Can POCUS (Point of Care Ultrasound) Replace Conventional Chest X-Ray for Confirmation of above the Diaphragm Central Venous Catheter Placement? A Prospective Observational Study

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ABSTRACT

Introduction: Rapid vascular access is often required during resuscitation and hence central venous catheter (CVC) placement is a common procedure in Emergency department. Conventional chest radiography is the standard method to confirm CVC placement and exclude complications but is time consuming thus delaying the use of CVC. So we decided to carry out a study to determine whether POCUS (Point of Care Ultrasound) can be used instead of chest radiograph (CXR) for confirmation of above the diaphragm CVC placement or not.

Material and methods: Prospective observational study was done on 100 adult patients who required emergency supradiaphragmatic CVC placement. POCUS was used for placement as well as to see the appearance of turbulent flow in the right atrium when the CVC was flushed with 10 ml agitated saline thus confirming its position. Bilateral thoracic cavities were scanned to rule out any pneumothorax. Portable chest radiograph was advised once CVC was placed. Time taken for CXR and POCUS, detection of catheter malposition and associated complications were assessed, charted and compared using P value.

Results: 100 patients were enrolled and included in the final analysis. POCUS time was 3.17± 1.34 (mean±SD) minutes compared to 35.91±17.23 minutes for CXR performance with a mean difference of 32.7 minutes making it statistically highly significant (P<0.0001). No catheter malposition or any complication was recorded in our study. Confirmation by both methods were comparable in detection of catheter malposition and complication.

Conclusion: POCUS can be used instead of CXR for confirmation of above the diaphragm CVC placement.

Keywords: POCUS, Saline Flush Test, Bubble Test, Agitated Saline Test, RASS (Rapid Atrial Swirl Sign)

INTRODUCTION

Central venous catheterization (CVC) is an important procedure in Emergency department (ED) and it is very useful in patients who requires vasoactive medications, hemodynamic monitoring, or sometimes multiple drug infusions. Although CVC is done routinely, sometimes it is associated with complications like catheter tip misplacement (5%-9%), pneumothorax (PTX; 0.1%-3%), and arterial puncture (3%-9%)[1–4], despite being made safer through ultrasound (US) guidance.[5-8] Traditionally, chest radiograph (CXR) is performed after post procedure for CVC confirmation and to rule out pneumothorax.

In past many studies have been done to shorten the delay to CVC use and expedite patient care through other methods for CVC confirmation.[11,12] One of the alternative is use of point of care ultrasound (POCUS) which has advantages over chest radiography like lack of ionizing radiation exposure, decreased resource utilization and decreased diagnostic time. Bedside echocardiography can accurately identify catheter tip position in right atrium by use of saline flush. The visualization of microbubbles within Right atrium after 2 seconds of saline flush from distal end catheter placement with 96% sensitivity and 93% specificity.[9-11]

The primary objective of this study was to assess if Point of Care Ultrasound (POCUS) could more rapidly confirm CVC tip position than standard portable CXR in ED. We hypothesized that POCUS confirmation of CVC placement would be faster than that of CXR confirmation.

MATERIAL AND METHODS

We performed a single centre prospective, observational study using a convenience sample of 100 adult emergency patients who had supradiaphragmatic CVC placement from October 2019 to December 2019. The study was performed in the emergency medicine department of our hospital (tertiary care centre) after taking institutional ethical committee approval (The Institutional Ethics Committee,

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dated 16/10/2019, approval number:135/2019) and obtaining written informed consent from patients for participation in the study and publication of material related to them. The study was conducted in accordance with the principles of declaration of Helsinki.

Inclusion criteria for participants were age above 18 years and placement of a CVC above the diaphragm with post procedure CXR. Exclusion criteria for participants were refusal for consent and below diaphragm CVC placement.

All above-the-diaphragm central venous catheters were placed by using real time sonographic guidance with no deviation from the standard hospital protocol. After successful placement of CVC, focused cardiac sonography was done at the time of a saline flush of the central line. All views were obtained using a Sonosite (Sonosite, Bothwell, WA) ultrasound machine. Linear array probe (10-5 MHz) was used for central line insertion and phased array probe (2-8 MHz)was used to obtain subxiphoid 4-chamber view of the heart demonstrating the Right atrium and ventricle (RV) and the Left atrium and ventricle. Once obtained, the Right Atrium was inspected for the presence of the CVC tip in it. Then from the distal port of the CVC 10-mL sterile saline was flushed while monitoring the heart in the subxiphoid plane, looking for the appearance of turbulence or microbubbles in the Right Atrium as the saline is infused into the heart. Video clips were taken also at the time of infusion for documentation. Bilateral thoracic cavities were also scanned for ruling out presence of pneumothorax.

Time taken for ultrasound confirmation was defined as attachment of normal saline filled syringe to the port of CVC till opacification of right atrium on ultrasound. Stopwatch was allowed to run further and stopped when chest X-ray was taken or if more than 1 hour elapsed after bubble test was completed without chest X-ray being taken.

Information were collected on the data sheet included patient name, indoor number, age, sex, date of birth, reason for catheterization, CVC location and site, colour of blood aspirated for blood gases analysis and time required for CXR to be done. If any complication was also noted in the data.

RESULTS

100 patients were enrolled in the study and all were taken into consideration in final analysis. Mean age was 47 years (SD±17), with 54 male patients and 44 female patients. 88% of central lines were inserted in right IJV whereas 9% were inserted in right subclavian vein and only 3% were inserted in left IJV.

The opacification of the right side of heart on saline flush was visualized in all patients, and no discrepancy existed between sonographic and radiographic confirmation of catheter placement. Lung sliding was confirmed in the bilateral lung fields in all patients, and no discrepancy existed between sonographic and radiographic exclusion of pneumothorax. No adverse events were reported.

POCUS time was 3.17± 1.34 (mean±SD) minutes compared to 35.91±17.23 minutes for CXR performance with a mean difference of 32.7 minutes making it statistically highly significant (P<0.0001). No misplacement of central line was found as it was done under USG guidance only.

DISCUSSION

Central venous catheter insertion is common procedure in emergency department. The main aim of this study was to determine whether this approach would save time in an emergency setting. Since most ED patients receiving central venous catheters are acutely ill, this approach can shorten the delay for the safe and rapid administration of life-saving medications, fluids, and blood products to critically ill patients.

Some of the traditional methods to check endovenous placement of CVC are as follows:[11] Aspiration of dark blood in the syringe after puncture of the vessel suggesting venous blood, absence of pulsatile flow from syringe hub giving an indirect evidence that a punctured vessel is not an artery, ABG analysis of the aspirated blood, pressure waveform analysis by pressure transducer for invasive monitoring, pressure waveform analysis by simple tube manometry, identification of guidewire in the right atrium by Trans-esophageal echocardiography (TEE) and fluoroscopy with simultaneous injection of contrast. All these methods are associated with some or the other advantages and disadvantages ranging from time, cost, accuracy and availability.

The results of our study are in correlation with other studies of ultrasound for confirmation of CVC placement. Vezzani et al[10] described a similar technique of ultrasound confirmation using agitated saline. Initial studies described the use of agitated saline to identify the cardiac chamber.[10,13] In our study, we used nonagitated saline, as described by Weekes et al.[11] They used normal saline flush and, as in this study, evaluated for turbulence of flow in the right heart chambers describing it as the Rapid Atrial Swirl Sign. We chose this technique as it is a standard practice to flush central venous catheters with normal saline during placement. The techniques of flushing the line with either agitated or nonagitated saline appear to confirm catheter placement with high sensitivity and specificity for central access above and below the diaphragm.[10,11]

In an emergency situation, the most important information regarding a recently placed central venous catheter is proper placement in the venous system and exclusion of pneumothorax. By using POCUS with saline flush, it is possible to both confirm the venous placement of the catheter and rule out iatrogenic pneumothorax. Mehrdad E et al also described similar study in which saline flush method with POCUS was found safe, accurate and rapid bedside method for CVC confirmation as compared to CXR.[14]

Our study had several limitations. Ours was a single entre study performed at an academic institution with emergency medicine residents who receive USG training as part of the residency curriculum. Therefore, additional US training may be necessary for physicians who are not trained in using it. The study was of a convenience sample, leaving chance for a potential selection bias. Finally, though our study was correctly powered to determine a statistically significant

difference in study performance time, it was not powered to confirm the results for accuracy.

CONCLUSION

POCUS can confirm CVC placement and also helps in ruling out pneumothorax faster than conventional chest radiograph thus expediting the use of CVC in critically ill patients of Emergency department.

REFERENCES

1. Ruesch S, Walder B, Tramer MR. Complications of central venous catheters: internal jugular versus subclavian access—a systematic review. Crit Care Med 2002;30: 454–60.
2. Polderman KH, Girbes AJ. Central venous catheter use. Part 1: mechanical complications. Intensive Care Med 2002;28:1–17.
3. McGee DC, Gould MK. Preventing complications of central venous catheterization. N Engl J Med 2003;348:1123–33.
4. Duran-Gehring PE, Guirgis FW, McKee KC, Goggans S, Tran H, Kalynych CJ, et al. The bubble study: ultrasound confirmation of central venous catheter placement. Am J Emerg Med. 2015;33:315–19
5. Teichgraber UK, Benter T, Gebel M, Manns MP. A sonographically guided technique for central venous access. AJR Am J Roentgenol 1997;169:731–3.
6. 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 :2053–8.
7. Atkinson P, Boyle A, Robinson S, Campbell-Hewson G. Should ultrasound guidance be used for central venous catheterisation in the emergency department? Emerg Med J 2005;22:158–64.
8. Srinivasan S, Govil D, Gupta S, Patel S, Jagadeesh K N, Tomar DS. Incidence of posterior wall penetration during internal vein cannulation: A comparison of two techniques using real-time ultrasound. Indian J Anaesth 2017 ;61:240-44
9. Liu YT, Bahl A. Evaluation of proper above-the-diaphragm central venous catheter placement: the saline flush test. Am J Emerg Med 2011;29:842.e1–3.
10. Vezzani A, Brusasco C, Palermo S, Launo C, Mergoni M, Corradi F. Ultrasound localization of central vein catheter and detection of postprocedural pneumothorax: an alternative to chest radiography. Crit Care Med 2010;38:533–8.
11. Weekes AJ, Johnson DA, Keller SM, Efune B, Carey C, Rozario NL, et al. Central vascular catheter placement evaluation using saline flush and bedside echocardiography. Acad Emerg Med 2014;21:65–72.
12. Bowdle A. Arterial cannulation during central line placement: Mechanisms of injury, prevention, and treatment. Available from: http://www.miradorbiomedical.com/wp-content/uploads/2012/01/review_ arterial cannulation.pdf. [Last accessed on 05 Jan 2014].
13. Horowitz R, Gossett JG, Bailitz J, Wax D, Pierce MC. The FLUSH study—flush the line and ultrasound the heart: ultrasonographic confirmation of central femoral venous line placement. Ann Emerg Med 2014; 63:678–683
14. Mehrdad Esmailian, Reza Azizkhani and Nazila Najafi Saline Flush versus Chest x ray in Confirmation of Central Venous Catheter Placement; a Diagnostic Accuracy StudyEmerg (Tehran). 2017; 5: e75.

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