Original Research Article

Clinical tests to determine the correct position of Central Venous Catheter in overweight patients in critically ill condition.

Short Title: correct position of Central Venous Catheter

Abstract

Objective: to demonstrate the utility of clinical test to determine the correct placement of the CVC in overweight patients in critical condition.

Methods. Cross-sectional Study carried out in the Intensive Care Unit of the High Speciality Medical Unit of Traumatology and Orthopedics from Mexican Social Security Institute during 2014. The variables were age, sex, Body Mass Index and clinical diagnostic test. The placement of the catheter was done percutaneously, once the catheter was placed, clinical tests for determining the correct placement were done, verifying cardiac arrhythmias, test of venous return, measurement of Central Venous Catheter pressure and external length of the catheter. The statistics used was descriptive.

Results: Thirty-one patients were included. To all the patients clinical diagnosis tests were performed to verify the correct placement of the Central Venous Catheter (58%). The average Body Mass Index was 26. Of the catheters placed, 29.03% were central and 70.96% were misplaced, according to the chest x-ray. The arrhythmias were presented in 9.67%, with a specificity of 90%, and negative predictive value of 90%. The variations in central venous pressure were presented in 32.25% patients; the sensitivity was 20%, the specificity and negative predictive value were 60% respectively.

Conclusion: We found low sensitivity and good specificity for these clinical tests.

Keywords: Clinical tests; critical care; Central Venous Catheter;

Introduction

Placement of a Central Venous Catheter (CVC) in patients in critical conditions in the Intensive Care Unit (ICU) is a primordial and standardized procedure for an adequate management of these patients.

The utility of a CVC is performed by measurements of central venous pressures, administration of total parental nutrition (TPN), antibiotic, fluids, vasoactive drugs and a long-term venous access[1,2].

The procedure for placement a CVC is very common, in the United States of America (USA) six millions of CVC are placed and in the United Kingdom (UK) about 200,000 per year[1,3,4] ; this makes the placement a relatively safe procedure.

The incidence of complications after placement of the CVC varies from 1% to 15% and is associated with the operator inexperience, placement of the CVC on the left, an increase number of needle passes and extremes of the Body Mass Index (BMI) [2]. These complications may be mechanical, infectious or thrombotic[4,5,6].

Schuster et. al concluded that the CVC tip must be over the carina in order not to cause cardiac tamponade or drilling of the superior vena cava; also the safe insertion must be 16.5cm in most adult patients even for another authors is 15 cm as they consider greater distances are too far[2]. According to the guidelines of the Food and Drug Administration (FDA) the tip of the CVC must be in the distal third of the superior vena cava near to the union with the right auricula which avoids complications with the administration of drugs and parenteral nutrition[1,7].

The clinical tests to determine the CVC position are useful for determining the correct position of its tip and these are:

Measurement of the final distance of the CVC tip, according to Martinez et. al its measurement is highly sensitive, they recommend to install the CVC at an average depth of 14 cm for the subclavian access[8,9].

The venous return is measured by the syringe aspiration in one of the catheter via or by placing an infusion bag under the level of the hearth and obtaining blood from it, however, it can give false positives or false negatives when the patient curses with severe alterations in arterial pressure[9,10], some authors consider that is positive in 95% of the cases, this test confirms the intravascular position of the CVC with an adequate blood return[8,9,10].

The measurement of the central venous pressure, is done with a central venous pressure column which is positive when it oscillates simultaneously with breathing[8,11]. The normal value is 5 ± 3 mmHg with oscillations in the 70 to 89% of patients to which pressure is measured through the CVC. Since mid 1980, a T connector has been used to obtain the pressure transduction in waveform during the CVC insertion[12].

The arrhythmias are present when the catheter touches the heart walls, therefore it is translated in an extreme depth of the catheter, its presence forces the immediate CVC relocation[13,14,15].

However, clinical studies that compare the utility of these tests with chest X-ray (Gold standard for correct CVC placement) are needed[1,8].

The objective of this paper is to demonstrate the utility of clinical test to determine the correct placement of the CVC in overweight patients in critical condition, treated in the ICU of the High Speciality Medical Unit (HSMU) of Traumatology and Orthopedics of the Mexican Social Security Institute of Puebla (IMSS in spanish).

Material and Method

Cross Sectional Study, carried out in the Medical Unit of High Speciality of Traumatology and Orthopedics of Mexican Social Security Institute in Puebla during the period from July to December of 2014.

Thirty one patients of the ICU were included to which 1 CVC was placed by patient in a subclavian via (incidence), bilateral, older than 14 years old, both genders, without alterations in the consciousness, with an BMI between 25 and 29.9 (overweight) and hemodynamically stable. The variables were age, sex, BMI and clinical diagnostic test.

The aseptic and antiseptic of the region was performed with cutaneous antiseptic solution of chlorhexidinegluconate at 2% p/v and isopropyl alcohol at 70% made by Care Fusion. The catheter used was a permanent type of three 7fr lumen of 20cm of length of radiopaque polyurethane with a flexible tip Blue Flex Tip made by Arrow International, Inc.

The placement was done percutaneous, once the catheter was placed clinical tests for determining the correct placement were done: verifying cardiac arrhythmias, test of venous return, measurement of CVC pressure and external length of the catheter. At

the end of the procedure to all of the patients a clinical examination and a chest x-ray were performed.

The statistics used was descriptive, the sensitivity, specificity, positive predictive value and negative predictive value, were determined for each clinical diagnosis test. The data obtained were processed in the statistical program StatCalc version 8.1.3 for Mac.

The population unit was consisted for each patient with subclavian CVC and a chest X-ray, which was considered the gold standard for the analysis of each clinical diagnosis test. All the patients who accepted to participate in the study filled up an Informant Consent (IC) and the anonymous of the participants was respect at all times.

Results

We included 31 patients who underwent a central venous catheter placement. To all the patients' clinical diagnosis tests were performed to verify the correct placement of the CVC, 18(58%) were women and 13(42%) were men. The more frequent site of punction was the left side with 65% and right side with 35%.

The average age was 55.77 (minimum 18, maximum 79) $\pm$ 19.46 years; 1(3.22%) patient was in the range of age of 14 to 20 years, 7(22.58%) patients between 21-40, 8(25.8%) between 41-60 and 15(48.38%) patients between 61-80 years old.

The average BMI was 26.26 (minimum 25.1 – maximum 29.7) $\pm$ 1.088.

One hundred percent of the placed catheters were of three lumens.

Of the catheters placed, 9(29.03%) were central and 22(70.96%) were misplaced, according to the chest x-ray.

The arrhythmias were presented in 3(9.67%) patients, with a 10% sensitivity, 90% specificity, 30% positive predictive value, and 90% negative predictive value. The variations in central venous pressure were presented in 10(32.25%) patients, the sensitivity was 20%, the specificity 60%; the positive predictive value of 20% and negative predictive value of 60%.

The central venous return was presented in 10(32.25%) patients, the sensitivity was 50%, specificity of 70%; while the positive predictive value was 50% and negative predictive value 80%. Regarding the external length catheter variation, this was presented in 9(29.03%) patients, this test had a sensitivity of 30%, specificity of 70%; positive predictive value 30% and negative predictive value of 70%. (Table 1 to table 5)

In no case difficulty to pass the catheter existed and clinical exploration of the thorax was negative in all cases.

Discussion

The correct performance of the CVC depends among other things, to the right location of its tip. It is fundamental to consider the potential complications that may be associated to a inadequate position of the catheter, therefore the length of insertion of the CVC must be rigorous[1,11,16].

The clinical tests for correct placement of the CVC are useful, may prevent severe complications in patients, and their results may show a incorrect position of the CVC[1,8,11].

These tests evaluate the results of the clinical tests in the placement of the CVC, its central position and its limitations in the correct position. There are studies that evaluate the clinical tests for placement of the CVC in critically ill patients, however, clinical studies that evaluate the utility of these tests in overweight population are needed, for this reason we decided to perform this study in population with a BMI between 25 and 29.9.

We must have in consideration that the results of these tests in terms of sensitivity, specificity are low for the location of the CVC. This disagrees with the findings of Martinez et al, who found greater sensitivity and specificity for these tests in population healthy-people[8,9].

It is important to mention that this population included patients with overweight which makes difficult the procedure. Another point to have in consideration is that the location of insertion for these catheters was subclavian in the 100% of cases which difficult the procedure as well for the location of the venous access. Having in consideration the sensitivity and specificity concepts, we consider that the qualities to evaluate the patient to obtain a positive result in the catheter application by this via were low and very high for limitations in the evaluation of those who did not have a central position[17,18,19.]

Considering the other three tests, the sensitivity found was low for central venous pressure and the external length catheter variation.

Regarding the specificity of the measure of central venous pressure, venous return and measure of external length catheter, the capacity of these tests to determine that the

position was not central was higher compared with the capacity to determine that the patient have positive results.

Regarding the negative and positive predictive values, that evaluate the probability that the catheter application had been central if the result is positive in the clinical test or that the probability of misplaced is the test turned out negative, the values were under 90% of all tests except for the arrhythmia presented with a VPN in 90%.

This study reveals the presence of arrhythmia as the greater specificity test to determine the central catheter position via subclavian.

Some authors proposed and promise that a chest x-ray is not necessary for testing the catheter position with some mechanical guidelines that influenced the technique, among these they added the a proximal measure of 15cm, as key data to secure the central line and with it accomplished the location in 89 of 100 catheters, testing a range of 2.5 cm of margins and three more tests to check position.

Other authors, suggest that the return venous test must be always performed to confirm the intraluminal catheter position, however, this test does not guarantee the central position of the catheter since only one part of the catheters that have venous return are central in the chest x-ray of the performed control[1,916].

The presence of arrhythmias is greater in critically ill patients and are present in some occasions transiently during colocation of the catheter giving in some minutes, therefore, this test must be taken in consideration as well as to determine whether the catheter is central or not.

We found low sensitivity and high specificity for these four clinical tests. It must be taken into consideration that medical and surgical procedures are hampered when realized in patients with overweight and obesity.

Conclusion.

We can conclude that the results of these clinical tests for determining the central position of the catheters placed via subclavian must be taken with cautious when patients are overweight and always perform a control chest x-ray which can confirm the central position of the catheter.

References.

1.- Marroquín-Cameras R. Pruebas clínicas para la determinación de la ubicación correcta del catéter venoso central en pacientes en estado crítico. Puebla, México: The author, 2014. [Specialist Thesis in Medical Emergencies, IMSS].

2.- Pearson ML. Hospital Infection Control Practices Advisory Committee. Guidelines for prevention of intravascular device-related infections. US: Centers for Disease Control and Prevention; 1999.

3.- Ezri T, Weisenberg M, Sessler DI, Berkenstadt H, Elias S, Szmuk P, et. al. Correct Depth of Insertion of Right Internal Jugular Central Venous Catheters Based on External Landmarks: Avoiding the Right Atrium. J Cardiothoracic Vasc Anesth. 2007; 21(4):497-501.

4.- Schummer W, Herrmann S, Schummer C, Funke F, Steenbeck J, Fuchs S, et. al. Intra-atrial ECG is not a reliable method for positioning left internal jugular vein catheters. Br J Anaesth. 2003; 91(4):481-486.

5.- Torres-Millan J, Torres-López M, Benjumea-Serna M. Ubicación de la punta del catéter venoso central en aurícula derecha: descripción en 2.348 pacientes críticos. Med Int. 2010; 34(9):595–599.

6.- Bailey SH, Shapiro SB, Mone MC, Saffle JR, Morris SE, Barton RG. Is Immediate Chest Radiograph Necessary after Central Venous Catheter Placement in a Surgical Intensive Care Unit? Am J Surg. 2000; 180(6):521–522.

7.- McGee DC, Gould MK. Preventing complications of central venous catheterizacion. N Eng J Med. 2003; 348:1123-1133.

8.- Martínez-Flores F, Márquez-González H, Márquez-Flores H, Rodríguez-Reyes ER, Guerrero-Almeida ML. Validez de las pruebas clínicas para determinar posición del catéter venoso central. Rev Med Inst Mex Seguro Soc. 2009; 47(6):665-668.

9.- Factor P, Sznajder JI. Intravascular cannulation. En: Wood LDH, Hall JB, Schmidt G, editors. Principles of critical care medicine. Philadelphia, Pa: JB Lippincott; 1991.

10.- American College of Surgeons Committee of Trauma. Advanced Trauma Life Support. ATLS Faculty Course Manual. US: American College of Surgeons Committee of Trauma; 2000.

11.- Pedemonte JC, Carvajal C. Posición ideal de la punta del catéter venoso central. Rev Chil Anestesia. 2006;35:63-70.

12.- Cummins S, Ornato J, Lance B. Reanimación cardiopulmonary avanzada. Second edition. Dallas, Tx; American Heart Association;1997. p. 1-13.

13.- Bishop L, Dougherty L, Bodenham A, Mansi J, Crowe P, Kibbler C, et. al. Guidelines on the insertion and management of central venous access devices in adults. Int J Lab Hem. 2007;29(4):261–278.

14.- Cheung E, Baerlocher MO, Asch M, Myers A. Venous Access a practical review for 2009. Can Fam Physician. 2009; 55(5):494.496.

15.- Fellipe-Martin F, González-Martínez JC, Domínguez-Ulibarri R, Shaffhauser-Ortega E, Cárdenas-Rodríguez I. Complicaciones mecánicas del abordaje venoso profundo en una unidad de cuidados intensivos. Rev Cubana Pediatr. 1999;71(1):28-32.

16.- Rajinikanth J, Stephen E, Agarwal S. Complications of central venous cannulation. Can J Surg. 2008;51(5):E113-E114.

17.- Yong Seon Choi, Ji Young Park, Young lanKwak, Jong Wha Lee. Inadvertent arterial insertion of a central venous catheter: delayed recognition with abrupt changes in pressure waveform during surgery -A case report-. Korean J Anesthesiol. 2011; 60(1):47-51.

18.- Peterfreund RA, Wargo JA. Errant central line placement. J Clin Anesth. 2007; 19(6):479–481.

19.- Nair-Venugopal A, Cherian Koshy R, Koshy S. Role of chest X-ray in citing central venous catheter tip: A few case reports with a brief review of the literature. J Anaesthesiol Clin Pharmacol. 2013; 29(3):397-400.

Tables

Table 1 to table 5 demonstrate validity of the clinical tests to determine the position of the central venous catheter.

Table 1.

		Simple Chest X Ray		Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Simple Chest		+	-					1.0

X Ray	+	9	22	1.0	1.0	1.0	1.0	
	-	0	0					

Abbreviations: PPV=positive predictive value, NPV=negative predictive value, %=percentage.

Table 2

		Simple Chest X Ray		Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Cardiac arrhythmias		+	-	10	90	30	90	0.74
	+	1	2					
	-	8	20					

Abbreviations: PPV=positive predictive value, NPV=negative predictive value, %=percentage.

Table 3

		Simple Chest X Ray		Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Central venous pressure		+	-	20	60	20	60	0.51
	+	2	8					
	-	7	14					

Abbreviations: PPV=positive predictive value, NPV=negative predictive value, %=percentage.

Table 4

		Simple Chest X Ray		Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Venousreturn in thecatheter		+	-	50	70	50	80	0.70
	+	5	5					
	-	4	17					

Abbreviations: PPV=positive predictive value, NPV=negative predictive value, %=percentage.

Table 5

Measurement of the final distance of the catheter		Simple Chest X Ray		Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
		+	-	30	70	30	70	0.61
	+	3	6					
	-	6	16					

Abbreviations: PPV=positive predictive value, NPV=negative predictive value, %=percentage.