ORIGINAL RESEARCH PAPER

Anaesthesiology

PRECANNULATION OF CENTRAL VENOUS CATHETER INSERTION DEPTH IN RIGHT SUBCLAVIAN VEIN BASED ON ANATOMICAL LANDMARKS AVOIDING THE RIGHT ATRIUM.

KEY WORDS: Subclavian Cannulation,thyrosternal , Insertion, Repositioning

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ABSTRACT

Introduction-Central venous cannulation(CVC) is a common procedure in intensive care units, operation rooms and emergency wards .CVC is done through various routes and subclavian vein cannulation through infraclavicular route is very common. The present study was to evaluate the anatomical landmark technique of precalculation of CVC insertion depth using the thyro-sternal distance against the conventional insertion depth of 15 cms thru the right SCV with regard to the need for catheter repositioning and incidence of complications related to catheter tip malposition.

Method A total of 100 patients were randomly selected and grouped into the thyro-sternal distance group (Group T) and the 15 cms insertion depth group (Group C) of each 50 patients. The operator who inserted the catheter was an experienced anaesthesiologist.

The study compared various variables like age, sex, height and the thyro-sternal distance. The following observations are madeduring the procedsure namely, the catheter tip to carina distance on the post procedure Chest X-ray and the need for catheter repositioning due to catheter tip malposition.The results were analysed by computing the statistics viz. mean, standard deviation, standard error of mean and P-value was tested using the unpaired student t-test and chi-square test.

Results-In Group T the TSD mean was 12.32±1.34 cms and in Group C the mean TSD was 12.52±1.28 cms.In Group T the average depth of insertion is 12.32±1.34 cms, with female having a lower mean insertion depth of 11.88 cms than males who had a mean insertion depth of 12.76 cms. In group C the mean insertion depth of all patients is 15 ±0 cms. (P<0.01).In the test Group T the mean T-C distance is 0.75±1.17 cms above the carina with the distance safer in females with a mean of 1.01±0.96 cms above the carina than in males with a mean of 0.49±1.32 cms above the carina.In the control Group C, where the insertion depth was fixed at the standard 15 cms the mean T-C distance was 0.87 ±1.06 cms below the carina with the tip dangerously close to the pericardial reflection in female with an average distance of 1.27±0.82 cms below the carina than in males whose average distance was 0.52±1.12 cms below the carina.In the test Group T total 2(4%) patients needed repositioning of the catheters due to too deep placement of the catheter which was far less when compared to the control Group C where a total of 16 (32%) patients needed repositioning of catheters

Conclusions- Central venous cannulation through subclavian route, using the thyro-sternal distance leads to lesser insertion depths than the conventional depth of insertion of 15 cms and the incidence of complications and need for catheter repositioning is greatly reduced .

INTRODUCTION

The history of central venous cannulation starts in 1929 when Forssmann described the advance of a plastic tube to the heart by puncturing his own arm vein1. At the beginning of the 1950s Aubaniac reported about the puncture of the subclavian vein (SCV). . Later in 1962, Wilson and associates popularized central venous catheterization through SVC2 The ideal insertion depth of the CVC varies from patient to patient and predicting this depth before the procedure is vital to prevent life threatening complications. In certain studies the reliability of thyro-sternal distance (the distance between the thyroid notch and the manubrium sternum) is tested in predicting the depth of insertion in right internal jugular vein (IJV)3Since the depth of insertion is comparable in both the right IJV and SCV approach, we planned a study to test the efficacy of thyro-sternal distance in predicting the depth of insertion in the right SCV.

AIMS AND OBJECTIVES

Primary objective:

To evaluate the need for repositioning of the central venous catheter when the depth of insertion is taken as the thyro-sternal distance of the patient against the standard insertion depth of 15 cms in CVC insertion in the right Subclavian vein.

Secondary objective:

Incidence of complications associated with malposition of catheter tip in the Indian reference population.

MATERIALS AND METHODS

A prospective, randomized, interventional, case-control study is designed. Informed written consent was obtained from the patient or from their relative.

INCLUSION CRITERIA

1. Patients requiring a central venous catheter for their management admitted into our hospital.
2. Patients who are undergoing cannulation of the Subclavian vein (SCV) through the infraclavicular approach.
3. Patients within the age range of 16-70 years.
4. Patients who are having the cannulation done on an elective or semi emergency basis.
5. All patients who have given consent for enrolling into the study.

EXCLUSION CRITERIA

1. All patients who have refused to give consent for the study.
2. Patients undergoing central venous catheter insertion on an emergency basis.
3. Patients having severe facio-maxillary and upper torso anatomical abnormalities which have led to considerable distortion in the anatomy.
4. Patients with burn injuries on the head and neck
5. Patients with genetic abnormalities of the head, neck and chest.
6. Patients with coagulopathy or bleeding disorder

A prospective, randomized, interventional, case-control study is designed. Informed written consent was obtained from the patient or from their relative.

Patient preparation
After careful selection of patients, complete explanation of the procedure, they are randomly assigned to either of the two groups (Group C /Group T). Patients are placed in supine position with 15 degree Trendelenburg position. After taking the required measurements required for the study protocol the head is rotated 20-30 degrees to the left to facilitate cannulation.

Measurement
In supine position the thyroid notch and the manubrium sternii are palpated and marked with a skin marker. Then the following details of the patient and measurements are taken and recorded.

1. Name, I.P. no, Diagnosis,
2. Age
3. Sex
4. Height
5. Vertical distance between the points marked earlier for the thyroid notch and manubrium sternii.

All the measurements are taken with the help of a measuring tape and values recorded in centimeters. After taking the required measurements the head is turned 20-30 degrees to the left to facilitate cannulation.

Cannulation
The patient prepared for cannulation is monitored with continuous non-invasive cardiac monitoring (NIBP, HR, ECG) and pulse-oximetry for oxygen saturation. After all aseptic precautions,All the patients were cannulated with 7 French, 20 cms double/ triple lumen catheters from B-BRAUN (Certofix Duo/Trio®) to minimize equipment bias.

The midpoint of the clavicle is identified. Skin is infiltrated with LA about 1.5 cms below the midpoint of clavicle. After a delay of 2 mins for the LA to act, the SCV is located with the help of a 5 cms three channeled locator needle mounted on a syringe. Localization of the SCV the J-tipped guide wire is passed into the vein with the tip directed caudally up to 15 cms or visible ECG changes, whichever is shorter. The vein is dilated over the guide wire with the dilator provided in the set. The catheter is inserted into the vein over the guide wire and then the guide wire is removed

The catheter is fixed at the predetermined depth of 15 cms (for Group C) or equal to thyro-sternal distance (for Group T).

Post procedure X Ray
A post procedure bedside digital X-ray taken with standardization. The focus –film distance is fixed at 110cms, the focus is directed perpendicularly at 90 degrees, the patient is supine and bed completely flat. A blinded radiologist is asked to measure the vertical distance between the catheter tip and the carina using PACS (Pictures Archiving and Communicating system) and issue a report. The catheter is repositioned if the tip lies 1 cm below the level of carina or 5 cms above the carina.

Sample size
The power of the study was kept as 0.80 and the significance criteria are set at 0.05 and the sample size was calculated using the following formula for comparative studies:

$$N = \frac{4\,\sigma^2\,(z_{crit} + z_{pwr})^2}{D^2}$$

Where, N = sample size,

assumed Standard Deviation of each group (Assumed to be equal),

value according to the table for the desired

z_{crit} = value according to the table for the desired

significance criterion,

z_{pwr} = valueis that given in the Table for the

desired statistical power,
D = minimum expected difference between the two means.

On the basis of results of preliminary studies, the Standard deviation for the depth of insertion is assumed to be 2.2cms. According to normal distribution 95% of the patients will experience the change if twice the standard deviation is used.

A significance criterion of 0.05 and power of 0.80 are chosen.

The difference of means is predicted by using the conclusions of previous studies to be 2.5 cms.

With these assumptions, σ = 2(2.2) = 4.4, z_{crit} = .960, z_{pwr} = 0.842, D = 2.5cms, the above formula yields a sample size of total 97.14 for both the groups. For practical purposes the sample size is rounded to the nearest whole number of 100 (50 in each group).

STATISTICAL METHODS
All data were collected and analysed statistically using appropriate tests. Windows Microsoft Excel was used to analyse mean and standard deviation of each variable. Independent sample t-test was applied after fulfilling the normality and equality of population variance assumption. Pearson Chi-square test was used to check the association among two study groups.

End point
The main study end point is the need for catheter repositioning.

CONCLUSIONS
The study validates that thyro-sternal distance can be used as a reliable marker for prediction of CVC insertion depth thru the right SCV, and helps in placing the catheter tip above the pericardial reflection. Using the thyro-sternal distance leads to lesser insertion depths than the conventional depth of insertion of 15 cms.

The incidence of complications and need for catheter repositioning is greatly reduced if not eliminated by the use of Thyro-sternal distance as the predictor of depth of insertion.

RESULTS AND OBSERVATIONS
The demographic profile ofage, sex and height were similar in both the groups and there was no statistically significant difference in mean age and height of patients in both the groups.

Anthropometric parameter- height
In the present study it was noted that the mean height of the patients was 160.55 ± 7.96 cms. The mean height of the patients in Group T was 161.82 ± 8.48 cms and in Group C was 159.28 ± 7.26 cms. The height in both the groups was comparable and the difference between the two groups was not statistically significant.

It was observed that the height difference between male and female patients in each group is statistically significant (p=0.74). The mean height of the male patients in Group T was 167.64 cms and that of females is 156 cms. And in Group C the average height of males is 163.33 cms and females is 154.52 cms. When taking the entire study population the mean height of male patients is 165.40 cms and females is 155.29 cms.

Anthropometric parameter-thyrosternal distance(TSD):
It iwas observed that the average TSD of the study population is 12.42±1.31 cms. In Group T the TSD mean was 12.32±1.34 cms and in Group C the mean TSD was 12.52±1.28 cms. The variation in the TSD between the two groups was not statistically significant. It was observed in the study that there is a statistically significant variation in TSD between the male and female sex. In Group T the mean TSD in males was 12.76 cms whereas in females it was 11.88 cms. In Group C the mean TSD in males was 13.03 cms whereas for females it was only 11.91 cms.

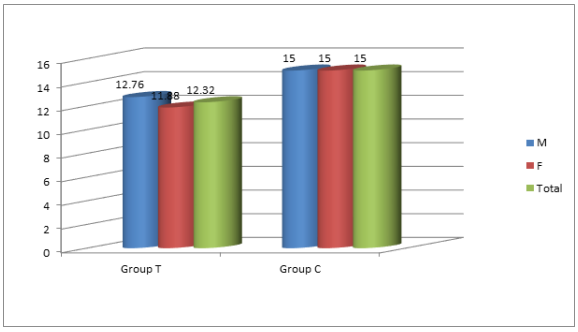
The thyro-sternal distance(TSD) is used as the depth of insertion in Group T. So the average depth of insertion in Group T was 12.32±1.34 cms which is much less compared to 15 cms in Group C

Study parameterCVC insertion depth:

The CVC insertion depth was taken as the study parameter with Group T having a pre-measured insertion depth by measuring the thyro-sternal distance. The CVC in Group T was fixed at the depth equal to the Thyro-sternal distance. In Group C the depth of insertion was taken as 15 cms for all patients irrespective of the thyro-sternal distance.

In Group T the average depth of insertion is 12.32±1.34 cms, with female having a lower mean insertion depth of 11.88 cms than males who had a mean insertion depth of 12.76 cms.

In group C the mean insertion depth of all patients was 15 ±0 cms. (P<0.01)



GRAPH1. Mean CVC insertion Depth in Study Population.

Study parameter-tip to carina distance (T-C DIST.)

The CVC tip to carina distance was taken as the end parameter of the study. The catheter was repositioned if the catheter tip lies 1 cm below or 5 cms above the carina in the chest X-ray taken post procedure. The position below the carina was denoted with a prefix "+" and above the carina is denoted with a prefix of "-".

In the test Group T the mean T-C distance is 0.75±1.17 cms above the carina with the distance safer in females with a mean of 1.01±0.96 cms above the carina than in males with a mean of 0.49±1.32 cms above the carina.

In the control Group C, where the insertion depth was fixed at the standard 15 cms the mean T-C distance was 0.87 ±1.06 cms below the carina with the tip dangerously close to the pericardial reflection in female with an average distance of 1.27±0.82 cms below the carina than in males whose average distance was 0.52±1.12 cms below the carina.

TABLE1. Average T-C distance in the Study population.

	T	S.D	C	S.D	P-value
Tot	-0.75	1.17842	0.87	1.056998	0.0001
M	-0.488	1.328006	0.525926	1.124754	
F	-1.012	0.963639	1.273913	0.823086	

Study parameter -catheterpositioning:

The need for catheter repositioning has been taken as the end point for the study.

In the test Group T total 2(4%) patients needed repositioning of the catheters due to too deep placement of the catheter which was far less when compared to the control Group C where a total of 16 (32%) patients needed repositioning of catheters.

In Group T both the patients who needed repositioning were males and no female patient needed repositioning of catheter. In Group C of the 16 patients who needed catheter repositioning 6 were male whereas 10 patients belonged to the female sex.

DISCUSSION

Central venous cannulation became popular during the 1960s and 70s. Further widespread appclication of long term total parental nutrition popularized subclavian venous cannula placement. Introduction of dedicated sets for placement of cannula in a large vein by Seldinger technique using spring loaded J wires made central venous cannulation simple and safe (Seldinger S I, 1953)4,5 Central venous catheterization can be accomplished, using a number of different venous access, including subclavian, internal jugular, external jugular, femoral, brachiocephalic, axillary, cephalic, basilic and umbilical6. The most popular site for placement of central venous cannula is the right sided subclavian vein. This is mainly due to the fact that it has the least chance of long term complications like catheter related infections and thrombosis.

But there is still no clarity on the prevention of short term complications, which are rare but fatal if at all occurred, like arrhythmias, cardiac tamponade, perforation, hemomediastinum, etc.7,8 These complications are related to inappropriate placement of catheter tip. In this study an attempt was made to individualize the depth of insertion before the procedure through a simple anthropometric measurement (thyro-sternal distance) and compare the results with the standard depth of insertion of 15 cms. Thyo-sternal distance (TSD) is the vertical distance between the thyroid notch and the manubrium sternum. Tiberu Erzi et al used this anthropometric measure in their study in predicting the depth of insertion in the right IJV and found it as a reliable measure for safe placement of CVC through the right IJV. This study objective is to check the TSD as the insertion depth in right subclavian vein. In this study it is observed that the average TSD of the study population is 12.42±1.31 cms. In Group T the TSD mean was 12.32±1.34 cms and in Group C the mean TSD was 12.52±1.28 cms. The variation in the TSD between the two groups is not statistically significant. It has been observed in the study that there is a statistically significant variation in TSD between the male and female sex. In Group T the mean TSD in males was 12.76 cms whereas in females it was 11.88 cms. In Group C the mean TSD in males was 13.03 cms whereas for females it was only 11.91 cms. The measured depth of insertion is much less than the universally accepted 15 cms. The mean depth of insertion in a study conducted by T Ezri (3) found that the depth of insertion in their study population ranged between 9 and 12.5 cm.

The end point of the study is taken as the need to reposition of the catheter in inappropriately placed catheter tips. In our study it was found that about 16 patients (32%) in the test group needed catheter repositioning of 10 patients (20%) were females and 6 patients (12%) belonged to the male sex. But when compared to the test group there was a statistically significant variation in the rate of catheter repositioning (P=0.033). the test group has a repositioning rate of 4% i.e. 2 patients all of them were males. None of the female patients in the test group needed catheter repositioning. All the patients with misplaced tips had their tips in the right atrium only. None of the patients had too proximally placed catheter tips. In a study conducted by T Ezri et al (3) two per cent of patients required repositioning in the topographic group compared with 78% in the 15-cm length group ($p < 0.001$). No patient in the topographic group and 10 patients (20%) in the 15-cm group had the catheter placed in the right atrium ($p < 0.05$).

No patient in the study was excluded due to complications in our study. None of the patients had any complications related to catheter tip malposition.

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