Original Article

Depth Of Insertion Of Right Internal Jugular Central Venous Catheter: Comparison Of Landmark Versus Formula Method

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Abstract

Background and aims: Central venous catheterization (CVC) is a vital procedure in major surgeries and also in critically ill patients for volume resuscitation, central venous pressure (CVP) monitoring, Misplacement of the catheter tip can cause lethal complications such as hemothorax, hydrothorax, or cardiac tamponade. The superior vena cava-right atrium (SVC-RA) junction is considered the optimal position for the central venous catheter tip. In this study, we wanted to compare the accuracy of central line placement using a post-operative chest x-ray using the landmark technique and the formula technique of peres.

Method: 40 Patients within the height range of 140-160cm were chosen for the study.20 patients in Group A/peres formula (height in cm/10) and Group B/Landmark technique. The position of CVC tip, in relation to the carina, was measured on a post -procedure chest X-ray from the PACS. CVC tips positioned above the carina were presented as positive values, and those below the carina were presented as negative values. Catheter tip position was considered acceptable if it was in the range of up to 5 cm above and up to 1 cm below the carina.

Result: Distribution of position of central line tip from carina was comparable between group A and B. (-3:-0% vs 5% respectively, -2:-0% vs 15% respectively, -1:-20% vs 15% respectively, 0:-5% vs 15% respectively, 1:-40% vs 20% respectively, 2:-20% vs 20% respectively, 3:-10% vs 5% respectively, 4:-5% vs 5% respectively) (p-value=0.495).Distribution of proper/improper placement was comparable between group A and B. (Proper placement:- 100% vs 80% respectively, Improper placement:- 0% vs 20% respectively) (p value=0.106)

Conclusion: It can be inferred that in a height range of 140-160cm using the peres formula or the landmark formula will give an approximate depth estimation for central line placement but the result will not be statistically significant. This means that using either technique there is a very high chance the central line tip will be in anatomically correct position and repositioning will not be require.

Keywords: right internal jugular vein, central venous catheterization, peres formula, landmark technique, depth of central line

INTRODUCTION

Central venous catheterization (CVC) is a procedure done multiple times in almost every hospital on a day-to-day basis. Central venous catheter insertion is mainly done in intensive care units and also for high-risk elective or emergency surgeries. They are used for fluid administration, inotropic drug infusions and central venous pressure measurement. The main drawback with this procedure is that it is an invasive procedure which till recently was done solely on palpation and landmark guidance. The complications like pneumothorax, arterial puncture and hemothorax can be life threatening.

There are numerous methods which are used to measure depth of catheter insertion. One of these and most widely used is the Peres formula which is height in centimeters/10 and the resulting value being the depth at which the catheter should be fixed. It is easy to remember and widely used.

The sterno-clavicular joint can be palpated on the skin. On chest radiograph, carina can correspond to the SVC-RA junction.

Using the anatomical landmarks, catheter insertion depth can be measured by adding the distances from the needle insertion to the midpoint of the sterno-clavicular joint and from the midpoint of the sterno-clavicular joint to the carina.

The right internal jugular vein was cannulated using the anterior approach under all aseptic precautions using a triple-lumen central venous catheter as per the institutional protocol.

The depth of insertion of the central line for the landmark group was performed as described by Kim et al[1] .

The depth of insertion for the formula group was calculated using the Peres formula[2] (for right IJV height [cm]/10).

The carina in adults is above the pericardial level. It can be easily identified on a chest x-ray and acts as an excellent reference point for accurate central venous catheter placement. [3,4]

The manubrio-sternal joint forms a prominence called the angle of Louis and it lies on the same horizontal axis of the carina. The internal jugular vein lies underneath the clavicular notch which is an oval shape on each side of the manubrium sternum and joins the sternal end of the clavicle.[5]

Patients within the height range of 140-160cm were chosen for the study as due to their height and the central line being an average of 15cm in length we could estimate the accuracy of the central line depth in this height range.

The right internal jugular vein is the most used route for insertion of central venous catheters in our hospital. In this study, we wanted to compare the accuracy of central line placement using a post-operative chest x-ray using the landmark technique and the formula technique of peres. To compare the accuracy of landmark method with the Peres formula estimation for depth of insertion of central venous line in right jugular vein and to assess accuracy

METHOD

Type of study: - Observational study

Place of study: -Department of Anesthesiology and Critical Care, Dr. D. Y. Patil Medical College, Hospital and Research Centre, Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune-411018

Period of study: -August 2021 to January2022

Period required for data collection: - 6 months

Period required for data analysis and reporting: - 6months

Sample Size: -Cases 40

Group A- using the Peres formula to estimate the depth of insertion of central venous line (cases 20)

Group B- using the landmark technique for estimating depth of insertion of central venous line (cases 20)

MATERIALS REQUIRED

Patients admitted in the surgical intensive care unit meeting the inclusion criteria were selected for assessment of depth of central venous line using Perez formulae.

Patient being posted for elective cardiac surgery or elective surgeries requiring central venous catheterisation meeting the inclusion criteria were selected for assessment of depth of central venous line using landmark technique.

INCLUSION CRITERIA

- ASA grade 1,2,3,4 patients.
- Patients between 18-70 years of age
- Patients between 140-160 cm in height

- Patients admitted in surgical intensive care unit.
- Patient without short neck (thyro-mental distance more than 6.5cm and sterno-mental distance more than 12.5cm)
- Anterior approach to right internal jugular catheterization
- Patients posted for elective cardiothoracic surgery
- Patients posted for elective surgery requiring central venous catheterisation

EXCLUSION CRITERIA

- Patients who are not willing to participate in the study.
- Patients with known carotid artery pathology
- Any gross anatomical or pathological deformities of the neck (scars, a history of multiple central venous catheterizations, and mass in the neck)
- Gross deformities of the chest (pigeon chest and barrel chest) were excluded from the study

Sample Size Calculation:

Assuming the mean SD of Group A and Group B from different studies and mean difference between both groups and entering the details in the WINPEPI version 11.38 Application: Sample size calculation was done using the SD of two groups, formula group SD-0.5 and landmark group SD-0.3 with a mean difference of 1.69 my sample size is 40 with 20 in each group

All cases were completed within the stipulated time.

Reference article – SAUDI JOURNAL OF ANAESTHESIA

M Vinay and CA Tejesh[6] did a study to assess depth of insertion of right internal jugular central venous catheter: Comparison of topographic and formula methods. The topographic method is superior to formula approach in estimating the depth of insertion of right internal jugular CVCs.

Statistical Analysis

The presentation of the Categorical variables was done in the form of number and percentage (%). On the other hand, the quantitative data were presented as the means ± SD and as median with 25th and 75th percentiles (interquartile range). The following statistical tests were applied for the results:

1. The comparison of the variables which were quantitative and not normally distributed in nature were analysed using Mann-Whitney Test and variables which were quantitative and normally distributed in nature were analysed using Independent t test.

2. The comparison of the variables which were qualitative in nature were analysed using Chi-Square test. If any cell had an expected value of less than 5 then Fisher's exact test was used.

The data entry was done in the Microsoft EXCEL spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, ver 25.0.

For statistical significance, p value of less than 0.05 was considered statistically significant.

METHOD

The right IJV was cannulated by the anterior approach under standard aseptic precautions using a double/triple lumen CVC as per the institutional protocol for CVC insertions.

Only patients satisfying the inclusion criteria were selected.

The central venous cannulation was done according to the seldinger's technique and once the backflow was confirmed and guidewire secured the catheter was placed according to the group in which the patient was selected.

In group A, The formula group used the Peres[2] formula and it was used to calculate the depth of catheter insertion in the formula group (for right IJV height[cm]/10).The resultant value being the mark on the central line till which the central line would be inserted. The entry point was at the apex of the triangle formed by the medial and lateral heads of the sternocleido-mastoid muscle and the clavicle.

In group B, the depth of insertion for the landmark group was determined as described by Kim et al[1] Patient's head and neck was placed in neutral position after insertion of guide wire. Topographical measurement was done by placing the catheter naturally with its own curvature over the draped skin (without direct contact with the skin), starting from

the insertion point of the needle through the ipsilateral clavicular notch, and to the insertion point of the second right costal cartilage to the manubrio-sternal joint.
The position of CVC tip, in relation to the carina[7,8], was measured on a post -procedure chest X-ray from the Picture Archiving and Communication System[9,10]. CVC tips positioned above the carina were presented as positive values, and those below the carina were presented as negative values. The primary endpoint of the study was the accuracy of central line placement and the need for repositioning. Catheter tip position was considered acceptable if it was in the range of up to 5 cm above and up to 1 cm below the carina.

RESULTS AND OBSERVATIONS

The study was conducted in Department of Anesthesiology and Critical care, Dr. D.Y. Patil Medical college, Hospital and Research centre, Pune. 40 patients of age 18-70 years, <=160 cm in height, admitted in surgical intensive care unit, posted for elective cardiothoracic surgery/surgeries requiring central venous catheterization were included in the study. Patients were divided into two groups:
Group A(n=20): -Peres formula was used to estimate the depth of insertion of central venous line.
Group B(n=20): -Landmark technique was used to estimate the depth of insertion of central venous line

Table 1: -Comparison of age(years) between group A and B.

Age(years)	Group A(n=20)	Group B(n=20)	Total	P value
21-30	7 (35%)	3 (15%)	10 (25%)	0.687*
31-40	3 (15%)	4 (20%)	7 (17.50%)	
41-50	3 (15%)	5 (25%)	8 (20%)	
51-60	3 (15%)	4 (20%)	7 (17.50%)	
61-70	4 (20%)	4 (20%)	8 (20%)	
Mean ± SD	43 ± 16.38	48.25 ± 13.6	45.62 ± 15.09	0.277‡
Median(25th-75th percentile)	41.5(28.75-58.5)	48.5(39.75-56.25)	44.5(33-58.5)	
Range	22-70	26-70	22-70	

‡ Independent t test, * Fisher's exact test

Distribution of age(years) was comparable between group A and B. (21-30 years: - 35% vs 15% respectively, 31-40 years: - 15% vs 20% respectively, 41-50 years: - 15% vs 25% respectively, 51-60 years: - 15% vs 20% respectively, 61-70 years: - 20% vs 20% respectively) (p value=0.687).
Mean ± SD of age(years) in group A was 43 ± 16.38 and in group B was 48.25 ± 13.6 with no significant difference between them. (p value=0.277) It is shown in table 1, figure 1.

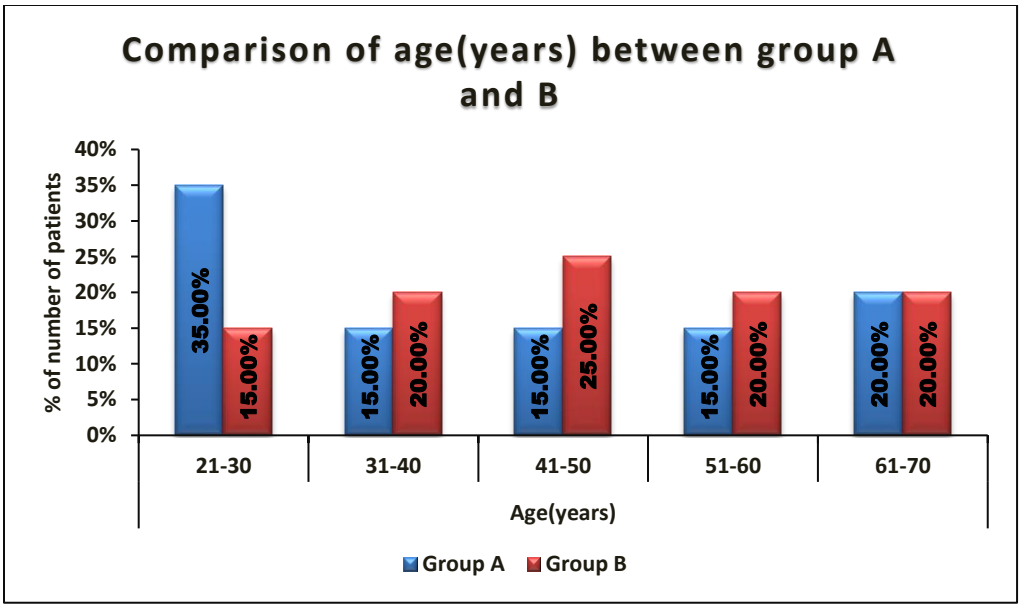

Figure 1: -Comparison of age(years) between group A and B.

Table 2: -Comparison of gender between group A and B.

Gender	Group A(n=20)	Group B(n=20)	Total	P value
Female	11 (55%)	7 (35%)	18 (45%)	0.204†
Male	9 (45%)	13 (65%)	22 (55%)	
Total	20 (100%)	20 (100%)	40 (100%)	

† **Chi square test**

Distribution of gender was comparable between group A and B. (Female:- 55% vs 35% respectively, Male:- 45% vs 65% respectively) (p value=0.204).

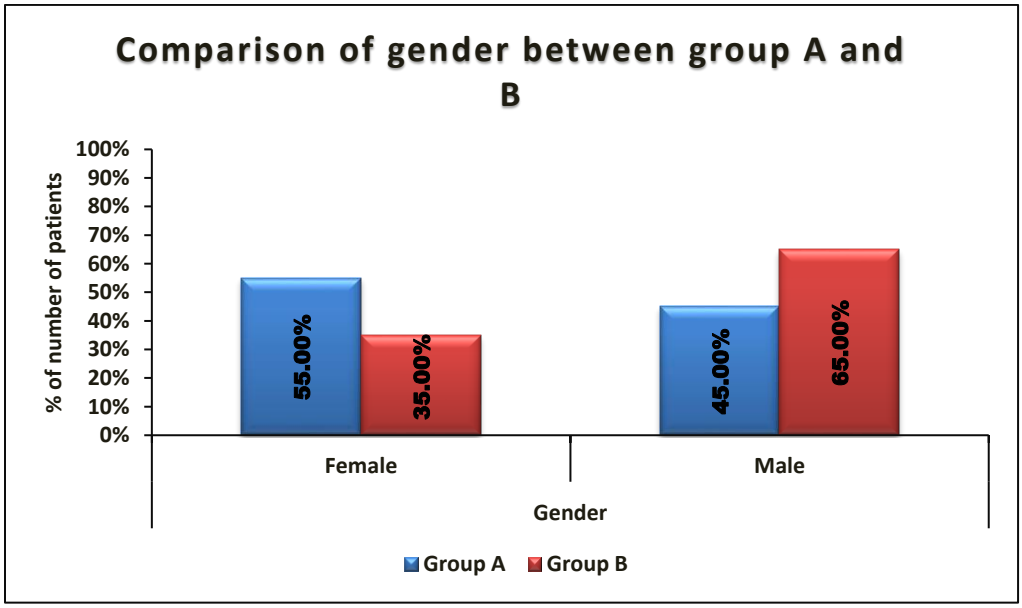

Figure 2: -Comparison of gender between group A and B.

Table 3: -Comparison of anthropometric parameters between group A and B.

Anthropometric parameters	Group A(n=20)	Group B(n=20)	Total	P value
Height(cm)				
Mean ± SD	150.25 ± 5.99	153.3 ± 6.35	151.78 ± 6.29	0.087§
Median (25th-75th percentile)	149(145.75-156)	156(148-158.25)	152(146-157.25)	
Range	141-160	142-160	141-160	
Weight(kg)				
Mean ± SD	57.4 ± 11.66	63.3 ± 9.86	60.35 ± 11.07	0.063§
Median (25th-75th percentile)	55(50-61.25)	60(56-70.5)	60(54-67.25)	
Range	32-82	46-82	32-82	

§ Mann Whitney test

No significant difference was seen in height(cm) (p value=0.087), weight(kg)(p value=0.063) between group A and B. Median(25th-75th percentile) of height(cm), weight(kg) in group A was 149(145.75-156), 55(50-61.25) respectively and in group B was 156(148-158.25), 60(56-70.5) respectively with no significant difference between them.

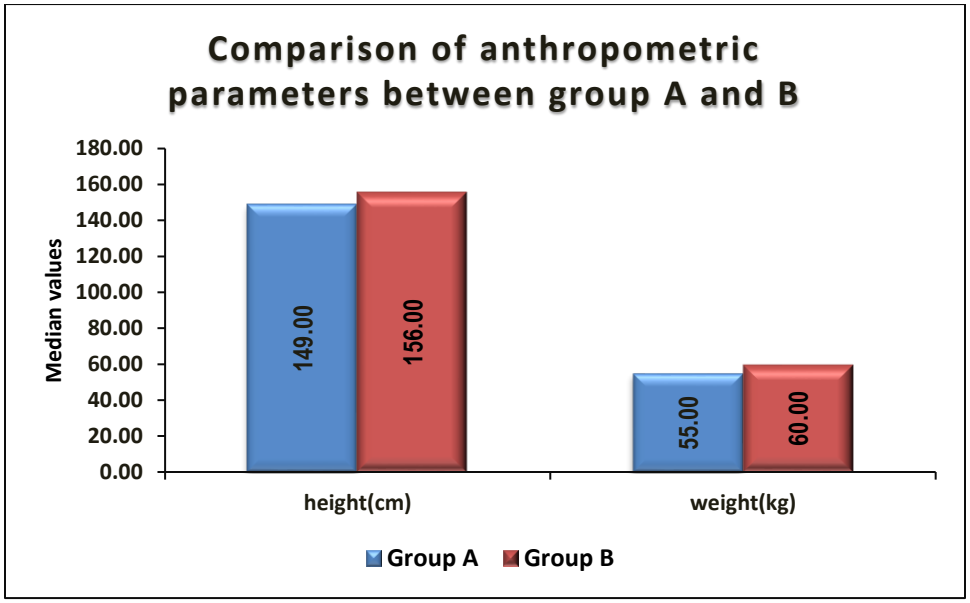

Figure 3: -Comparison of anthropometric parameters between group A and B. (non-parametric variables)

Table 4: -Comparison of calculated depth of insertion(cm) between group A and B.

Calculated depth of insertion(cm)	Group A(n=20)	Group B(n=20)	Total	P value
Mean ± SD	15.02 ± 0.61	15.45 ± 0.51	15.24 ± 0.59	0.012§
Median(25th-75th percentile)	14.9(14.575-15.6)	15(15-16)	15(14.95-15.85)	
Range	14.1-16	15-16	14.1-16	

§ Mann Whitney test

Median (25th-75th percentile) of calculated depth of insertion(cm) in group B was 15(15-16) which was significantly higher as compared to group A (14.9(14.575-15.6)). (p value=0.012)

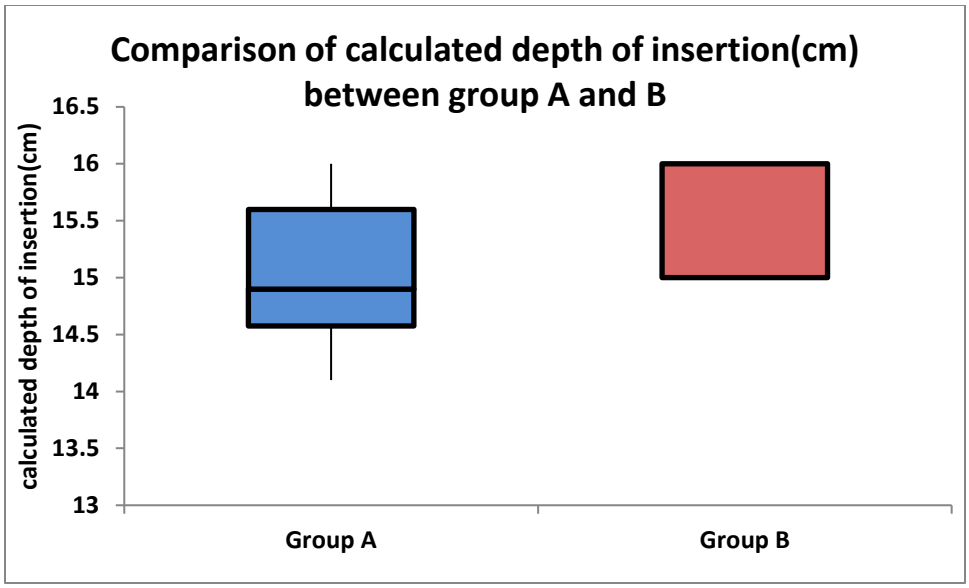

Figure 4: -Comparison of calculated depth of insertion(cm) between group A and B.(non-parametric variable, Box-whisker plot)

Table 5: -Comparison of position of central line tip from carina between group A and B.

Position of central line tip from carina	Group A(n=20)	Group B(n=20)	Total	P value
-3	0 (0%)	1 (5%)	1 (2.50%)	
-2	0 (0%)	3 (15%)	3 (7.50%)	
-1	4 (20%)	3 (15%)	7(17.50%)	
0	1 (5%)	3 (15%)	4 (10%)	
+1	8 (40%)	4 (20%)	12 (30%)	0.495*
+2	4 (20%)	4 (20%)	8 (20%)	
+3	2 (10%)	1 (5%)	3 (7.50%)	
+4	1 (5%)	1 (5%)	2 (5%)	
Total	20 (100%)	20 (100%)	40 (100%)	

* **Fisher's exact test**

Distribution of position of central line tip from carina was comparable between group A and B. (-3:- 0% vs 5% respectively, -2:- 0% vs 15% respectively, -1:- 20% vs 15% respectively, 0:- 5% vs 15% respectively, 1:- 40% vs 20% respectively, 2:- 20% vs 20% respectively, 3:- 10% vs 5% respectively, 4:- 5% vs 5% respectively) (p value=0.495).

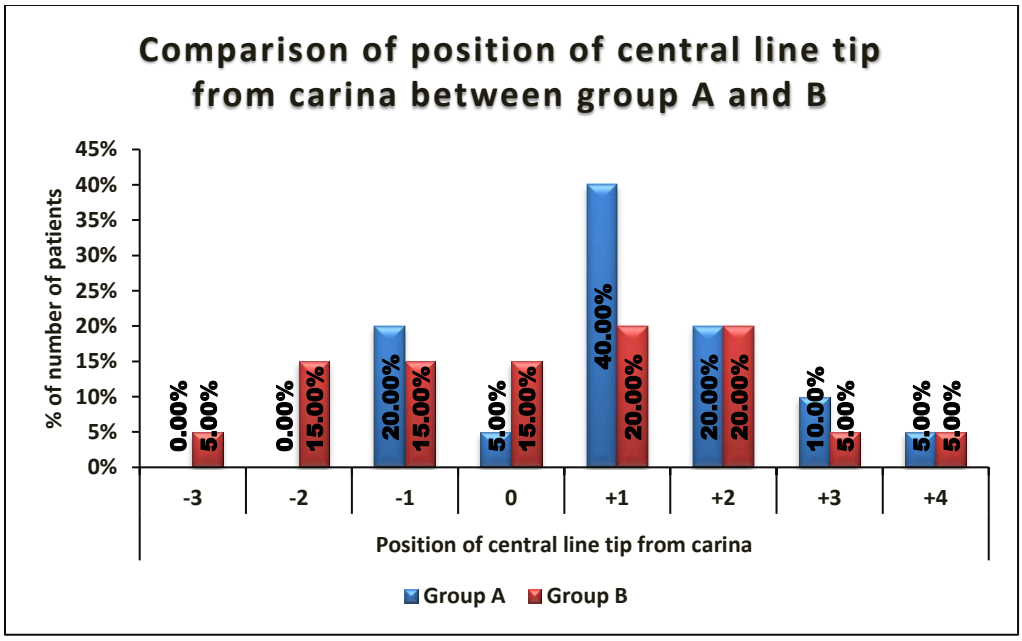

Figure 5: -Comparison of position of central line tip from carina between group A and B.

Table 6: -Comparison of proper/improper placement between group A and B.

Proper/improper placement	Group A(n=20)	Group B(n=20)	Total	P value
Proper placement	20 (100%)	16 (80%)	36 (90%)	0.106*
Improper placement	0 (0%)	4 (20%)	4 (10%)	
Total	20 (100%)	20 (100%)	40 (100%)	

* **Fisher's exact test**

Distribution of proper/improper placement was comparable between group A and B. (Proper placement: - 100% vs 80% respectively, Improper placement: - 0% vs 20% respectively) (p value=0.106).

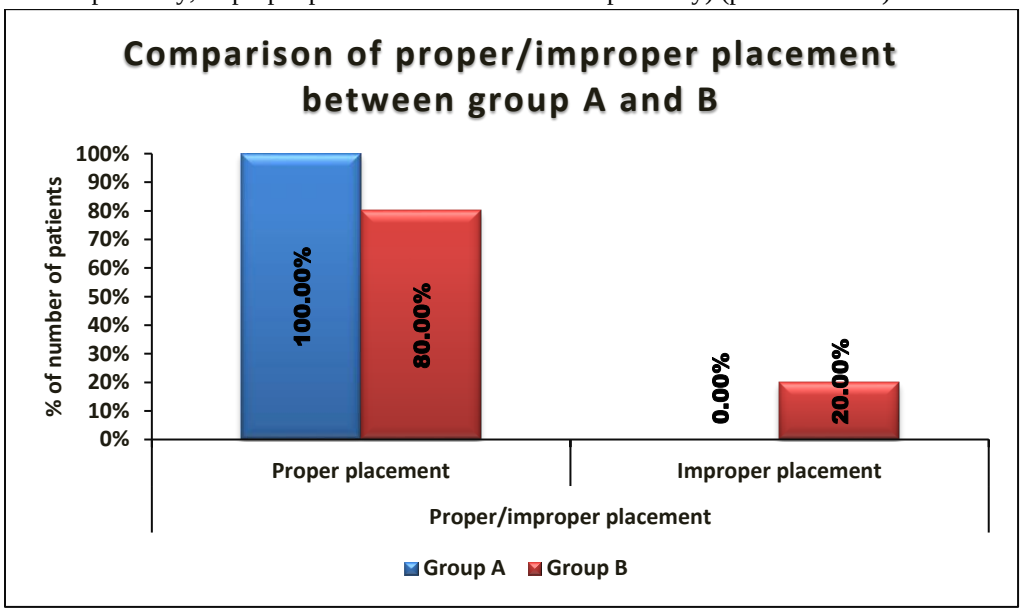

Figure 6: -Comparison of proper/improper placement between group A and B.

Table 7: -Comparison of complications during procedure between group A and B.

Complications during procedure	Group A(n=20)	Group B(n=20)	Total	P value
None	20 (100%)	20 (100%)	40 (100%)	NA
Total	20 (100%)	20 (100%)	40 (100%)	

No complications were seen during the procedure in all patients of group A and B.

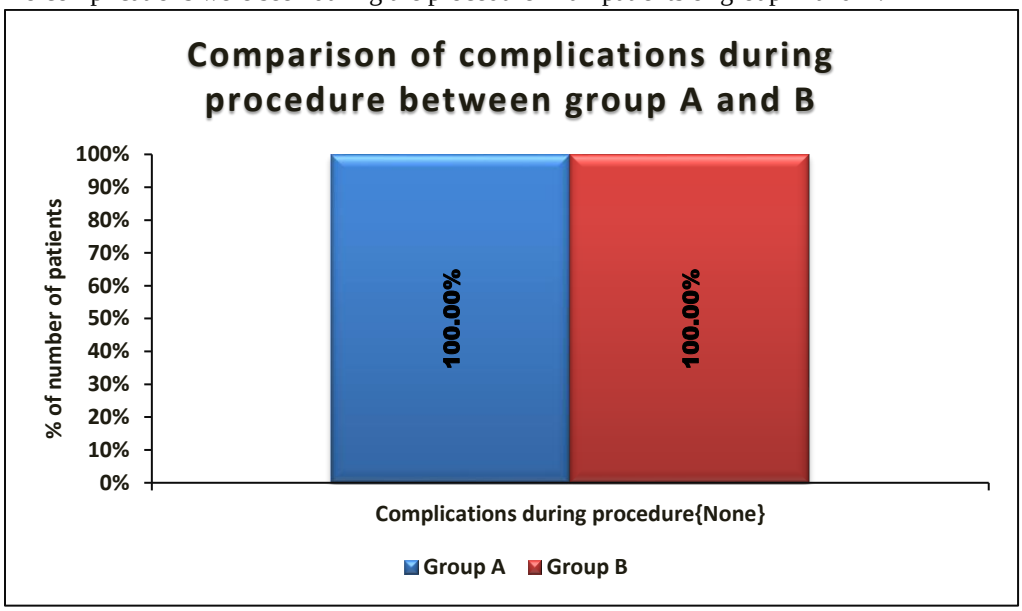

Figure 7: -Comparison of complications during procedure between group A and B.

DISCUSSION

A central venous cannula is one of the important techniques that is a must know for all medical practitioners be it an emergency scenario or an elective procedure. One of the most commonly used sites is the right internal jugular vein because of its anatomy, caliber of the vein and its relation with the heart. In our institution, right internal jugular venous cannulation is the preferred choice for all elective cases and also in the surgical intensive care unit.

There are multiple approaches for the right internal jugular venous cannulisation[11] and currently ultrasound guidance is also being used in most teritiary centre's for the same. Ultrasound guidance gives visualization of the vein in relation to carotid artery,depth of the vein ,proper placement of guidewire and confirmation of catheter placement in the vein. A major question during the placement of such catheters is at how much length to fix the catheter.

In our study we have taken 40 patients and according to their allocation used either the peres formula to assess this value or used the landmark technique for the same.

Distribution of age(years) was comparable between group A and B. (21-30 years:- 35% vs 15% respectively, 31-40 years:- 15% vs 20% respectively, 41-50 years:- 15% vs 25% respectively, 51-60 years:- 15% vs 20% respectively, 61-70 years:- 20% vs 20% respectively) (p value=0.687) and mean ± SD of age(years) in group A was 43 ± 16.38 and in group B was 48.25 ± 13.6 with no significant difference between them. (p value=0.277).

No significant difference was seen in height(cm) (p value=0.087), weight(kg)(p value=0.063) between group A and B. Median(25th-75th percentile) of height(cm), weight(kg) in group A was 149(145.75-156), 55(50-61.25) respectively and in group B was 156(148-158.25), 60(56-70.5) respectively with no significant difference between them.

Median(25th-75th percentile) of calculated depth of insertion(cm) in group B was 15(15-16) which was significantly higher as compared to group A (14.9(14.575-15.6)). (p value=0.012)

Distribution of position of central line tip from carina was comparable between group A and B

Distribution of proper/improper placement was comparable between group A and B. (Proper placement:- 100% vs 80% respectively, Improper placement:- 0% vs 20% respectively) (p value=0.106).
No complications were observed during the procedure's.
From the above mentioned details we can infer that even though the proper placement of catheter was 100% in group A compared to 80% to group B it is not statistically significant.

CONCLUSION

In conclusion, as per the statistical results and analysis it can be inferred that in a height range of 140-160cm using the peres formula or the landmark formula will give an approximate depth estimation for central line placement but the result will not be statistically significant. This means that using either technique there is a very high chance the central line tip will in the anatomically correct position and repositioning will not be required **[12,13].**

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