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Assessment of the acceptable length of right internal jugular central venous catheters for Indian population

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Abstract---Background: Central venous catheters have been used in various lengths based on the height of the patient or predetermined lengths. This study compared the different lengths of right IJV central venous catheters to determine the better length for average heights of Indian population. Patients and Methods: This was a prospective observational study done on 148 patients with average heights of Indian population (160±10cm) who are scheduled for right IJV central venous catheters are a part of this study. The patients are divided into 3 group (10,13,15 cm). Three different lengths of catheters are inserted. An anteroposterior chest X-ray was taken for the patients and carina was taken as the acceptable landmark. The outcome measured between the three groups is need for repositioning. Statistical analysis was done using Chi square test, Fisher's exact test. Results: 10 cm catheters were considered acceptable in terms of less incidence of repositioning and statistically significant with p value of 0.0001(H S) with respect to other lengths (13,15cm) for heights of average Indian population. (160±10 cm). Conclusion: From our study, we concluded that 10 cm CVC catheters are acceptable in cannulating right IJV for an average Indian height adult patients (160±10 cms).

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Keywords---central venous catheters, right internal jugular vein, repositioning of catheters.

Introduction

Central venous catheters were introduced into the clinical practice about 20 years ago and now it has become one of the essential parts of the treatment provided to adult and paediatric critically ill patients. Central venous catheters are used to measure the hemodynamics of the patient which is highly accountable than other means of monitoring and can provide medicines and nutrition which is difficult through peripheral cannula. Improper positioning of central venous catheters can cause potential cardiac complications like lung injury, venous perforation and cardiac tamponade and life-threatening arrhythmias and pneumothorax. [1]

Anatomical landmarks, Traditional formula (Peeres formula), electrocardiographic guided placement and post insertion echocardiography have been used to achieve proper placement of tip of catheter. [2] Routinely in clinical practice, chest x-ray is used to assess the optimum position of central venous catheter tip. Right Tracheobronchial angle coincides with superior vena cava-right atrium intersection.[3,4] so the tip of catheter should be placed at the level of carina.[5].

Peeres formulae does not hold good for all. Previous study done by Chaskar et al, shows Peers formula does not work in Paediatric population[6]. Even though various formulas are derived based on the height of the patient, complications are still arising due to inadvertent placement.[7] There are literature available for 15 and 13 cm catheters. In this study we have included 10 cm catheter to compare with other sizes (13.and 15 cm) for the patients with average Indian subcontinent Height (160±10 cm) in terms of post procedure reposition requirement.

Methods

After the scientific and ethics committee approval, 148 patients scheduled for coronary artery bypass grafting surgeries were included in the study. Central venous catheter insertion was done after obtaining written informed consent. All patients underwent detailed pre-evaluation and required investigations were done. This study was enrolled in CTRI with no. CTRI/2019/12/022552

Patients were allocated to 3 groups. The length of catheters (10, 13 and 15 cm) were allocated for 3 different groups in sealed, opaque envelopes. Experienced Anesthetists in central line placement performed central venous cannulation. All catheters were obtained from same company. Similar insertion technique was followed in all the patients.

Patient was placed in supine position with head inclined to left (15-20 degree). The head of the table was inclined slightly groundward (10-15 degree). Under aseptic precautions, the insertion was made by puncturing in between carotid artery and sternocleidomastoid muscle with level horizontally coinciding upper border of thyroid cartilage at a 30-degree angle with the skin after confirming the steady venous flow return, the central venous line was sutured to the skin.

Three failure attempts or any other methods of insertion were not included in the study. Post procedure, supine anteroposterior chest X ray was done. A straight angle (90°) of x-ray to the chest was used, with a focus-film distance of 100 cm. The same technique was be used in all patients. The post procedure x ray was assessed for catheter tip position. The main study conclusion was the need for central venous catheter repositioning.

Catheter tip position was considered acceptable through a range of up to 5 cm above and up to 1 cm below the carina. If the CVC was too high (5cm above the carina) [3] or if the CVC tip was placed 1 cm below the carina, it was repositioned. The catheter was maneuvered so that it was finally placed at the carina level. The new CVC tip position was confirmed with a new chest x-ray. The position of the CVC tip was measured on a chest X ray in all patients and number of repositions are also recorded.

With 95% of confidence interval and 80 percent of power, the sample size came upto 145.,$=z\text{-}2.\times,\sigma\text{-}2./,d\text{-}2.$ Where z=1.96 at 95%of confidence interval, σ=standard deviation=5.5, d = clinical significant difference=0.9. Data between groups were analysed and compared using Chi square test / Fisher's exact test for association between categorical variables. A statistical package SPSS version 17.0 was used to do the analysis. P<0.05 was considered as significant.

Results

The variables measured in the study between three groups are age, sex, weight, height, BMI, distance of the tip from carina and incidence of repositioning. Of the 148 patients evaluated, 53% are male and 46% are female patients. Mean heights of 10 cm, 13 cm,15 cm catheters are 161.42, 160.61, and 160.41 respectively which was not statistically significant with p value of 0.752. The distance of tip of catheter was measured from carina for three different lengths of catheter and 10 cm catheters had lesser incidence of aberrant/malpositioning as compared to other sizes and found to be statistically significant with p value of 0.025. Catheter repositioning was highly significant in 15 cms catheters Compared to 10 and 13 cms cathters. There was no incidence of repositioning with 10 cm catheters compared to other sizes

Table 1

AGE	10 cm	50	56.140	12.397	.077	NS
	13 cm	49	50.959	12.109		
	15 cm	49	51.612	12.408		
	Total	148	52.926	12.440		
WEIGHT	10 cm	50	63.060	12.559	.568	NS
	13 cm	49	65.633	13.335		
	15 cm	49	65.510	14.727		
	Total	148	64.723	13.523		
HEIGHT	10 cm	50	161.420	6.780	.752	NS
	13 cm	49	160.612	7.334		
	15 cm	49	160.408	7.035		

	Total	148	160.818	7.017		
BMI	10 cm	50	24.146	4.515	.344	NS
	13 cm	49	25.333	4.149		
	15 cm	49	25.490	6.112		
	Total	148	24.984	4.998		

The above Table illustrates the percentage of various variables included in the study. The demographic variables (age, gender, height, weight, BMI) are included. The variables are comparable and not statistically significant.

Table 2

		10 cm	13 cm	15 cm	
DISTANCE FROM CARINA	1 cm above carina	10	11	11	32
		20.0%	22.4%	22.4%	21.6%
	1cm below carina	7	8	13	28
		14.0%	16.3%	26.5%	18.9%
	2cm above carina	12	5	7	24
		24.0%	10.2%	14.3%	16.2%
	2cm below carina	0	2	11	13
		0.0%	4.08%	22.4%	8.7%
	2cmabove carina	1	0	0	1
		2.0%	0.0%	0.0%	0.7%
	3cm above carina	8	5	3	16
		16.0%	10.2%	6.1%	10.8%
	3cm below carina	1	3	7	11
		2.0%	6.1%	14.2%	4.7%
	4cm above carina	4	4	0	8
		8.0%	8.2%	0.0%	5.4%
	5cm above carina	0	3	1	4
		0.0%	6.1%	2.04%	2.7%
	at thelevel of carina	5	7	5	17
		10.0%	14.3%	10.2%	11.5%
Total		50	49	49	148
		100.0%	100.0%	100.0%	100.0%

Fishers exact test p= 0.025, significant.

The above table illustrates the tip of catheter seen in the chest x ray measured in centimetre from carina. It shows 10 cm catheters have lesser incidence of malpositioning than other lengths and found to be statistically significant.

Table 3

		10 cm	13 cm	15 cm	
REPOSITIONING	No	50	41	32	123
		100.0%	83.7%	65.3%	83.1%
	Yes	0	8	17	25
		0.0%	16.3%	34.7%	16.9%
Total		50	49	49	148
		100.0%	100.0%	100.0%	100.0%

Chi square test = 21.23, p=0.0001, HS

The above table illustrates the repositioning is maximum in 15 cm catheters than other length of catheters and also statistically significant.

Discussion

Improved accuracy in selecting the catheter length were done based on the tailored fit formulas.[2] The tip of catheter should not be placed in the right atrium.[8] It should lie in the SVC just above the pericardial reflection. [9] CVCs not inserted to an adequate depth could easily lie outside the SVC, potentially increasing the risk of thrombus formation and/or infection.[10,11,12] There are studies done previously showing 15 and 13 cm catheters are better compared to other length.[13,,14]. But none of the studies were done including 10 cm catheter which can be used for average Indian heights

Raja Sriswan Mamidi et al studied the height of Indian population and found average heights of adult men and women were 165 and 152 cm respectively which is the range of heights our study has taken into account.[15] Peeres in 1990 was the first one to conduct a prospective survey on 266 subjects and concluded the formula for subclavian and internal jugular venous catheters.[2] He calculated the length of catheters based on the height of patients. For Right IJV catheters (Height/10 centimeters). But our study proves that smaller length of catheters are acceptable for Indian population as 34.7% of patients required repositioning in 15 cms catheter. Perforation of SVC or right atrial wall can occur immediately during the procedure. Head, arm and cardiac movement can augment the tissue erosion caused by catheter tip abutting against vessel or cardiac wall.

Our study basically points out using smaller length of catheters have the greater potential to eliminate intracardiac placements which goes with the study done by Mc Gee Et al[1]. He conducted a prospective study comparing 16 and 20 cm catheters and concluded 16 cm catheters are most favourable. A study was performed by Russel et al on 106 patients and concluded 13 cm catheters can be used for all patients for right IJV cannulation compared to 16 cm catheters.[14] The fixation of catheter length was postulated by a study on 107 patients done on Indian subpopulation by Rash kujur et al proclaiming catheter can be fixed at 12-13 cm in males and 11-12 cm in females for right IJV which was proved in our study.[16]

Lesser length of CV Catheters was also favoured by topographic landmark methods. Many topographic landmark method were described previously and they require lesser repositioning. [13,17] In the study performed by Tiberiu Ezri et al , 15 cm catheters were inserted in one group and topographic landmark technique was used in other group, concluded that topographic landmark technique was superior than predetermined length group.[13] Catheter length requirement was between 9 to 12.5 cm in topographic method group with lesser repositioning. Our study also found smaller length of catheters have lesser rate of repositioning (10 and 13 cm) compared to longer 15 cm catheters.

Various investigative method are followed to know the exact position of CVC catheter tip. Catheter tip position was considered acceptable through a range of up to 5 cm above and up to 1 cm below the carina.[3] In X ray chest, upper limit of the pericardial reflection cannot be seen but is generally accepted to be approximately 0.8 cm below the carina. The preference of 15 cm catheters was reported by a study done by Won youg kim et al in 2012 on CVC cannulated patients who underwent chest CT and measured the distance from catheter insertion site to SVC-RA junction and calculated 15 cm as recommended depth.[2] This goes paradoxical with our study since we use chest X ray as the radiological evidence post insertion.

While most of the studies were done in western setting, it appears that smaller CVC catheter length are sufficient far cannulating right IJV in Indian population (average height of 160±10 cm) which avoids repositioning.

Conclusion

X ray chest is very useful for identifying the CVC catheter tip position in relation to carina and lesser repositioning was done with 10 cms size catheter compare to 13and 15 cms. From our study, we concluded that 10 cm CVC catheters are acceptable in cannulating right IJV for an average Indian height adult patients (150-170 cms).

Abbreviation
CVC : Central venous catheter
IJV: Internal jugular vein
Cm: Centimetre
SVC : Superior vena cava
SVC-RA: Superior vena cava- Right atrial
CT: Computer Tomography

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