similar other studies done by Filho et al[15] showed mean access time for US group was 119.4±56.9 seconds and for blind group the access time was 137.8±94.6 seconds($p<0.98$). In a study done by Cajozzo et al[16] the average time for central venous catheterization for landmark group was 7 minutes and for USG group it was 4 minutes. Whereas in the study by G. Turker[12] et al the access time in seconds for LMG group was 236±110 and USG group was 95±136. ($p<0.01$) This showed that the ultrasound guided technique consumes lesser access time from penetration of the skin to suturing the catheter than the landmark technique. Thus, the study showed statistical significance.

In the present study the IJV access time was significantly shorter in USG group compared to the LMG group. It was consistent with the previous studies. This is important in case of emergency department where the patients' conditions are critical and the time saving would be vital for the patients.

The total no of cases that underwent internal jugular catheterization for the first attempt in ultrasound guided technique were 28 patients (93.3%) whereas for LMG there were 24 patients (80%). Also, second attempt was needed in the both technique where out of 30 patient 2 cases were successful in second attempt by USG technique and 6 cases were successful in second attempt by LMG($p=0.254$). Kunhahamed et al[5] conducted similar study in which 48.6% of patients in AL group had successful cannulation in first attempt whereas in USG group there was 91.4% success was seen in first attempt. There was statistically significant difference seen in the study ($p<0.001$). Similarly, the others studies were done by Karimi Sari. et al[17], Hrics et al,[18] Denys et al[19] (88%, 71%, 77.8%) showed significant difference in first attempt between USG and LMG.

The use of ultrasound for central venous puncture reduces the number of attempts and puncture because the puncture takes place with direct visualization of the area in which the needle is being inserted.[8,20] In our study second attempt of catheterization was needed in two patients due to an abnormality of the vascular track (thrombosed vessel and secondly the ultrasound scanner could not identify the internal jugular vein because the diameter was small).

The incidence of mechanical complications using ultrasound guided technique was negligible. Out of 30 patients who underwent landmark guided technique 16.7% had carotid artery puncture whereas there were no cases seen in ultrasound guided technique and it showed statistical significance with p- value 0.05. These findings were in accordance with the literature Kayir et al[11], Denys et al[19], G. Turker et al[12] who reported (7%, 8.3% 4.73% respectively) the incidence of complications from carotid puncture using landmark technique. The statistical difference was strongly significant with (p value 0.01, <0.05, <0.05 respectively)

The reason behind the carotid artery puncture could be due to anatomical difference in the location of jugular vein relative to carotid artery. It has a close anatomical proximity to the IJV. In the study done by Denys et al[19] showed 92% of patients had anterolateral location of internal jugular vein, 1% had >1cm lateral to the carotid artery, 2% of patients had medial to the carotid artery and 5.5% of patients were not within the anatomical reference.

The incidence of arrhythmia and hematoma was higher with landmark guided group with 3.3% and 13.3% respectively, but was not statistically significant.

The reason behind the arrythmias in the study could be because of accidentally excess insertion of guide wire during catheterization as there was no level marking in the guide wire.

Similarly, study conducted by Karakitosis et al[13] the rate of complication was significantly higher in the landmark group of patients as compared with ultrasound group

(p<0.001). Out of 450 patient complication were seen under hematoma, hemothorax, and pneumothorax 2(0.4%), 0(0%), and 0(0%) respectively in USG group whereas in LMG group 38(8.4%), 8(1.7%), and 11(2.4%) respectively were seen.

Another study conducted by Denys et al[19] found complication rate was significantly higher (p<0.001) with hematoma seen in 10 patients (3.3%). (i.e. p< 0.05) in landmark guided technique whereas 2 patient had hematoma (0.3%) in ultrasound guided technique.

In this study, there was one case (3.3%) of pneumothorax seen during LMG technique and no cases were seen in USG technique. But it was statistically insignificant. (p=0.313). This was similar to the study done by Karimi S. et al[17] where one case from anatomical landmark group had pneumothorax which statistically insignificant with p value 0.501. In this study there was one case of pneumothorax in landmark guided group and no cases of pneumothorax in ultrasound group.

CONCLUSION

Ultrasound guided central venous cannulation showed many advantages over landmark technique by reducing the access time significantly and decreasing the incidence of number of attempts. There was no statistical difference found between the two groups for total complications but statistical difference was seen between groups for arterial puncture. Thus, we conclude that ultrasound technique affords an easier, safer and more rapid cannulation for central venous access.

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