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Study For Evaluation of Right Internal Jugular Central Venous Catheter Tip Length and Position Using Topographical & X-Ray Landmarks

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ABSTRACT

Background: Central venous catheter is commonly used in the operation theatre and intensive care units all over the world. But the exact length of insertion has been elusive and despite various techniques, formulas described in the literature application of the same in the Indian population have not been thoroughly evaluated. This study was done to compare 2 techniques in the Indian population. **Methods:** 64 patients were allocated randomly into 2 groups. In the study group (Gr I) the length of the catheter to be inserted was calculated in the following manner: the length from the carina to right clavicular notch measured on the preoperative X-ray chest PA view, and this length was added to the length from needle insertion point at the apex in the Sedillot's triangle to the clavicular notch on the right side. In the control group (Gr-II) the length of insertion was taken as 11.5 cm in females and 12.5 cm in males, from the needle insertion point. The distance of the tip of the central venous catheter from the carina was measured in a postoperative chest x-ray. **Results:** The distance of the tip of the central venous catheter from the carina was 0.902±0.708 in the study group and 0.829±0.814 in the control group (p= 0.703). 81.25 % of the study group & 75 % of control group were at a safe distance of 0-1 cm from carina. **Conclusion:** In this study, the landmark technique and fixed distance technique was found to be comparable with respect to the accurate length of the insertion of the central venous catheter.

Keywords: Central venous catheter, length, insertion, x-ray, Landmark.

INTRODUCTION

Central venous catheters (CVC) play an important role in the management of critically ill patients in the operating room and intensive care unit (ICU). It has multiple uses which include preload monitoring, fluid management, administering medications and intra-atrial pacing. Its placement has been associated with several serious complications, such as vascular perforation, arrhythmias, hydrothorax and cardiac tamponade.[1] Different method such as an anatomical landmark, simple formulae, right atrial (RA) electrocardiography and echocardiography have been used to ensure correct placement of the CVC tip.[2] The correct position of the tip of CVC is considered to be in the superior vena cava (SVC) above the level of the pericardial reflection.[2] In our study we have compared a fixed insertion length for males and females with the radiological landmark technique to guide the correct placement of catheter tip.

MATERIALS AND METHODS

After Institutional review board approval and patient's written informed consent, adult patients aged 18 – 60 years, scheduled for elective cardiac surgery, requiring central venous catheterization, were enrolled. Patients having altered coagulation parameters, arrhythmias, pacemaker in situ, burn contractures of the neck and cervical spine injury, anatomical deformities of the neck or chest and left internal jugular vein (IJV) cannulation, were excluded from the study.

After antiseptic skin preparation and sterile draping, central venous catheterization was performed using a triple-lumen CVC (Arrow International Inc., Reading, PA) with the Seldinger technique. Using the anterior approach, the apex of Sedillot's triangle (formed by sternal and clavicular heads of the sternocleidomastoid muscle and inferiorly the clavicle), was the point of insertion of the needle for IJV cannulation. The patient was positioned in 15-20 degrees Trendelenburg position with the head turned 45 degrees to the left and neck slightly extended to facilitate CVC insertion.

In the study group (group I) the length of the catheter to be inserted was calculated in the following manner: the length from the carina to right clavicular notch measured on the preoperative X-ray chest (CXR) posteroanterior(PA) view and this length was added to the length measured by a sterile thread from needle insertion point at the apex in the Sedillot's triangle to the clavicular notch on the right side in a patient positioned as stated above. The total distance was taken as the length of the CVC catheter to be

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inserted in the patient. All lengths were measured in centimeters. For the readings in decimal sterile ruler was used to measure the exact length because markings on the CVC are at 1 cm each.

In the control group (group II) the length of insertion was taken as 11.5 cm in females and 12.5 cm in males, from the needle insertion point. This is the current practice in the unit and also has been found accurate in a previous study.[3] The exact level of the CVC tip in all patients was determined by the postoperative CXR in the ICU. This X-ray film was exposed to anteroposteriorly (AP) in the supine position. The position of the CVC tip was recorded in relation to the carina in both the groups.

The distance of CVC tip was recorded in relation to the carina (either above/below) in the postoperative CXR in all patients. In our study, a margin of 0-1 cm was considered to be in the safe range and values outside it were considered unsatisfactory.

Complications like tamponade, hemorrhage, arrhythmias, thrombosis etc if any, were also recorded. The effect of the height of the patient and enlargement of the heart, on the CVC tip position, were also recorded.

Statistics

We planned a study of a continuous response variable from independent control and experimental subjects with 1 control (s) per experimental subject. In a previous study, the response within each subject group was normally distributed with standard deviation 1.4.4 Using R version 3.3.1 software if the true difference in the experimental and control means is 1, we needed to study 32 experimental subjects and 32 control subjects to be able to reject the null hypothesis that the population means of the experimental and control groups are equal with a probability (power) of 0.8. The Type I error probability associated with this test of this null hypothesis is 0.05. The $\chi 2$ test was used to compare categorical variables, Student's unpaired t-test and the Mann–Whitney U-test was used for continuous variables.

RESULTS

The baseline characteristics like age, sex, weight &height were comparable in the 2 groups [Table 1].

Table 1: Demographics of the population Pair wise significance

Variables	Study group	Control group	P-value
Age (yrs)	34.32±10.01	37.93±11.74	0.19
Sex (Male: Female)	14:18	15:17	0.45
Height (cm)	160.70±7.88	162.87±8.69	0.29
Weight (kg)	51.41±7.29	54.29±1.22	0.25

The average distance of the tip from carina was found to be within the safe range in both groups, and there was no statistical significance between them. [Table 2]

Table 2: Mean distance of cvc tip from carina

Variable	Study group	Control group	P-value
Distance of tip from carina (cm)	0.902±0.708	0.829±0.814	0.703

The distance of the tip from carina was found to be within the defined safe range in over 80% of patients in the study group and in 75% of patients in the control group. [Table 3]

Table 3: Relative percentage of cvc tip distance from carina in both groups

Distance of tip from carina	Study group (n=32)	Control group (n=32)
0-1 cm	81.25% (n=26)	75% (n=24)
1-2 cm	15.62% (n=5)	15.62% (n=5)
2-3 cm	3.12% (n=1)	6.25% (n=2)
3-4 cm	0	3.12% (n=1)

DISCUSSION

The subject of the correct length of the insertion of CVC is an extensively debated one. Bodenham et al have identified mid-portion of SVC, outside the pericardial reflection as the ideal position for CVC tip, to prevent potentially severe and life-threatening complications. Stonelake and Bodenham have described three zones, A, B and C for optimal positioning of CVCs, inserted from both left and right sides. Zone A represents lower SVC and upper RA, zone B is the upper SVC and its junction with the left and right innominate veins and zone C, the left innominate vein proximal to SVC. Part of zone A lies within the pericardial reflection, therefore catheters inserted from the right side should be pulled back slightly into the mid to upper SVC. Zone B is the ideal area for placement of right-sided catheters while left-sided catheters may abut the lateral wall of SVC and should be advanced to zone A, lest the angle of the catheter tip to vessel wall cause erosion, pain on injection, infections and thrombosis.[5-7] The safety of zone C for the positioning of a catheter tip is questionable.[5]

There is a potential risk of the catheter tip eroding the vessel wall and causing pericardial tamponade which may prove life-threatening if the catheter is positioned below the pericardial reflection.[8] Though not visible radiologically, anatomically the pericardial reflection is unlikely to extend above the level of the carina, thus the carina assumes considerable importance as a radiological landmark.[2,5,9]

Different studies have used a variety of methods to assess ideal CVC positioning, eg. Peres formula10, Andropoulos formula,[11] right atrial ECG, radiographic guidance, transesophageal echocardiography (TEE)and proximity of cardiac motion.[12] In a study by Lee et al, a landmark technique, similar to ours, was found comparable with ECG guidance.[13] In another study, the landmark technique was compared with Pere's

formula by using a computerized tomographic scan.[14]

Ryu et al, in their study, placed CVC at a depth derived by adding the length between the needle insertion point and clavicular notch and the distance between the clavicular notch and carina on preoperative CXR, similar to the technique in our study. They found this technique safe and appropriate; nevertheless, they also accepted that factors like the variation in needle insertion point and patient's body size should be taken into consideration along with the physical and radiological landmarks, for prediction of optimal length of CVC insertion.[2]

The Landmark technique was used in combination with sonography for infra-clavicular cannulation of the subclavian vein and was found suitable by Choi et al.[15] A recent study by Ahn et al, compared the radiological landmark technique using the carina as a landmark with Peres formula based on body height, demonstrated by TEE. They concluded that catheter insertion depth strongly correlated with the actual distance to the RA-SVC junction compared with Peres formula.[16]

Another study performed on Indian subjects but with a larger sample size and using the same technique as in our study, also concluded that the ideal length for right-sided IJV catheterization is 12-13 cm in males and 11-12cm in females.3The use of a fixed length for CVC insertion has therefore been endorsed by several authors earlier.[1,3,8]

In the present study, the length of insertion in the study group was measured using carina as a radiological landmark, while in the control group fixed length of insertion (11.5cm for females and 12.5 cm for males) was used. The post-operative radiological position of catheter tip from the carina, in both the groups, was not found statistically significant ($p>0.05$). In addition, the CVC tip was within the safe range from the carina in 81.25% patients in the study group and in 75% of patients in the control group, but this difference was not statistically significant.

As we have discussed earlier landmark technique has been found comparable to other techniques in various studies. This method was chosen as it was economical, did not require any special devices and was easy to follow and learn. We chose to compare this technique with a fixed-length insertion technique because in routine clinical practice anesthesiologists are in need of a rapid and easy method of placing CVC correctly. Since there is no consensus among anesthesiologists and intensivists, on the ideal method for determining the length of insertion, they mostly follow their institutional protocols. Therefore, the need arises to determine a fixed length of insertion which also ensures safe positioning of the catheter tip and avoids complications.

However, our study has some limitations, firstly the sample size is small and the length of insertion as found appropriate by us, may undergo changes with larger sample size. Secondly, it was not a blind study that could result in bias.

CONCLUSION

Insertion of CVC and correct positioning of its tip using a fixed length of 12.5 cm in adult male and 11.5 cm in adult female in the Indian population, was found to be comparable with the radiological landmark technique, less time consuming and easier to apply. However, the number of patients in whom the catheter tip was positioned correctly was greater in the group where the topographical method was used, though the difference with the radiological method was not statistically significant. The interpretation of the result may change with larger sample size and the difference in the position of a tip from carina can become significant between the two groups.

REFERENCES

1. Lee J, Lee Y. Pre-Measured Length Using Landmarks on Posteroanterior Chest Radiographs for Placement of the Tip of a Central Venous Catheter in the Superior Vena Cava. Journal of International Medical Research 2010;38:134-141.
2. Ryu H, Bahk J, Kim J, Lee J. Bedside prediction of the central venous catheter insertion depth. Br J Anaesth 2007;98:225-7.
3. Kujur R, Rao S, Mrinal M. How correct is the correct length for central venous catheter insertion. Indian Journal of Critical Care Medicine 2009;13:159.
4. Ezri T, Weisenberg M, Sessler DI. Correct Depth of Insertion of Right Internal Jugular Central Venous Catheters Based on External Landmarks: Avoiding the Right Atrium. J CardiothoracVascAnesth 2007;21:497–501
5. Stonelake PA, Bodenham AR. The carina as a radiological landmarkfor central venous catheter tip position. Br J Anaesth 2006; 96: 335–40
6. Raad, I, Hohn D, Gilbreath B, Suleiman N, Hill L, Bruso P, Marts K, Mansfield P, Bodey, G. Prevention of Central Venous Catheter-Related Infections by Using Maximal Sterile Barrier Precautions during Insertion. Infection Control and Hospital Epidemiology 1994; 15:231-238.
7. Cadman A., Lawrance J, Fitzsimmons L, Spencer-Shaw A, Swindell R. To clot or not to clot? That is the question in central venous catheters. Clinical Radiology2004; 59:349-355.
8. Fletcher SJ, Bodenham AR. Safe placement of central venous catheters: where should the tip of the catheter lie? Br J Anaesth 2000; 85: 188–91
9. Schuster M, Nave H, Piepenbrock S, Pabst R, Panning B. The carina as a landmark in central venous catheter placement †. Br J Anaesth. 2000;85:192-194.
10. Peres PW. Positioning central venous catheters—a prospective survey. Anaesth Intensive Care 1990; 18: 536–9
11. Andropoulos DB, Bent ST, Skjonsby B, Stayer SA. The optimal length of insertion of central venous catheters for pediatric patients. AnesthAnalg 2001; 93: 883–6
12. Konings MK, van Schelven LJ, Meijer RC, Westra AH, Snijder RA, van Boxtel AJ. Correct positioning of central venous catheters using a new electric method. J Vasc Access 2015; 16:327–32
13. Lee J, Bahk J, Ryu H, Jung C, Jeon Y. Comparison of the bedside central venous catheter placement techniques:

landmark vs electrocardiogram guidance. British Journal of Anaesthesia 2009;102 :662-666.
14. Kim W, Lee C, Sohn C, Seo D, Yoon J, Koh J et al. Optimal insertion depth of central venous catheters—Is a formula required? A prospective cohort study. Injury 2012;43:38-41.
15. Choi Y, Hahm K, Kwon K, Lee E, Ro Y, Yang H. Bedside prediction of right subclavian venous catheter insertion length. Brazilian Journal of Anesthesiology (English Edition) 2014;64:419-424.
16. Ahn J H, Kim I S, YangJ H, Lee I G, Seo D H, Kim S P.Transoesophageal echocardiographic evaluation of central venous catheter positioning using Peres' formula or a radiological landmark-based approach: a prospective randomized single-centre study. Br JAnaesth 2017; 118: 215–22.

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