Original Article



# COMPARISON BETWEEN ANATOMICAL VERSUS ULTRASONOGRAPHIC INSERTION OF CENTRAL VENOUS LINE

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## ABSTRACT

***Objective:*** To compare complications of anatomical versus ultrasonographic insertion of central venous line.

***Study Design:*** Randomized control trails.

***Place and duration of study:*** Department of Critical Care Military Hospital Rawalpindi, from 1st January to 30 April 2011.

***Methodology:*** One hundred patients were included in the study and divided into two groups: insertion with Anatomical Land mark Technique (ALT) and under Ultrasonography (USG) guidance. Data was collected on operator skill, technique and site of placement of central venous catheters (CVC) end results included number of attempts, successful insertion of central venous line and complications.

***Result:*** A total of 100 patients were enrolled for the study, 50 each in ALT and USG group. The success rate was 92% in anatomical approach and 100% in USG method. Complications were observed in 12% cases in anatomical group and USG group did not show any complications.

***Conclusion:*** Ultrasonography assistance reduces the complication rates, number of attempts as well as the failure rates with Internal Jugular Vein (IJV) cannulation. We advocate the use of USG to guide CVC insertion, particularly in the IJV, and it should become the pattern of care in intensive care in Pakistan.

**Keywords:** Anatomical land mark technique, Ultrasound guided central line, internal jugular vein.

## INTRODUCTION

Central venous catheterization has attained a phenomenal role in the treatment of seriously sick patients. Central venous pulse (CVP) measurement is a simple method for hemodynamic evaluation[1]. Central venous catheters (CVC) are vital for the delivery of parenteral nutrition, hyperosmolar or vasopressor medications and rapid infusion of large volumes of fluids. Central access is also used when the insertion of a peripheral access is difficult to establish. Conventionally, CVC cannulation has been done using the landmark techniques. The frequently used sites are internal jugular, subclavian and femoral veins. , Complication rates of up to 25% have been reported for CVC insertions using the usual land mark technique, even in the hands of experienced operators[2]. CVC insertion is now becoming a routine practice in intensive care units. Every effort should be made to reduce the complication rates while carring out this procedure.

The utility of ultrasonography in central line insertions has gained some recognition. The European society of intensive care medicine has approved the use of USG guidance for CVC placement as one of the practices to improve patient care[3]. Despite these guidelines, the use of USG assistance when inserting CVCs has not been routinely used and is still used only in few centers in our country as well as in Western countries.

Critical Care is emerging as a very promising specialty in our country, most of the big centres are now equipped with portable ultrasound. The aim of the study was to determine the success rate, number of attempts, and complication rates.

## PATIENTS AND METHODS

### Study design

The randomized control trails were carried out in the medical intensive care unit at Military Hospital Rawalpindi from 1st Jan to 30th April 2011.

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*Received: 06 Oct 2011; Accepted: 14 Dec 2011*

**Selection of participants**

Patients admitted to the Intensive Care unit (ICU) during the study period and requiring central venous access as part of their management were included in the study. Indications for CVC insertion included tricky peripheral cannulation, need for minute by minute CVP estimation and administration of vasopressor drugs or hyperosmolar compounds. Consent was taken either from the patient or from the relatives before start of the study. Patients age below 12 years and refusal to give consent were excluded from the study and those patients with local infection, untreated coagulopathy (international normalization ratio > 1.5 and platelets < 50000/$mm^3$) were also excluded from the study.

A computer-generated randomization chart was used to divide patients into two groups. In the first group anatomical landmark technique was used and in the second group USG guidance was used for inserting CVCs (USG group).

According to the credentials, operators were categorized into two groups. Consultants with primary qualification in anesthesia or medicine and the second group included the medical trainees performing their intensive care rotation.

**Interventions**

The primary site was right internal jugular vein (IJV). Other sites such as left IJV, left or right subclavian (SCV) or femoral veins were used only if there was evidence of infection or haematoma formation by previous attempts at right IJV.

CVC insertion using the anatomical technique was performed as shown in (Fig.1). With the help of a portable USG system (SSA-580A/7.5MHz/Toshiba), CVC insertions were performed. Aseptic measures included cleaning of the lead and transducer with an antiseptic solution and gel was used to cover the probe. After proper patient positioning the neck was draped with pyodine solution, keeping in mind the anatomical land marks, the transducer was placed at right angle to the vessels at the tip of the triangle formed by the two heads of the sternocleidomastoid muscle and the clavicle. The vein was recognized by its large size and compressibility and confirmed by checking its easy compressibility. It is advisable to place the transducer in such a way so that on the ultrasound monitor vein is seen at the center (Fig 2 & 3).

After infiltration with local anesthesia (2 ml of 1% lignocaine), the needle was kept at the center of the probe directed towards the vein, under vision of ultrasonography. On the ultrasound screen, the introducer needle can be visualized either entering the vein or compressing the vessel. After penetration of the CVC , Seldinger technique was used to pass a central venous catheter. A chest radiogragh is needed to confirm the position, ideally it should lie at the junction of superior vena cava and right atrium.

The CVC cannulation was considered a failure if the cannulation is not done within three attempts. An attempt is considered as failure if skin puncture is done and then it is withdrawn from the skin. In case of unsuccessful insertion either help was taken from a senior member of the staff the site was changed or a different technique was used i.e., ultrasonography was employed if an anatomical land mark technique was used.

Data was collected at the conclusion of the procedure, patient particulars were endorsed, mode of placement, number of successful and failed attempts and untoward effects such as hematoma formation were endorsed.

**Outcome measures**

The outcome measures were the successful insertion of a CVC, the number of attempts and incidence of complications such as hematoma, pneumothorax, artery puncture and misplacement.

**Statistical analysis**

SPSS, version 12.0 were used for the statistical analysis. The frequencies were compared by chi square test and $p$-value < 0.05 was considered significant.

## RESULTS

A total of 100 patients were enrolled for the study, 50 each in the ALT and USG groups. There was 20 (40%) males in ALT groups while 23 (46%) males in USG group ($p$>0.05). Average age in ALT group is 35.9±10.26 years while in USG group it was 49.8±11.6 years ($p$>0.05)

There was significant difference in rate of complications ($p$≤0.0001), the success rate ($p$= 0.0412) and number of attempts ($p$=0.01152) between the two groups as shown in table. Therefore USG group was found to be better than ALT group with the rate of complications, success rate and number of attempts were compared.

Complications were observed in 12% of cases in ALT group while USG group did not show any complication. The only complications observed included pneumothorax in one patient and hematoma formation in 5 patients.

**Fig.1: Internal jugular vein cannulation using land mark technique (internal jugular vein is being identified by location & palpation)**

## DISCUSSION

Placement of central line has become a pivotal part of treatment of seriously ill patients. A low central venous pressure along with clinical parameters can be a guide for fluid

**Table: Comparison of number of attempts, success rate and complication between both the groups.**

| | | ALT groups (n=50) | USG groups (n=50) | $p$-value |
|---|---|---|---|---|
| No. of Attempts | | | | <0.001 |
| | Simple | - | - | |
| | Multiple | - | - | |
| Successful Procedure | | | | 0.118 |
| | Yes | 46 (92%) | 50 (100%) | |
| | No | 4 (8%) | 0 (0%) | |
| Complication | | | | 0.027 |
| | Present | 6 (12%) | 0 (0%) | |
| | Absent | 44 (88%) | 50 (100%) | |


**Fig. 2: Identification of internal jugular vein by its compressibility using ultrasonography technique.**

**Fig.3: Internal jugular vein cannulation using ultrasound guided technique.**

replacement therapy especially in the settings of septic shock. No procedure is free of complications and this holds true for central venous catheter cannulation as well. Mechanical complications are reported to occur in 5-19% of cases, infectious complications in 5-26% and thrombotic in 2-26%[4].

Ultrasound guided placement should be considered especially in difficult situations[5]. Different procedures performed under ultrasound guidance in ICUs can save time and increase the accuracy and efficiency of many interventions including CVC insertion. There is rich proof that USG-guided catheter placement increases the safety and effectiveness of the procedure[6]. Evidence based use of ultrasonography dates back as far as thirty years and the bulk of literature following the use of USG continues to boost[7]. There are several benefits of USG guidance over ALT in CVC insertion which include risk cut, better success rates, faster insertion, number of attempts are decreased and the ability to perform the procedure in difficult circumstances. The use of USG can warrant higher success rates in children[8]. The use of USG provides an opportunity for the operator to cannulate under vision so it averts the need of post CVC insertion chest x ray which is both cost effective and environmental friendly. The incidence of line sepsis increases with the number of attempts so ultrasonographic guided placement can be of use in reducing the incidence of line related sepsis[9].

**Internal jugular vein catheterization**

High failure rates up to 42% have been reported with Anatomical Landmark Technique, but 81.3 to 100% success rates have been reported for USG-guided IJV lines[10]. Relation of the vein and its nearby structures can be visualized with the help of ultrasonography which will also result in reducing the complications and failure rate. Ultrasonography guided CVC insertions in IJV has reported 35% decrease in failure rates. Our study had a success rate of 92% for IJV cannulation by the landmark technique, the success rate was higher (100%) for cannulation under USG guidance.

Intensivist can be easily trained in performing ultrasound guided CVC insertion as it is a fairly simple procedure and in this way they can save the precious time of the radiologist, In our study, USG guided CVC cannulation were performed by intensivists/ medicine trainees.

In this study the incidence of mechanical complications like hematoma formation, pneumothorax etc. was low (0%) with the use of ultrasound. Our study showed higher rates of successful cannulation under USG in the first attempt and showed a lower average number of attempts required for successful cannulation under USG guidance.

The number of insertion attempts increases the risk for complications, the frequency of mechanical complications increases after three or more insertion attempts as compared to an insertion in the first attempt[11]. In the present study, complication rate was 12% in ALT group and 0% in USG group.

## LIMITATIONS

The purpose of the study was only to observe the mechanical complications associated with CVC insertion and the number of attempts, the effect of USG guided CVC-related infections was not studied. The patients were not categorized by their body weight as obese and short necked people can pose a challenge even for an experienced operator while using anatomical land mark technique. Time factor was not considered as setting of an ultrasound machine can be time consuming.

## CONCLUSION

Ultrasonography guided CVC insertions are increasingly becoming popular all over the world in critical care settings. The advantages of ultrasonography cannot be overlooked. Rates of successful insertions are more with ultrasound use as compared to failure rate, it is also helpful in reducing the rate of complications. Subclavian vein catheterization by ultrasonography needs a bigger trial. This study reflects the benefits of ultrasonographic insertion of CVC particularly in IJV, so we

advocate the utilization of ultrasonography in IJV.

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