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Internal Jugular Vein Cannulation: A Comparative Study of Two Techniques-Anatomical Landmark and Ultrasound Real Time – A Prospective Randomized Control Study

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Abstract: ***Background and Objectives: Central venous catheterization plays an important role in patient care in major operative procedures and in intensive care units. The objectives of this study were to evaluate and compare the number of attempts, Vascular access time and complications of cannulating the Internal Jugular vein (IJV) by anatomical landmark and Real time ultrasound. Methodology: A total of 100 patients were taken and randomly assigned into two groups of50 patients each. IJV was cannulated (Seldinger technique) by anatomical land mark method in group 1 and by real time ultrasound method in group 2.Following parameters were observed: Age, Sex, Height and Weight, Neck Circumference, Number of Attempts, Vascular access Time and Complications. Results: The demographic data of the patients didn't show statistical significance between the two groups.The mean ± standard deviation of neck circumference (cms) in anatomical landmark group was 40.08±2.80, and real time ultrasound was 41.08±2. 80 with p value of 0.18, not significant in this study. The mean ± standard deviation of Body mass index in anatomical landmark group was 24.1±2.06, and real time ultrasound was 25.06±3.42 with p value of 0.09 not significant in this study. The mean ± standard deviation of Vascular access time (seconds) in anatomical landmark group was 340.34±160.89 and real time ultrasound was 160.78±70.01 with p value < 0.001 which was statistically significant. In Real time ultrasound group the internal jugular vein was cannulated in first attempt in 46 patients, where as in anatomical landmark only 28 patients with p value < 0.02 which was statistically significant.The incidence of complication was 6 %in anatomical landmark group and nil in real time ultrasound group. Conclusion: The ultrasound real time is more beneficial in placing internal jugular vein cannulation compared with traditional anatomical landmark technique with higher success rates and decreased number of complications and increases the safety and comfort of the patients.***

Keywords: Internal Jugular Vein, central venous line, Anatomical landmark, Real Time Ultrasound.

1. Introduction

Central venous catheterization plays an important role in patients care in major operative procedures and in intensive care units. Central venous catheterizations are usually inserted in the Internal Jugular Vein (IJV), Subclavian vein, and femoralvein [1, 2]. Subclavian access potentially presents a higher risk of pneumothorax while femoral access displays a higher risk of artery puncture and of infectious complications when compared to the jugular approach [3, 4]. Cannulation of the internal Jugular vein is usually preferred because of its anatomical position and large diameter in the Trendelenburg position. Different approaches have been described, which pose mechanical complications during insertion, such as accidental Carotid artery (CA) puncture, local hematoma and pneumothorax, at an incidence of 3% to 10% for ICA and/or local hematoma, and 0.8% to 2.4% for pneumothorax [5, 6].

Additionally, the IJV approach by anatomical landmarks displays a variable incidence of failure, ranging from 2% to 35%. Many studies have identified the factors associated with complications during Central Venous Line placement by anatomical landmarks, namely operator's experience, site of placement, number of attempts, patient's Body Mass Index (BMI) [7, 8, 9].Doppler ultrasound has been applied to describe the anatomy of Internal Jugular vein and its relationship with carotid artery, which helps the clinicians to determine the direction, depth and site of venepuncture. Ultrasound guided cannulation limits complications and also decreases the cannulation time [10, 11, 12, 13].

The aim our study is to compare the ease of insertion, number of attempts taken, time required for insertion and complications of internal jugular vein cannulation using anatomical landmark technique without using ultrasound, and real time ultrasound.

2. Methodology

The study was undertaken after obtaining ethical committee clearance as well as informed consent from all patients. In this Prospective, observational, comparative and randomized control study, Patients were randomly assigned into two groups. Randomization was done using computer generated random numbers inserted into opaque concealed envelopes; inside these envelopes was a number, which indicates the group to which the patient was assigned.

Patients undergoing elective surgical procedures requiring internal jugular vein cannulation of either sex, between the age group 20-60 years were included in study. Exclusion criteria were being Patient refusal, Previous history of central venous line insertion on same site, Abnormal coagulation profile (international normalization unit INR > 1.5 and platelets <50000 cells/ccmm), Patients with local infection at the site of insertion. A thorough preanaesthetic evaluation was done and required investigations done accordingly. The baseline heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) was recorded for all patients using the monitor. Patient was kept nil per orally for 6 hours, a thorough preanaesthetic drill performed

and drugs and resuscitation equipment kept ready. Patient was shifted to preoperative room and pulse oximeter, blood pressure, electrocardiography are connected to the patient. Based on the random group allocation following procedure was be followed.

Group – 1: Anatomical landmark technique: The patient was placed in supine and head down position (15 degree) with head turned 20-30 degrees to the opposite side to expose the neck. Anatomic landmarks including sternal notch, clavicle, sternocleidomastoid were assessed. The carotid artery was then palpated and its course determined .Under sterile aseptic precaution, the intended venipuncture site was anaesthetized by subcutaneous infiltration with local anaesthetic solution (2% Lignocaine). With the finger of the left hand gently resting on the carotid arterial pulse as a valuable anatomic landmark, the venipuncture is then preceded with a 22G finder needle mounted on a 2 ml syringe. The needle was inserted at the apex of the triangle formed by the two heads of sternocleidomastoid muscle (Sellindot's triangle), at an angle of approximately 30 degrees from the plane of the skin, and directed towards the ipsilateral nipple. Gentle aspiration will identify the internal jugular vein when dark venous blood enters the syringe. The finder needle was then gently withdrawn, keeping the left hand on carotid fixed. The vein is then punctured with an 18G thin walled needle attached to a 2ml syringe, directed along the same track used by the finder needle. Once venipuncture was successful as confirmed by aspiration of dark venous blood into the 2ml syringe the syringe is detached. A guide wire was inserted through the needle and was advanced with least resistance. The ECG is monitored to detect arrhythmias. The puncture site is then enlarged with no.11 scalpel blade. A firm taper tip dilator was used to dilate the subcutaneous tissue. The central venous catheter was then inserted over the guide wire while the traction over the skin is maintained. The guide wire was gently withdrawn. Once aspiration of blood and free flow of infusate are documented, the catheter secured in place with suture material and sterile occlusive dressing is applied. Bilateral breath sounds auscultated.

Group –2: Real Time Ultrasound Technique:
The patient was placed in supine position with head turned 20-30 degrees to the opposite side to expose the neck.The chosen insertion site was prepared with 2% chlorhexidine. Maximum barrier precaution like sterile gloves, gown, drape and mask were used to decrease the risk of bacterial colonization .A portable ultrasound scanner array probe with 7.5MHz ultrasound machine is used.The transducer was covered with ultrasound gel and wrapped in a sterile plastic bag. Sterile physiological saline solution is spread on the patient's skin to eliminate the air interface between the skin and the plastic bag. In this study 2D linear 3MHz-12MHz Tranducer was used throughout the study in real time ultrasound. The carotid artery was visualized as a thick-walled, pulsatile and non-compressible by probe with no changes with respiration whereas internal jugular vein was visualized as thin-walled, non-pulsatile, compressible by probe and decrease in diameter on inspiration.

Internal jugular vein is identified by anatomical location compressibility and non-pulsatile. After positioning the vein in the center of ultrasound screen, the vessel is punctured under direct vision using 18 gauge needle. Backflow of dark coloured blood is noted then preceded as modified Seldinger technique. Chest X-ray was obtained to verify the correct position of tip and to rule out pneumothorax and haemothorax.

Following parameters are noted: Age, Sex, Height and Weight, Neck Circumference, Puncture Site, Number of Attempts, Vascular access Time, Complications. Vascular access time was defined as the time from the starting of insertion of the introducer needle to the end of catheter placement, not including the suturing and fixation time. Carotid artery puncture is diagnosed by visualization of throbbing bright red blood return through the syringe. Local hematoma is diagnosed through inspection and palpation of the puncture site. Pleural complications were diagnosed by chest radiography.

The sample size was calculated with alpha of 0.05 and, Power of 0.8 which revealed 43 patients in each group. It was decided to include 50 patients in each group with total of 100 patients for this study. Demographic data, (age, weight, height, body mass index), Vascular access time are compared using one- way analysis of variance (ANOVA).Sex distribution, complications are compared by using Chi-square test. P value less than 0.05 is considered significant and $p<0.001$ is considered highly significant.

3. Results

A total of 100 subjects were included in the study.The demographic data of the patients didn't show statistical significance between the two groups. The mean value of neck circumference (cms) in anatomical landmark group was 40.08±2.80, and real time ultrasound was 41.08±2. 80 with p value of 0.18, not significant in this study.The mean value of Body mass index in anatomical landmark group was 24.1±2.06, and real time ultrasound was 25.06±3.42 with p value of 0.09 not significant in this study.The mean time for Vascular access time (seconds) in anatomical landmark group was 340.34±160.89 and real time ultrasound was 160.78±70.01 with p value < 0.001 which was statistically significant.

Table 1: Neck circumference, BMI, Vascular access time

Group	Landmark		USG-RT		P value
Value	MEAN	SD	MEAN	SD	
Neck Circum	40.08	2.80	41.08	2.80	o.18
Body Mass Index	24.1	2.06	25.06	3.42	0.09
Vascular Access Time	340.34	160.89	160.78	70.01	< 0.001*

*statistically significant.

Forty six patients in group 2, internal jugular vein was cannulated in first attempt where as in anatomical landmark only 28 patients with p value < 0.02 which is significant in the study.In group 1, there was difficulty to cannulate internal jugular vein inspite of third attempt in one patient and carotid puncture occurred in first attempt. So we used Ultrasound real time to secure internal jugular vein.

Table 2: Number of Attempts

Group	*Landmark*		*USG-RT*	
Attempts	Number	%	Number	%
One	28	56	46	92
Two	16	32	3	6
Three	6	12	1	2
Total	50	100	50	100

The only complication observed was of carotid artery puncture which was **6**% in group 1 and nil in group 2.No other complications were noted in both groups as shown in table 3.

Table 3: incidence of Complications

Group	Landmark		USG-RT	
Compications	Number	%	Number	%
Arterial Punture	3	6	0	0
Pneumothorax	0	0	0	0
Hematoma	0	0	0	0
Nerve Injury	0	0	0	0

4. Discussion

In the recent years central venous cannulation is gaining popularity. It is used for hemodynamic monitoring, total parenteral nutrition, renal replacement therapy, transvenous cardiac pacing, antibiotics, to measure pulmonary artery pressures and port for medication administration [14].

With increase longevity and changes in lifestyle, numerous patients are coming for major/ multiple surgeries in one sitting. In addition there is a major inflow of patients requiring various interventions requiring continuous monitoring of central venous pressures and if required pulmonary arterial pressures to achieve better outcome. So, it has become mandatory for an anesthesiologist to become familiar and expert with the technique of placement and monitoring of central venous pressure [9, 11].

Central venous line can be secured at different sites like Internal Jugular Vein, Subclavian Vein, External Jugular Vein, femoral vein, but internal jugular vein is most common because of its straight course with heart, valveless and less number of complications. [10]

Central venous cannulation can be done in different ways like Anatomical landmark technique and Ultrasound Real time. Recently Ultrasound guided cannulation of internal jugular vein has gained popularity and also increase ease of insertion. Ultrasound guided cannulation reduces the complications and increases the safety of the patients [14, 15, 16].

This study took various anthropometric measurements like Height, Weight, Neck circumference and bio-chemical parameters into considerations to know whether any of these have significant in either of the techniques compared. The position of the patient throughout the study was in 15 degree Trendelenburg position and neck tilt to opposite site in the range of 15-20 degree in both techniques of insertion of internal jugular vein cannulation.

The mean ± standard deviation of neck circumference in anatomical landmark group was 40.08±2.80 and real time ultrasound was 41.08±2. 80 .The neck circumference at thyroid cartilage was measured to know the girth and any binding on the techniques. In the our study thick neck patients there was difficulty in appreciating the anatomical landmarks and in this patients number of attempts and complications are more compared to patients with thin neck patients.

The mean ± standard deviation of Vascular access time in anatomical landmark group was 340.34±160.89 and real time ultrasound was 160.78±70.01 with p value <0.001.This results were similar to a study done by Bikash R. Ray, Virender K. Mohan, Lokesh Kashyap, Dilip Shende, Vanlal M. Darlong, Ravindra K. Pandey (225 sec and 165 seconds in anatomical landmark and real time ultrasound respectively) [17].

In Real time ultrasound group out of 50 patients 46 patients internal jugular vein was cannulated in first attempt where as in anatomical landmark only 28 patients. This shows superiority and safety of Real time ultrasound over anatomical landmark and results were similar to Shrestha B R, Gautam (39/60 (63 %) in the ultrasound group and 19/60 (32 %) with the land mark technique) [3]. Bikash R Ray (25/40, 30/40 and 31/40 in anatomical landmark, ultrasound prelocation and real time ultrasound respectively) [17].In this study the complications rates where 6 in anatomical landmark and nil in real time ultrasound which is similar to Bikash R Ray, Virender K Mohan, Lokesh Kashyap, Dilip Shende, Vanlal M Darlong, Ravindra K Pandey [17] and to Shrestha B R, Gautam B (2/60 (3 %) and 6/60 (10 %) of patients in the ultrasound and land mark group respectively) [3].

There were no serious complications like Pneumothorax or nerve injuries in both groups. All the internal jugular vein cannulation cases were subjected to Chest X-Ray posterior-anterior view for confirmation of catheter position and complications if any. In this study all chest X-Ray of both groups were found to be normal.

5. Conclusion

The study validates the ultrasound real time is more beneficial in placing internal jugular vein cannulation compare with traditional anatomical landmark technique. Ultrasound real time reduces the number of attempts, decreases vascular access time, number of complications and increases the safety, comfort of the patients.

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