Comparison of the Depth of Central Venous Catheterization Tip In The Left Subclavian Using The Peres Formula With Radiological Evaluation Of Supraclavicular And Infraclavicular

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DOI: 10.29322/IJSRP.13.01.2023.p13335
http://dx.doi.org/10.29322/IJSRP.13.01.2023.p13335

Paper Received Date: 14th December 2022
Paper Acceptance Date: 15th January 2022
Paper Publication Date: 24th January 2023

Abstract

Introduction : Central Venous Pressure (CVP) is the measure most often used to guide fluid resuscitation in critically ill patients. CVC placement has become common practice for anesthesiologists and intensivists in operating theaters and intensive care units. It is very important to position the catheter tip in the correct position to avoid the consequences of malposition.

Objective : To determine the comparison of the accuracy of the tip depth of centralvenous catheterization in the left subclavian using the Peres formula with evaluationof the radiological images between the supraclavicular and infraclavicular.

Methods : This study used a *double blind* RCT (*Randomized Clinical Trial*) design , ie the research subjects and observers did not know the treatment or intervention given. Sample study are patients who have a *central venous catheter installed* in the emergency room, ICU, or surgery at the Adam Malik Haji Center General Hospital in Medan who fulfill criteria inclusion and exclusion.

Results : The frequency of Supraclavicular samples with incorrect tips was 36 samples (42.4%) and 9 samples (10.6%) were correct. Furthermore, for the experiment using the inflaclavicular as many as 32 samples (37.6%) were not correct, while 8 samples (9.4%) the tip was correct. It is known that the analysis was carried out using the Chi-Square test and it was known that there was no significant relationship between groups with the level of accuracy of central venouscatheter tip depth (p = 1.000).

Conclusion : The accuracy of central venous catheterization in the left subclavian using the Peres formula supraclavicular and infraclavicular is known to be the same,namely 20.0% or 1 out of 5 procedures directly reaches the carina/region about thefifth thoracic vertebra which does not have a significant difference between infraclavicular and supraclavicular.

Keywords : CVC, Infraclavicular, Supraclavicular.

Introduction

Central venous pressure (CVP) is the measure most frequently used to guidefluid resuscitation in critically ill patients. This is most often done through a *centralvenous catheter* (CVC) which is positioned in the right atrium or the superior orinferior vena cava as close to the right atrium as possible. Therefore, the ability to obtain rapid and accurate vascular access has become an essential skill that must bepossessed by critical care and emergency physicians. [1] There are various indications for central venous catheterization such as volume resuscitation, monitoring of central venous pressure, transvenous pacing, hemodialysis access, infusion of hypertonic or irritant substances and infusion of vasoactive or inotropic substances.[2] The infraclavicular (IC) approach and the supraclavicular (SC) approach are two subclavian vein catheterization techniques

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that have been described in the literature. The infraclavicular approach is the most widely practiced of the two, but the supraclavicular approach for SCV catheterization has several distinct advantages. It shows clear *landmarks* (clavisternomastoid angle), shorter distancefrom skin to vein and straighter course to superior vena cava, less proximity to lung and fewer complications of arterial or pleural puncture resulting in possibility of pneumothorax less. In addition, the supraclavicular approach requires CPCR (*Cardiopulmonary Cerebral Resuscitation*) interruption less frequently than theinfraclavicular method. Furthermore, a lower incidence of malposition has been reported with the supraclavicular approach. [3]

The overall success rate in the supraclavicular group was 93.33% whereas, 90% in the infraclavicular group which was not statistically significant . [2] This is comparable to the study of Govindswamy et al. where the failure rate in the study was simply due to the inability to locate the vein. While in Bodkhe et al.'s study, there were several reasons for failure such as inability to find a vein, punctured artery and inability to insert guide wire. [2.4] In the study by Bodkhe et al., access time for successful cannulation in the supraclavicular group was 252.98 ± 76.27 seconds and in the infraclavicular group was 314.98 ± 121.28 seconds which was statistically significant with p = 0.001 . Similar to the results of the study by Thakuret al., it was documented that the time required for successful cannulation via the supraclavicular approach (4.30±1.02 minutes) was lower than that for the infraclavicular approach (6.07±2.14) which was statistically significant. [2.10] In the study of Bodkhe et al. there was no catheter malposition in the supraclavicular group whereas in the infraclavicular group, there were two cases of catheter malposition. In the study of Manjunatha et al., complications such as hematoma were seen in only one patient in the supraclavicular group and *arterial puncture* intwo patients, catheter malposition in one patient and hematoma in one patient seenin the infraclavicular group, were treated appropriately. There are various ways to prevent catheter malposition such as the use of ultrasound-guided catheter insertion, more horizontal insertion, caudal bevel, and early suspicion of resistance during guidewire insertion. [2,5]

There is no *gold standard* that predicts the exact depth of CVC insertion. Surface *landmarks* , formulas, electrocardiography and transesophageal echocardiography have been proposed to position the catheter to adequate depth in adults. The pericardium cannot be seen on the chest x-ray that is routinely taken to check the position of the catheter. Karina is easily identified on chest radiograph and has been used as a reference point for optimal positioning for central venous catheterization . [6]

Landmark formula is better than the Peres formula for optimal depth of right internal jugular catheter insertion. The average depth of catheter insertion in the Peres group was 16.21 ± 0.82 cm. This correlates with previous research conductedby Ahn et al. 16.4±1.1cm. In the radiological *landmark group, the* average depth ofcatheter insertion was 12.71 ± 1.30 cm. But the study of Ahn et al. had a mean depthof catheter insertion of 16.7 cm, which is slightly more than what was observed in the study of Manudeep et. al., because in the study of Manudeep et al., more catheters were positioned optimally in the radiological *landmark group* (74.5%) compared to the Peres group (49%). This finding correlates with previous researchconducted by Ahn et al. who compared the Peres formula and radiological *landmarkformula* for central venous catheter positioning where 69 out of 93 (74%) catheters were optimally positioned in the Peres formula group and 88 out of 95 (93%) catheters were optimally positioned in the radiology *landmark group* with a P valueof 0.001 . [7,8]

Based on the previous presentation , the results obtained were that the accuracyof the central venous catheterization tip depth using the Peres formula was lower when compared to the radiological evaluation picture on the right subclavian , therefore this study was conducted to test whether the comparison of the accuracy of the central venous catheterization tip depth on the left subclavian using the Peres formula with evaluation of the radiological appearance between the supraclavicular and infraclavicular as well occurs in the patient, to avoid malposition and complications of central venous catheterization.

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Methods

This study used an RCT (*Randomized Clinical Trial*) design with *double blind* , meaning that neither the research subjects nor the researchers had to know about the treatment or intervention given. This study aims to compare the accuracy of thedepth of the central venous catheterization tip on the left subclavian using the Peresformula with the evaluation of radiological images between the supraclavicular andinfraclavicular at Adam Malik Haji Center General Hospital Medan. The sample size in the study was 40 for each group with a total sample of 80.

Results

Table 4.1 Data Characteristics Table

Characteristics	Supraclavicular		Infraclavicular		Total	
Gender	**n**	**%**	**N**	**%**	**n**	**%**
Man	24	28,2	24	28,2	48	56.5
female	21	24,7	16	18,8	37	43.5
Age						
21-30	4	4,7	3	3,5	7	8,2
31-40	3	3,5	4	4,7	7	8,2
41-50	8	9,4	7	8,2	15	17,6
51-60	13	15,3	15	17,6	28	32,9
61-70	11	12,9	10	11,8	21	24,7
>70	6	7,1	1	1,2	7	8,2

Table 4.1 shows that there were 24 male patients in the supraclavicular group (28.2%) and 24 infraclavicular group (28.2%) with a total of 48 male patients(56.5%) while the There were 21 women (24.7%) in the supraclavicular group and 16 women (18.8%) in the infraclavicular group, with a total of 37 women (43.5%).In addition, it is also known that patients aged 21-30 years in the supraclavicular group totaled 4 people (4.7%) and in the infraclavicular group there were 3 people(3.5%) with a total of 7 people (8.2%), patients aged 31-40 years in the supraclavicular group totaling 3 people (3.5%) and in the infraclavicular group totaling 4 people (4.7%) with a total of 7 people (8.2%), patients aged 41-50 yearsin the supraclavicular group totaling 8 people (9.4%) and the infraclavicular grouptotaling 7 people (8.2%) with a total of 15 people (17.6%), patients aged 51-60 years in the supraclavicular group totaling 13 people (15.3 %) and the infraclavicular group totaled 15 people (17.6%) with a total of 28 people (32.9%), patients aged 61-70 years in the supraclavicular group totaled 11 people (12.9%) and the infraclavicular group totaled 10 people (11.8%) with a total of 21 people (24.7%), patients aged >70 years in the k supraclavicular numbered 6 people (7.1%) and the infraclavicular group numbered 1 person (1.2%) for a total of 7 people (8.2%).

Table 4.2 Distribution of Patient Data

Data	Means	±SD	Normality
Age	54	13.81	0.019
TDS	127,26	11.03	<0.001
TDD	72,66	7,52	<0.001
HR	85,42	10.89	<0.001
RR	19.74	1.57	<0.001
BB	57.85	7,32	0.006
TB	161.44	7,63	0.005
BMI	22,14	1.74	0.008

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Peres Formula	18.08	0.75	0.003
Tip Distance	2.44	0.89	<0.001

Based on Table 4.2, it is known that the average (standard deviation) age ofthe study subjects was 54 (13.81) years, the average (standard deviation) systolic blood pressure of the study subjects was 127.26 (11.03) mmHg, the average (standard deviation) diastolic blood pressure of study subjects was 72.66 (7.52) mmHg, average (standard deviation) of study subject's heart rate pressure was

85.42 (10.89) times, average (standard deviation) frequency the study subject's respiration was 19.74 (1.57) times, the average (standard deviation) of the study subject's body weight was 57.85 (7.32) kg, the average (standard deviation) of the study subject's height was 161, 44 (7.63) cm, the average (standard deviation) BMIof the study subjects was 22.14 (1.74), the average (standard deviation) calculated using the Peres formula was 18.08 (0.75) cm, the average (standard deviation) tip distance to T5 of the study subjects was 127.26 (11.03) mmHg with both data not normally distributed.

4.2 Results of Analysis of the Supraclavicular and Infraclavicular Groups with Central Venous Catheterization Tip Depth Accuracy Levels .

In this data, an analysis of the relationship between groups with the level ofaccuracy into the central venous catheterization tip was carried out with the Chi- Square test to see the relationship between the two, but if an *expected count* <5 is found in the data, an alternative Fisher Exact test will be performed.

Table 4.3 Analysis of the Supraclavicular and Infraclavicular Groups with the Depth Level of Central Vein Catheterization Tips

Accuracy Group	Not exactly		Appropriate		Total		*p-values*
	f	%	*F*	%	*F*	%	
Supraclavicular	36	42.4	9	10.6	45	52.9	
Infraclavicular	32	37.6	8	9.4	40	47.1	1,000
Total	68	80	17	20	85	100	

Based on table 4.3 , the frequency of supraclavicular samples with incorrecttips was 36 samples (42.4%) and 9 samples (10.6%) were correct. Furthermore, forthe experiment using the inflaclavicular as many as 32 samples (37.6%) were not correct, while 8 samples (9.4%) the tip was correct. It is known that the analysis was carried out using the Chi-Square test and it was known that there was no significant relationship between groups with the level of accuracy of central venous catheter tip depth (p = 1.000).

4. 3 Analysis Results of Average Depth of Central Venous Catheterization Tips Based on the data, it is known that there were 45 research subjects who underwent a central venous catheter insertion procedure with a supraclavicularapproach and 40 research subjects with an infraclavicular approach. The accuracy assessment was carried out based on the previously determined *Limit of Agreement*,where the LoA is considered acceptable is ± 2 cm from T5 or the patient's carina.

Table 4. 4 Analysis of Average Depth of Central Venous Catheterization Tips

Data	Means	±SD	Accuracy
Supraclavicular	18,13	0.82	20%
Infraclavicular	18.01	0.78	20%
Total	18.08	0.75	20%

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Based on Table 4.4, it is known that the average (standard deviation) tip depth for central venous catheterization with the supraclavicular approach is 18.13(0.82) cm and the infraclavicular approach is 18.01 (0.78) cm, and the overall tip depth is 18.08 (0.75) cm. Based on these data, an analysis of the percentage of accuracy was also carried out in each group and both obtained a percentage of 20

% of the total research subjects for each group.

4.4 Analysis Results of Average Tip Distance of Central Venous Catheterization

Based on the data, it is known that there were 45 research subjects who underwent a central venous catheter insertion procedure with a supraclavicularapproach and 40 research subjects with an infraclavicular approach. The accuracyassessment was carried out based on the previously determined *Limit of Agreement*,where the LoA is considered acceptable is ± 2 cm from T5 or the patient's carina. **Table 4. 5 Analysis of average tip distance for central venous catheterization**

Data	Means	±SD	Accuracy
Supraclavicular	2.55	1.00	20%
Infraclavicular	2,33	0.79	20%
Total	2.44	0.89	20%

Based on data it is known that the average (standard deviation) tip distance for central venous catheterization with the supraclavicular approach is 2.55 (1.00) cm and the infraclavicular approach is 2.33 (0.79) cm, and the overall tip distance is 2.55 (1.00) cm. 44 (0.89) cm.

Table 4.6 Average height and weight based on the accuracy of installation

CVC precision	Amount	Average height
Appropriate	17	175,29
Not exactly	68	160.02
Total	85	163.08

Based on the table above, it can be seen from the table above that the 17 samples that had the right CVC position had an average height of 175.29 cm and the 68 samples had an average height of 160.02.

Discussion

This study basically compared the accuracy, or precision, of two invasive intervention approaches in performing central venous (left subclavian) catheterization through the supraclavicular or infraclavicular spaces. With a mean participant age of 54.0 ± 13.8 years (56.5% of them were male), approximately 85 catheter insertions were included in this study with 17 of these procedures being found to be appropriate, accurate, and in line with intervention expectations. It is hoped that the reliability of this study can be guaranteed through the normality testresults as shown in table 4.1, with all the variables tested showing a P value <0.05 so that there is no significant difference from the *baseline for* all the individuals included. Of the 85 procedures performed, 45 (52.9%) applied the supraclavicular approach. It is known, the success rate of this approach is 20.0%. Interestingly, this figure is also obtained from the success rate of the infraclavicular approach with 8 out of 20 catheter insertion procedures achieving success.

Thus, there is no statistically significant difference in the comparison of the two variables (20.0% accuracy level in both approaches) giving rise to a P value =

1.000. The similarity of the finishes of the two approaches makes the choice of where to install the CVC completely dependent on operator preference or experience.

With an accuracy rate of 20.0% or 1 in 5 catheter insertion trials, it does notmean that the results obtained in this study are

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known to be lower than other studiessuch as Durrani *et al.* (87.51% vs. 69.64%) and Govindswamy *et al.* (80-90% vs. 60-70%) on the first attempt of supraclavicular and infraclavicular catheterization respectively. The entire process of attempting to insert a catheter in this study was reported to have a success rate of 100.0%, so the definition of accuracy in the context of this study is not the same as success. Technically, only 20.0% of trials actually reached the left subclavian vein directly (at the level of the carina or aboutthe fifth thoracic vertebra) although in the end the catheter insertion was declared asuccess from the point of view of anesthesiology and intensive therapy. Although the study of Durrani *et al.* and Govidswamy *et al.* previously different quantitatively, in fact there was no statistically significant difference (P > 0.05) in the success rate analysis. Furthermore, supraclavicular catheter insertion is known to be "more comfortable" in patients who are fully conscious. Durrani *et al.* also mentioned that the supraclavicular approach also requires a shorter time and is easier to do using a needle the size of a 10 ml *syringe* . [9,32]

To discuss this in more depth (from a technical point of view), an analysis of the mean left subclavian vein catheterization tip depth in this study was quantitatively deeper in the supraclavicular group than infraclavicular group (18.13 ± 0.82 cm vs. 18.01 ± 0.78 cm; respectively). The difference in catheter length is quite significant when compared quantitatively with the study by Bodkhe *et al.* namely 12.19 ± 1.03 cm in the supraclavicular and 13.24 ± 0.86 cm in the infraclavicular. Despite the differences between the studies, the differences betweenprocedures in the two studies were also not too great although the need for deeper catheter length was found in this study which used the Peres formula to estimate the catheter length. The distance between the tip of the catheter and the carina/Vth thoracic vertebra was also farther in the supraclavicular group (2.55 ± 1.00 cm) compared to the infraclavicular group (2.33 ± 0.79 cm) although an analysis of the difference was not performed in this study. The use of the fifth thoracic carina/vertebra as a radiological marker to determine how far the tip is in agreementwith the structure is basically based on the relatively easy identification or determination of the distance between these two variables in posteroanterior (PA) thoracic radiology.

The average depth of the catheter based on Peres' calculations was 16.21 ± 0.82 cm; almost similar to this study although Manudeep *et al.* approach the jugularvein rather than the subclavian vein. [13] By using the Peres formula which varies, depending on the anatomical location to be invaded with the catheter, determining how far the catheter has been attached and its accuracy will certainly be a significantfactor in the venous catheterization procedure. Approach to the left subclavian veinusing Peres' formula: height (cm)/10 + 2 cm; so that if someone has a height of 175cm, then the depth of the catheter needed is 17.5 cm. This case example relates to this study, with a population that has an average height of 171.44 ± 7.63 cm, it is estimated that the average depth of the catheter inserted is 19.14 cm, which indicates continuity or consistency between the calculation results of the Peres formula , mean height, and actual catheter depth encountered in this study.

The study showed that the CVC catheter was in the right location when theheight was ≥ 175 cm, but the height of Indonesians is generally shorter than the height of the Caucasian race so that when installing the CVC it is always deeper than desired. [9] So that it makes limitations in this study which has a majority of thesample with an average height of 163.08. so to determine the comparison of the accuracy of the infraclavicular tip compared to the supraclavicular tip using the Peres formula still needs to be done with samples that have a height ≥ 175 cm.

Conclusion

The accuracy of central venous catheterization in the left subclavian using the Peresformula supraclavicular and infraclavicular is known to be the same, namely 20.0%or 1 out of 5 procedures directly reaching the carina/region about the fifth thoracic vertebra.

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