ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 06 | June - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

PROSPECTIVE COMPARISON OF ULTRASOUND AND CHEST X RAY FOR CONFIRMATION OF CENTRAL VENOUS CATHETER PLACEMENT

Emergency Medicine

Dr. Laxmi Dinkarrao Zade — Medical officer, Mumbai Port Trust Hospital, DA, DNB Anaesthesiology

Dr. Satish Kulkarni* — Senior Consultant, DA, MD, FRCA, Department of Anaesthesiology, Lilavati Hospital and Research Centre, Mumbai*Corresponding Author

ABSTRACT

BACKGROUND Ultrasound guided puncture of central vein is the standard of care in routine practice but central venous catheter tip confirmation is not routinely done with ultrasound. In most of the hospitals, in perioperative period chest x ray is usually done at the end of surgery. Aim of our study is to prove whether Transthoracic ultrasound can check correct position of central venous catheter tip during insertion of catheter itself and also reduce delay in confirmation as well as patient's exposure to ionising radiations.**METHOD** Study was done after approval by ethics committee and a basic training course on Focussed Assessed Transthoracic Echocardiography. Transthoracic ultrasound was done in real time during insertion of catheter. We used normal saline for flushing central venous catheter (FLUSH TEST) without any contrast. Opacification of right atrium was considered as positive Rapid Atrial Swirl Sign. Post procedure chest x ray was done to reconfirm the position. **RESULTS** Out of 64 catheter insertions, Rapid Atrial Swirl Sign was positive in 48 catheters and negative in 16 catheter insertions. While chest x ray showed 50 catheters in correct position and only 14 were actually misplaced. **CONCLUSION** We conclude that Transthoracic ultrasound is equally reliable and good method to evaluate tip of central venous catheter. Positive Rapid Atrial Swirl Sign can detect correct position of catheter tip at right atrium and superior vena cava junction while negative sign can be taken as not so ideal position. Chest x ray can be reserved for obese patients in whom ease of echocardiography view may be difficult or in cases of inconclusive results.

KEYWORDS

Central Venous Cannulation, Rapid Atrial Swirl Sign, Chest X Ray, Transthoracic Echocardiography, Focussed Assessed Transthoracic Echocardiography

INTRODUCTION

Catheterization of central veins is a standard procedure in operation theatres and critical care units (1). Post-procedural chest radiography (CXR) is routinely done and considered as the gold standard for the assessment of correct central venous catheter (CVC) tip position. Transthoracic echocardiography with its modified subcostal four chamber view provides imaging of superior vena cava, right atrium, inferior vena cava and allows real time localisation of guide wire tip as it is advanced (3). Presence of positive Rapid Atrial Swirl Sign (RASS) can be easily identified with minimal training and a routine chest x ray can be safely omitted in such patients, reducing time, costs and radiation exposure.

MATERIALS AND METHODS

Written informed consent for the ultrasound scanning during central venous catheterization were taken explaining risks and benefits of the procedure. Under all aseptic precautions, with patient in supine or head low position and 45 degrees neck tilt to the opposite side. Insertion site was anesthetized by injecting 2 % plain lignocaine. USG (Ultrasound) guided or USG assisted puncture was done with introducer needle followed by transthoracic visualization of guide wire in right atrium. Catheter was passed over the guide wire (Seldinger technique). Guide wire was removed and back flow of blood in all three ports were confirmed. Saline flush of 10 cc was used to see opacification of right atrium (RA) (Rapid atrial swirl sign, Fig.1) immediately after insertion of CVC. For transthoracic USG a low frequency (2-5 MHz) phased array cardiac probe was used to view four chamber subcostal view for visualization of right atrium and inferior vena cava junction. Post procedure chest x-ray was done to confirm position of CVC tip.

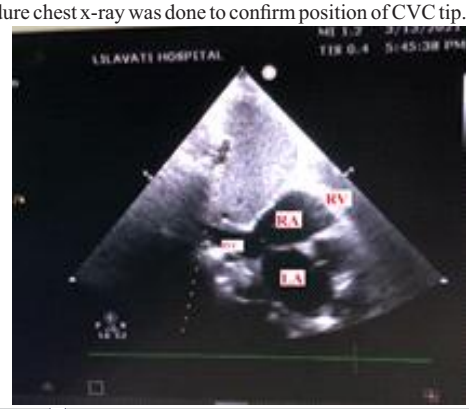

Fig. 1 Opacification of Right Atrium as seen in Rapid Atrial Swirl Sign (RASS)

Rapid atrial swirl sign (RASS) interpretation as follows:

1. immediate opacification of RA
2. delayed opacification of RA
3. absent opacification of RA

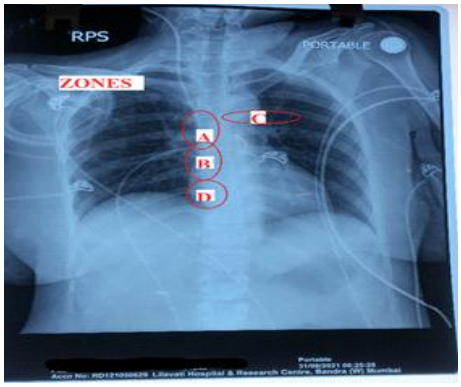

Fig.2 Probable zone of catheter tip on the basis of Rapid Atrial Swirl Sign

Radiological interpretation as follows (Fig.2):

1. Zone A (vena cava superiorly to the carina)
2. Zone B (vena cava inferiorly to the carina)

3. Zone C (innominate vein)
4. Zone D (right atrium)

STATISTICALANALYSIS

Sample size was calculated using SAS 9.2 software package. Data were analysed using SPSS V15.0 (Statistical Package for Social Sciences, Version 15.0) package. Chi square test was applied to compare percentages of more than 2 groups. Chi square statistical tests were two tailed. Alpha (α) Level of Significance was taken as P<0.05.

RESULTS

Out of our 64 patients, 62 were right IJV cannulations and 2 were left IJV cannulations. Cannulation data was obtained from all 64 patients. All patients were above 18 years of age. Male= 37(57.8%), Female=27(42.2%). Insertion of CVC was easy in all 64 patients. Ease of echocardiography view was easy in 55(85.9%) patients and difficult in 9(14.1%) patients. During insertion guide wire was seen in 51(79.7%) patients and was not seen in 13(20.3%) patients. Based on RASS 14(21.9%) patients had catheter tip in Zone A, 34(53.1%) patients had in Zone B, while (6)9.4% patients had in Zone C and (10)15.6% in Zone D (TABLE 2).

TABLE 1:PROFILE OF RASS

RASS	Number	Percentage
Absent opacification	3	4.79%
Delayed opacification	4	6.3%
Immediate opacification	57	89.1%

TABLE 2:POSITION OF CATHETER TIP BASED ON RASS

ZONES	Numbers	Percentage
Zone A	14	21.9%
Zone B	34	53.1%
Zone C	06	09.4%
Zone D	10	15.6%

On CXR 14(21.9%) patients had catheter tip in Zone A while 36(56.3%) had in Zone B and 1 (11.6%) had in Zone C while 13(20.3%) patients had in Zone D (TABLE 3).

TABLE 3:POSITION OF CATHETER TIP BASED ON CXR

ZONES	Numbers	Percentage
Zone A	14	21.9%
Zone B	36	56.3%
Zone C	01	01.6%
Zone D	13	20.3%

Out 64 patients both RASS and CXR could equally identify 14 catheters in ZONE A. RASS showed 34 catheters in ZONE B, while CXR identified 36 catheters in ZONE B. Out of 16 misplaced catheters in ZONE C and D in RASS about 6 were found in ZONE C and 10 were found in ZONE D. CXR showed in total 14 misplacements out of which only 1 was in ZONE C, remaining 13 were in ZONE D (TABLE 4).

TABLE 4: CORRELATION BETWEEN CXR AND RASS

RASS\CXR zone	CORRECT POSITION	MISPLACED POSITION	TOTAL
CORRECT POSITION	44	4	48
MISPLACED POSITION	6	10	16
TOTAL	50	14	64

On statistical analysis, out of 64 catheters RASS showed 48 catheters in correct position and 16 catheters in misplaced position. While 50 catheters showed correct position in CXR and only 14 were actually misplaced. We applied Fisher Exact Probability test (value=0.000, DF=1) P value was <0.001. In conclusion, significant association was found between RASS and CXR (Fig.3).

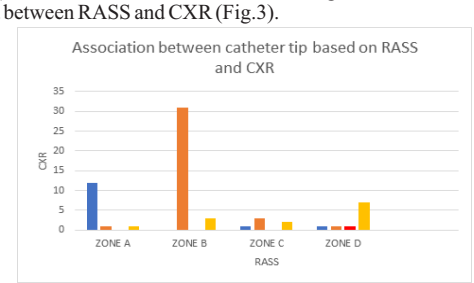

Fig4

DISCUSSION

Centrally placed catheters are known to kink within the lumen of the vein or directed to the right or left subclavian vein. The American College of Radiology recommends CXR after Central Venous Catheter insertion to check correct position of catheter tip before being used. Apart from exposure to ionizing radiations there can be significant delay in CXR confirmation in critical care units or specially those done in operation theatres. Aim of our study is to prove whether Transthoracic ultrasound can check correct position of CVC tip in real time during insertion of CVC itself, which will avoid the delays. We compared ultrasound imaging for catheter tip position to that of chest x ray. Though ultrasound assisted or guided puncture of central vein is becoming the standard of care in routine practice, CVC tip confirmation is not routinely done with ultrasound. The puncture of central vein with ultrasound guidance or assistance, USG detection of guide wire at right atrium and IVC junction together with confirmation of positive rapid atrial swirl sign can increase safety and aid in immediate confirmation of central line. The safe position of catheter tip should be in low SVC above the pericardium. Safety and correct placement may improve if guidewire is visualized during placement of CVC on subcostal four chamber view. In patients with pacemakers, pacemaker leads or wires may be mistaken for the guide wire. In these patients, the guide wire tip can be distinguished by moving it slightly to distinguish it from other wires at the SVC–RA junction (5). In the critically ill patients, needing immediate central acting vasoactive drugs, may benefit from even a reduction in delay of only 5 to 15 minutes. Our protocol allows immediate use of catheter after insertion without any delays.

Presence of rapid atrial swirl sign (RASS) allowed us to predict if the catheter tip is in SVC or RA. Use of Transthoracic ultrasound allows us to confirm the tip position at bedside and ensures early detection of complications like CVC malposition, arterial puncture and may have potential to detect pneumothorax (PTX). Other methods to know the misplacement include: pain on injection, difficulty in aspirating blood from one or more lumens or an abnormal pressure waveform, or arterial pattern blood gas on sampling (7).

Overall echocardiography window was poor in patients with BMI > 45. We feel this can easily be overcome with more training and scanning of more patients. While inserting the catheter guide wire was visualized at right atrium and IVC junction in 51 patients. In remaining 13 patients guide wire was not visualized. In our study we used non agitated normal saline for flushing CVC catheter (FLUSH TEST / BUBBLE TEST) without any contrast as catheters are usually checked with normal saline after insertion as standard practice. Appearance of bubbles in right atrium or opacification of right atrium was considered as positive RASS (Rapid Atrial Swirl Sign). Overall, 57 catheter insertions showed immediate opacification of right atrium, and 4 insertions showed delayed opacification 3 were absent opacification. We considered both immediate and delayed RASS as CVC positioned either in IJV or right atrium. The catheter tips showing absent RASS (3 catheters) were included in ZONE C. ZONE A and ZONE B were considered as correct position and ZONE D was considered misplaced, non-ideal but acceptable position of CVC tip. ZONE C was considered misplaced catheters. For all surgical patients CXRs were done in recovery unit before going back to ward or critical care unit. For all patients in intensive care units CXR was done bedside after insertion of CVC. RASS identified 16 misplaced catheters but out of them 14 were actually misplaced on CXR. There were situations that made interpretation of RASS difficult. Difficult anatomical situations or logistic circumstances might have led to these results. We think that with more practice and expertise we can avoid those. Our study showed a good correlation between RASS and CXR.

Our secondary objective was to reduce patients' exposure to ionizing radiations and reduce the overall cost of radiography. Amy Berrington de Gonzalez (6) in a study to estimate risk of cancer from diagnostic x rays in UK and 14 other countries revealed that Germany was second in annual frequency of x rays and that diagnostic imaging contributed with 1.5% to the cumulative cancer risk.

Limitations in our study are training required for handling of ultrasound, difficulty in visualization of four chamber view in obese patients due to excess abdominal fat. Secondly, interpretation of immediate or delayed RASS was observer biased but we came to a conclusion that presence of positive or delayed RASS are enough to prove that tip of catheter is in vein or right atrium. For absent RASS situations we can assess for possible misplacement of catheter tip.

CONCLUSION

From our observations we conclude that Transthoracic ultrasound is equally reliable and good method to evaluate tip of CVC catheter. Positive RASS (rapid atrial swirl sign) can detect correct position of CVC tip in SVC or right atrium while negative RASS can be taken as misplaced catheter. Post procedure CXR can be reserved for obese patients in whom ease of echocardiography view will be difficult or in case of inconclusive RASS results.

REFERENCES

1. Korsten P, Mavropoulou E, Wienbeck S, Ellenberger D, Patschan D, Zeisberg M, et al. The "rapid atrial swirl sign" for assessing central venous catheters: Performance by medical residents after limited training. PLoS One. 2018;13(7):1–15.
2. Kim SC, Heinze I, Schmiedel A, Baumgarten G, Knuefermann P, Hoeft A, et al. Ultrasound confirmation of central venous catheter position via a right supraclavicular fossa view using a microconvex probe: An observational pilot study. Eur J Anaesthesiol. 2015;32(1):29–36.
3. Lalu MM, Fayad A, Ahmed O, Bryson GL, Fergusson DA, Barron CC, et al. Ultrasound-Guided Subclavian Vein Catheterization: A Systematic Review and Meta-Analysis. Crit Care Med. 2015 Jul;43(7):1498–507.
4. Baviskar AS, Khatib KI, Bhoi S, Galwankar SC, Dongare HC. Confirmation of endovenous placement of central catheter using the ultrasonographic "bubble test". Indian J Crit care Med peer-reviewed, Off Publ Indian Soc Crit Care Med. 2015 Jan;19(1):38–41.
5. Bedel J, Vallée F, Mari A, Riu B, Planquette B, Geeraerts T, et al. Guidewire localization by transthoracic echocardiography during central venous catheter insertion: A periprocedural method to evaluate catheter placement. Intensive Care Med. 2013;39(11):1932–7.
6. Berrington de González A, Darby S. Risk of cancer from diagnostic X-rays: estimates for the UK and 14 other countries. Lancet (London, England). 2004 Jan;363(9406):345–51.
7. Sulek CA, Blas ML, Lobato EB. A randomized study of left versus right internal jugular vein cannulation in adults. J Clin Anesth. 2000 Mar;12(2):142–5.