

ORIGINAL ARTICLE

Ultrasound guidance increases the safety and ease of insertion of central venous catheters in patients undergoing elective procedures

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ABSTRACT

Objective: To determine the advantages of ultrasound guided central venous catheter insertion over anatomical land mark technique regarding ease of insertion and safety.

Study Design: Comparative, cross-sectional study

Setting: Quaid-e-Azam Hospital, Islamabad (Pakistan)

Duration: August 2014 to May 2015

Methodology: Sixty elective patients requiring central venous catheter were selected and randomly divided into two groups, e.g. ultrasound and anatomical landmark groups. Central catheter was inserted under aseptic measures by the same operator. Variables including ease of access, number of attempts, arterial punctures and other complications in both groups were recorded.

Results: Ultrasound guidance in central catheter insertion resulted in a statistically significant ease of insertion ($P = 0.024$), while decreasing number of attempts to gain venous access as compared to the anatomical landmark group ($p = 0.0453$). Two cases of arterial puncture were recorded in the anatomical landmark group while no arterial puncture occurred in the ultrasound group. $P < 0.05$ was considered significant.

Conclusion: Ultrasonographic guidance for central catheter insertion makes it easy and safe as it allows better identification of vascular structures. It also reduces the rate of complications associated with central catheter insertion and improves the success rate thereby justifies its cost.

Key words: Central catheter; Ultrasound; Landmark technique; Internal jugular vein; CVP

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INTRODUCTION

Central venous catheterization (CVC) is a relatively common procedure to obtain central venous access for multiple purposes. Some of its uses include providing parenteral nutrition to patients, treatment of intravascular volume depletion, monitoring for hemodynamics, intravenous (IV) access during cardiopulmonary arrest, hemodialysis, difficult peripheral IV access and long-term IV access for

medications such as antibiotics.^{1,2} The placement of CVC is a blind procedure making it risky and leads to many complications. The risk is enhanced by a number of factors such as obesity, site of attempted access, operator experience, and associated comorbidities such as coagulopathy.¹ The anatomical landmark technique has traditionally been used for CVC. In order to decrease complications, ultrasound guidance was introduced. Initial studies have proven that ultrasound guidance can not

only improve the rate of success but also decrease repeated attempts for obtaining access to internal jugular vein (IJV), thus leading to reduced rate of complications.¹

The use of IJV for cannulation is favored because of its likely better anatomical location as well as the diameter when patients are placed in Trendelenburg position. One of the most common complications of IJV cannulation is the puncture of the internal carotid artery because of its closeness to the IJV.^{3,4}

The advantages of ultrasound guidance include detection of anatomical variations, exact location of the vessel, avoidance of veins with pre-existing thrombosis and thus add to ease in the catheter placement. This technique has now overtaken the previously used blind technique for central venous access due to multiple benefits.³

In Pakistan, use of ultrasound guidance is very limited for the insertion of CVC. No significant local data exists to justify its routine use. Hence this study was designed to document our experience and to encourage its use in IJV cannulation to make it a routine practice.

METHODOLOGY

This study was conducted at Department of Anesthesiology, Quaid-e-Azam International Hospital, Islamabad, between August 2014 and May 2015 after getting approval from hospital ethics committee and informed consent of patients. A total of 60 patients scheduled for elective surgery were included in this prospective, randomized study. Patients with platelet count below 50 thousand/mm³, INR greater than 1.2, (ASA-PS IV) and those on ventilator were excluded from the study.

The CVC placement was performed by a single experienced anesthetist either using traditional anatomical landmark technique or use of ultrasound guidance.

The anatomical landmark technique: Using aseptic technique while keeping the patient in Trendelenburg position, 1% lidocaine solution was injected under the skin at the site of catheter insertion. Finder needle was introduced into skin at an angle of 45 degrees to localize and cannulate the vein. After the confirmation of the venous blood, guide wire was passed in the IJV through needle. After removing the needle, catheter was inserted through guide wire. The catheter was secured after removing the wire.

The ultrasound technique: Patient position and preparation was same as used in anatomical technique. A 6.3 MHz transducer (linear convex probe) was attached to the 2D image display of the portable ultrasound machine (Logic Model, GE Health Care USA) and used in this group. IJV was located using ultrasound probe and finder needle was introduced into skin and direction was dictated by the location of vein in ultrasound. This was followed by the placement of the catheter.

Data collection: For all the patients, their demographic characteristics such as age, gender and indications for CVC, were recorded. The measured outcomes were the ease of insertion, arterial puncture and number of attempts. Various complications such as carotid artery puncture, hematoma formation, pneumothorax, hemothorax and incorrect position of catheter were noted. Postprocedure chest x-ray films were taken to confirm the location of catheter tip and to assess any complication.

Statistical analysis: SPSS 19 was used to analyze data. Two independent groups were selected and all variable were analyzed. Independent sample t-test was applied that showed the p value of all these variables and p value < 0.05 was considered statistically significant.

RESULTS

A total of 60 patients were assessed in this study. Mean age of our patients was 53 years and range was 18-81 years.

In case of anatomical technique, significant difficulty was faced while insertion in nearly half of cases but with ultrasound guidance vast majority of cases were easily done. Thus a statistically significant association (p value = 0.024) of ease of insertion was found using ultrasound technique (Table 1).

There were two cases of arterial puncture in anatomical landmark group, but none occurred in ultrasound group. There were no other complications seen in both groups.

The catheter was placed in first attempt in 25 (83.3%) patients using the ultrasound technique, only 5 (17%) insertions required a second attempt and none required a third attempt. However, in anatomically landmark technique 17 (56.7%) insertions were done in first attempt and one third (33.3%) required a second attempt. Another 10% required third attempt. Here a statistically significant statistical relationship was found (p-value = 0.0453) (Table 2).

Table 1: Comparison of ease of insertion in two groups

Ease of insertion	Central Catheter Insertion		Total	P Value
	With Ultrasound	Without Ultrasound		
Easy	26 (86%)	17 (56.7%)	43 (71.7%)	0.024
Moderate difficulty	4 (13.3%)	10 (33.3%)	14 (23.3)	
Very difficult	0 (0%)	3 (10%)	3 (5%)	

Table 2: Comparison of number of attempts in two groups

Number of Attempts	Central Catheter Insertion		Total	P Value
	With Ultrasound	Without Ultrasound		
First attempt	25 (83.3%)	17 (56.7%)	42 (70%)	0.0453
Second attempt	5 (16.7%)	10 (33.3%)	15 (25%)	
Third attempt	0 (0%)	3 (10%)	3 (5%)	
Total	30	30	60	

DISCUSSION

This study clearly demonstrates the superiority of ultrasound assisted cannulation as compared to the traditional landmark technique. The advent of ultrasonography has changed the overall technique of the placement of CVCs in both the internal jugular and femoral veins. Recently, it has been embraced with fervor across the medical fraternity as a diagnostic and therapeutic aid.³

On the contrary, some studies show that the use of ultrasound had no effect on the rate of complication and in reducing the number of attempts in CVC placement.⁴ In contrast, our study showed significantly decreased incidence of complications.

Many studies have compared the ultrasound technique to the landmark technique. A number of studies have concluded that the overall complication rate was higher in the landmark group than in the ultrasound-guided group ($p < 0.01$). The number of attempts for successful placement were significantly higher in the landmark group accompanied by a significantly increased access time.⁵⁻⁸ Our study showed similar results.

As ultrasound machines have become portable and convenient to carry, their use has become more feasible for common use. The vascular structures are identified with ease. More accurate needle placement results in safer and more successful procedures. Appropriate training is vital for proper placement of IJV catheter so that the safety of patients can be ensured.⁸

In critically ill patients, difficulties in obtaining venous access may occur in up to one quarter of

patients.⁸⁻¹¹ In our study about 30% insertions were moderate to very difficult, although this study was done in patients undergoing an elective procedure. So ultrasound guidance can be very helpful in critically ill patients where insertion is more challenging. Our study showed that vast majority of CVC was easily done using ultrasound guidance. Several benefits of ultrasound include regular and reliable access to the IJV, patient satisfaction, reduced risk for acquiring infections and decreased arterial damage.

The skill of the physician in placing the IJV catheter is an important factor in determining the success of catheter placement. A number of studies show that in 54% cases the carotid artery can partly cover the IJV and 5.5% of the time the IJV can lie medial to the carotid artery.^{12,13,14} Hence, it becomes imperative to locate the vessel with ultrasound. Our study also proved that ultrasound guidance can eliminate complication of carotid artery puncture during CVC.

One study also shows that ultrasound guidance for CVC may be beneficial in emergency with higher anticipated success rates and lower complications.¹⁵ This will require further studies in emergency settings. Another study confirms that although ultrasound equipment is costly but the benefits of decreased complication rate and lesser time in success to cannulate the patients can justify its cost.¹⁶ Studies done earlier provide satisfactory proof to support the concept that ultrasound-guided CVC is cost-effective.¹⁷⁻¹⁹ Our study was limited but it also shows safety of ultrasound guidance.

No extensive local published material is currently

available to see the benefits of ultrasound guidance in IJV cannulation.^{20,21} So this study can motivate our local physicians to adopt this technique for enhanced patient safety.

CONCLUSION

Using ultrasonographic guidance makes central venous catheter insertion easy and safe as it allows better identification of vascular structures. It also reduces the rate of associated complications and improves the success rate thereby justifies its cost.

Availability of ultrasound at every institution should be mandatory so physicians can use it in their routine clinical practice.

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Authors' contribution:

AR: conducted the clinical procedures; review and revision of the manuscript

HZ & AULN: Literature search, manuscript preparation

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