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Original Article

Bedside Prediction of Correct Length of Right Internal Jugular Venous Catheters Based on Anatomical Land Marks

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Abstract
Background: *Correct positioning of the central venous catheter tip near or at the junction of the superior vena cava and right atrium is necessary for better monitoring and avoid complications.The anatomical landmark method is a simpler, cost effective, and performed at bedside, thereby facilitating safe positioning of the CVC tip. Therefore this study was conducted to compare the accuracy of the two method of central venous catheter positioning based on anatomical landmarks and Trans Eosophageal Echography.*
Methods: *After obtaining approval of hospital ethical committee and informed written consent 200 adult patients of either sex scheduled to undergo cardiac surgery were randomly allocated to Group 1,(Anatomical landmark) and Group 2 (Trans-esophageal echo-cardiography group) . The right internal jugular vein was cannulated to a depth calculated from apex of the sternocleidomastoid triangle and the junction of superior and middle one third of the manubrium and under the guidance of trans-esophageal echo-cardiography till SVC-RA junction respectively. The catheter was identified on TEE by Saline flush test. Catheter tip was considered acceptable up to 10mm to SVC –RA junction in both the groups on TEE.*
Results: *The power of study was 80% and level of significance as 0.05.The two groups were matched. The average length of catheter inserted in anatomical landmark group was 10.36± 1.34 cm and in TEE group was at 10.90± 0.96 cm (p-value < 0.05).65% of catheter had correct placement of tip by anatomical landmark as assessed by TEE (p value <0.001). Out of 65, 40 had tip placed above SVC-RA junction with the mean distance 6.785 ± 1.78 mm and 4 had tip placed below the SVC-RA junction with the mean distance 7.75 ±2.87 mm and 21 tip was positioned at the SVC-RA junction on TEE.TEE guided catheter insertion resulted in 100% correct placement.*
Conclusion: *In our study we found that the anatomical landmark method is 65% accurate compared to TEE guided central venous catheter insertion. At the bedside, in an emergency situation where vascular access takes priority, anatomical landmark method can be safely practiced to insert central venous catheter to an appropriate depth.*
Keywords: *Internal jugular venous catheters, anatomical landmarks.*

Introduction

Cannulation of a large central vein is the standard clinical practice, done usually through the internal jugular vein (IJV), the subclavian vein, and the femoral vein for the administration of vasoactive drugs, rapid fluid resuscitation, blood products and parenteral nutrition. In addition, the pressure in the central veins serve as a useful monitor of the hemodynamic status of critically ill patients [1,2,3]. There are various method for correct placement of the CVC catheter tip at the junction of SVC and Rt atrium viz. landmark techniques, Chest X-ray, ECG and USG guided. The anatomical guided method is most widely used especially in emergency settings.

The aim of the study is to compare insertion depth of the central venous catheter (CVC) through the Right Internal Jugular Vein based on aqnatomical landmarks and Trans Esophageal Echocardio-graphy (TEE) guided CVC insertion technique, so as to assess the accuracy of the method of CVC positioning based on anatomical landmarks,which is also simpler, cost effective and can easily be performed at bedside without much aids.

Methods and material

After approval of hospital ethical committee and informed written consent, 200 adults of either sex scheduled for cardiac surgery were randomly allocated to Group1 (anatomical landmark group) and Group2 (Trans-esophageal echo-cardiography group) with 100 patients in each group. The random allocation was done using concealed envelope technique. After attaching all monitors ,induction and intubation, under strict asepsis the Right Internal Jugular Vein was cannulated in both the groups using 7.5Fr double lumen /triple lumen (16 and 18 G) 15 cm long central venous catheter. The method of insertion in group 1 and group 2 were to a depth calculated from the external topographic landmarks and under the guidance of trans-esophageal echo-cardiography respectively.

In the Group 1(Anatomical landmarkgroup)The patients were positioned for landmark marking by giving the head tilt of 15 -20 degree to left in the preoperative room. Two topographic points were marked on the patient's skin, using surgical skin marker. The first point (A) was located at the apex of the triangle formed by a sternal and clavicular head of sternocleidomastoid muscle. The second point (B) was drawn at the manubrium-coastal joint on a transverse line situated at the junction between the middle third and superior third of sternal manubrium. The distance between point (A) and point (B) was measured using ruler. The distance represents the final CVC length insertion in cm in this group.

Fig. 1 Figure showing surface anatomical landmarks for Right IJV cannulation

In the Group 2. (Trans-Esophageal Echo-Cardiography Group) technique of RIJV was same as in Group1 but the CVC catheter was inserted under TEE guidance in SVC till SVC-RA junction. TEE was performed by trained anaesthesiologist and the catheter tip was identified on TEE by saline flush test. The catheter tip was considered acceptable up to 10mm to SVC –RA junction in both the groups on TEE.

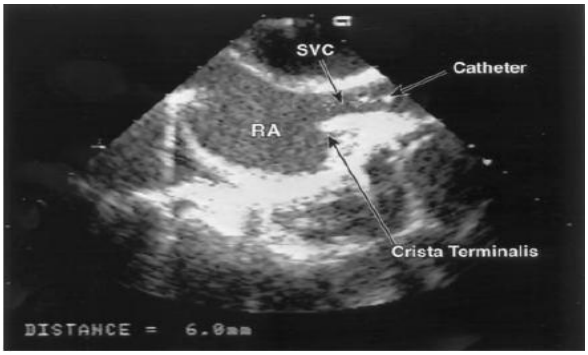

Fig. 2 Figure showing TEE image ME Bicaval view showing SVC-RA junction and catheter tip

Catheter tip position was considered acceptable up to 2 cm above and 1cm below the carina in both the groups on Chest X-ray. The TEE machine used in study was iE33 Philips Diagnostic Ultrasound System with S73t port. After surgery, an anterior-posterior chest x ray was performed with patient lying in supine position with his/her head in neutral position in Intensive Care Unit. The chest x-ray was analysed by a radiologist, who was blinded to the study population groups. The data was tabulated and statistically analysed using SPSS version 21.

Results

As CVC cannulation cannot be done by both the techniques in same patient, the study population was randomly divided into two groups (Group1 & Group2). The two groups were matched based on demographic variables.

Table1.Demographic Variables

Variables	Group1(n=100)	Group2(n=100)	P value
Sex(M/F)	84/16	73/27	0.084
Age(Years)	53.28±14.84	55.23±13.07	0.325
Height(CM)	164.07±7.92	162.99±8.30	0.348
Weight(Kg)	62.79±11.35	60.22±12.04	0.122
BMI	23.40±4.39	22.61±4.04	0.189
Thyroid-manubrium distance(CM)	5.93±1.10	5.93±1.02	0.215

The average length of central venous catheter inserted and fixed in anatomical landmark group was at 10.36± 1.34 cm and in TEE group was at 10.90± 0.96 cm and by using 2 independent sample t-test, p-value obtained was< 0.05, therefore there was significant difference between mean distance between the groups. Out of 100 patients in group 1, 65% of patients had correct placement of catheter tip by anatomical landmark as assessed by TEE. On the other hand, TEE guided catheter insertion resulted in 100% correct placement. The difference between two groups obtained was statistically significant in our study.

Out of 65 patients , 40 patient had tip placed above SVC-RA junction with the mean distance 6.785± 1.78 mm and 4 patients had tip placed below the SVC-RA junction with the mean distance 7.75± 2.87 mm. There were 21 patients in anatomical landmark group in whom catheter tip was positioned at the SVC-RA junction on TEE. In group 1, out of 100 catheters, 54 catheter tips were at carina on post-op chest x-ray. In group 2, out of 100 catheters placed correctly on TEE, 77 catheter tips were at carina on post-op chest x-ray. In total 200 patients, Out of 165 catheters that are correctly placed at SVC –RA junction on TEE only 113 catheters were found to be corroborating radiologically on CXR. The inference drawn is the x ray can detect 68.48 % (P value 0.077) of correctly placed catheter on TEE as shown in fig3.

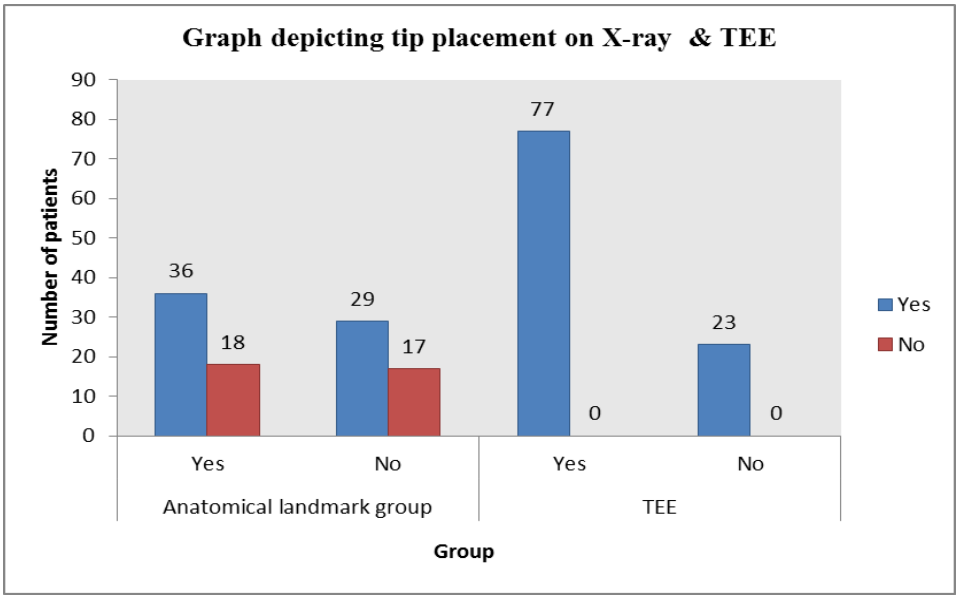

Fig .3 Correlation between correct placement of catheter tip on TEE and X-ray

There was poor correlation between the height of the patient and the depth of catheter insertion as shown in fig 4

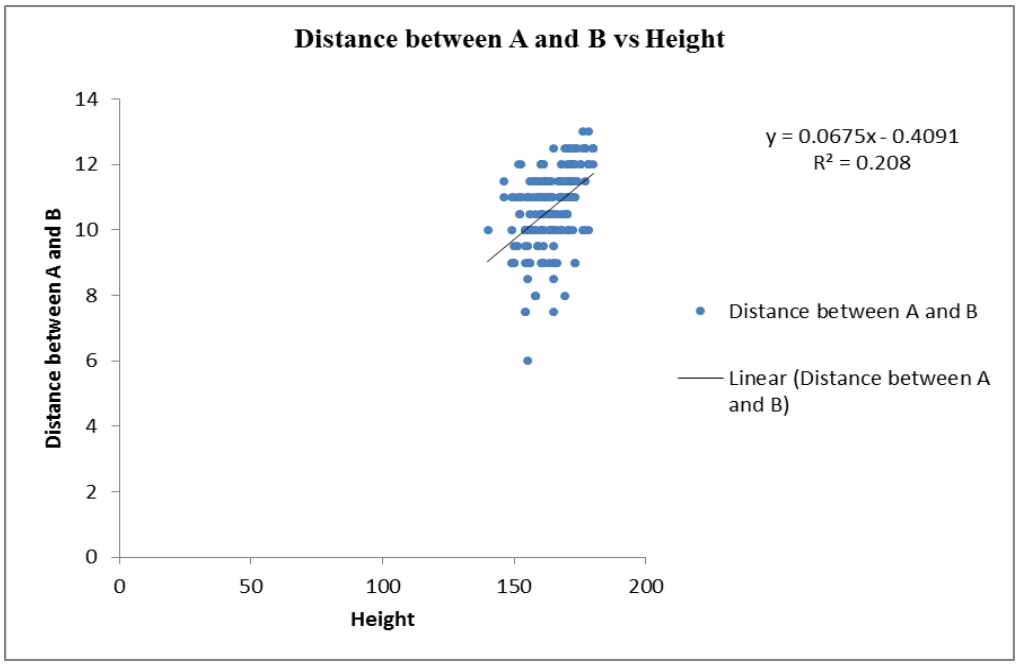

Fig. 4 Correlation between height of the patients and depth of central venous catheter insertion

Discussion

Correct placement of central venous catheter is of prime importance for proper functioning of central venous access devices and avoiding complications. There is no gold standard in estimation of correct length of central venous catheter insertion. The present study included a total of 100 cases in each group who were demographically similar. Out of 100patients in group 1, 65% of patients had correct placement of catheter tip by anatomical landmark method as assessed by TEE. Dean B. Andropoulos et al. In their study involving 145 pediatric patients, studied the comparison of two techniques (TEE guided and Anatomical landmark) of CVC (right IJV or Subclavian) insertion and observed that 86.3% of patients have correct placement of catheter tip by anatomical landmark as assessed by TEE. (P=0.01) [4]

In a prospective randomized study by Ezri T et al. on 100 patients, for the comparison of CVC insertion by topographic landmark technique and predetermined length (15 cm) insertion, 98% of patients in landmark technique were found to have catheter tip positioned at right place on chest X-ray. In this the author did not use TEE to check the position of catheter tip as in our study [5]

Lee JH et al. compared the accuracy of CVC tip localization between ECG- and landmark-guided catheterization and concluded that central venous catheterization via the right IJV, landmark guidance was comparable with ECG guidance with regard to CVC tip positioning in the superior vena cava [6]

In a study by Myung-Chun Kim et al. to determine whether the topographical measurement along the course of the central veins can estimate the approximate insertion depths of central venous catheters (CVC). The CVC locations could be predicted with a margin of error between 2.2 cm below the carina and 2.3 cm above the carina in 95% of patients [7] The above studies have done the IJV cannulation using different landmark techniques. These studies have not used the TEE to confirm the placement of the catheter. The present study used both TEE and CXR to confirm the placement of the catheter tip. Hence, in all the studies mentioned above, no studies have technique of catheter placement and confirmation comparable with this study.

In anatomical landmark inserted catheter group, we found 27 catheter tips above and 8 catheter tips below the SVC-RA junction when assessed on TEE. However, we did not find complications due to malpositioning of catheters. TEE guided catheter insertion resulted in 100% correct placement. This finding is similar to a study by Dean B. Andropoulos et al. in pediatric population, which showed that 100% of patients have correct placement of catheter tip by TEE [(4)].

The average length of central venous catheter inserted and fixed in anatomical landmark group is at 10.36 +/- 1.34 cm and fixed in TEE group is at 10.90 +/- 0.96 cm. Rash Kujur et al determined the length of the catheter insertion through Rt IJV by central approach in Indian population and concluded that the catheter can be fixed at a length of 12-13 cm in males and 11-12 cm in females in the right IJV[(8)].

Out of 165 catheters that are correctly placed at SVC –RA junction on TEE, 113 catheter were only found to be corroborating radiologically on CXR. The inference drawn is the X ray can detect 68.48 % (P value 0.77) of correctly placed catheter on TEE. In a study byDean B. Andropoulos, Stephen A. Stayer et al. found 84.4% catheter tips were in correct position on chest X-ray when compared with TEE.[(4)]

The Food and Drug Administration guidelines suggest that the tip of central venous catheter should not be positioned in the right atrium [(9)]. Koung-Shing Chu et al. have done a study for accurate central venous catheter placement, comparing Intravenous Electrocardiography and Surface Landmark Techniques using Transesophageal Echocardiography. 81.3% of catheters in IV-ECG Group and 76.7% of Catheters in Surface Landmark (P = 0.52) were in the radiographically defined proper position. The remainder 20% of the catheters appeared in the mid portion of the atrial cavity.[(10)]

Joshi AM et al. compared the electrocardiography guided technique to Peres' formula for Right IJV central venous insertion. They showed that 48% patients had over-insertion of the catheter in to the right atrium when catheter was inserted blindly using Peres' formula of "height (in cm)/10" [(11)]. Eagle et al. had shown the lack of correlation between patient's height, length of neck on CT scan study of the neck [(12)]. The routine airway assessment of the patient in preoperative period reveals different proportions among the height and thorax and the neck of the patients. Similarly, our study showed poor correlation between length of catheter placement and height of the patient. This emphasis the need to develop alternative techniques to determine the length of catheter placement rather than using generalized crude formulae.

Conclusion

Confirmation of the correct placement of the CVC catheter can be done by a number of techniques like USG, ECG, fluoroscopy and TEE guided but for emergency vascular access where we can't find immediate resources, anatomical landmark technique remains a method of choice to determine approximate length of central venous catheter to be inserted and fixed. This method should decrease serious complications of CVC insertion such as vascular perforation, arrhythmias, and cardiac tamponade to a greater extent as compared to blind predetermined length insertion technique.

In our study we found that anatomical landmark technique is 65% accurate compared to TEE guided central venous catheter insertion. In cardiac operating rooms, TEE is available inevitably, but at bedside, especially in an emergency situation where vascular access takes priority, anatomical landmark method can be safely practiced to insert central venous catheter to an appropriate depth of about 13-16 cm in an adult.

Conflicts of interest

The authors have no conflicts of interest.

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