

Original Research Article**Clinical tests to determine the correct position of Central Venous Catheter in overweight patients in critical 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 ICU of Traumatology and Orthopedics of Mexican Social Security Institute of Puebla in 2014. The variables were age, sex, BMI and clinical diagnostic test. The placement 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 CVC 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 CVC(58%). The average BMI 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 60 and negative predictive value of 60%.

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.

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

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

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

46 Schuster et. al concluded that the CVC tip must be over the carina in order not to cause
47 cardiac tamponade or drilling of the superior vena cava; also the safe insertion must be
48 16.5cm in most adult patients even for another authors is 15cm as they consider greater
49 distances are too far². According to the guidelines of the Food and drug Administration
50 (FDA) the tip of the CVC must be in the distal third of the superior vena cava near to the
51 union with the right auricula which avoids complications with the administration of drugs
52 and parenteral nutrition^{1,7}.

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

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

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

64 The measurement of the central venous pressure, is done with a central venous
65 pressure column which is positive when it oscillates simultaneously with breathing^{8,11}.

66 The normal value is 5 ± 3 mmHg with oscillations in the 70 to 89% of patients to which

67 pressure is measured through the CVC. Since mid 1980, a T connector has been used
68 to obtain the pressure transduction in waveform during the CVC insertion¹².

69 The arrhythmias are present when the catheter touches the heart walls, therefore it is
70 translated in an extreme depth of the catheter, its presence forces the immediate CVC
71 relocation^{13,14,15}.

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

74 The objective of this paper is to demonstrate the utility of clinical test to determine the
75 correct placement of the CVC in overweight patients in critical condition, treated in the
76 ICU of the Medical Unit of High Specialty (MUHS) of Traumatology and Orthopedics
77 (TAO) of the Mexican Social Security Institute of Puebla (MSSI).

78

79 Material and Method

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

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

87 The aseptic and antiseptic of the region was performed with cutaneous antiseptic
88 solution of chlorhexidine gluconate at 2% p/v and isopropyl alcohol at 70% made by
89 CareFusion. The catheter used was a permanent type of three 7fr lumen of 20cm of
90 length of radiopaque polyurethane with a flexible tip Blue FlexTip made by Arrow
91 International, Inc.

92 The placement was done percutaneous, once the catheter was placed clinical tests for
93 determining the correct placement were done: verifying cardiac arrhythmias, test of
94 venous return, measurement of CVC pressure and external length of the catheter. At
95 the end of the procedure to all of the patients a clinical examination and a chest x-ray
96 were performed.

97 The statistics used was descriptive, the sensitivity, specificity, positive predictive value
98 and negative predictive value, were determined for each clinical diagnosis test. The
99 data obtained were processed in the statistical program StatCalc version 8.1.3 for Mac.
100 The population unit was consisted for each patient with subclavian CVC and a chest x-
101 ray, which was considered the gold standard for the analysis of each clinical diagnosis
102 test. All the patients who accepted to participate in the study filled up an Informant
103 Consent (IC) and the anonymous of the participants was respect at all times.

104 Results

105 Thirty one adult patients whom one CVC was placed. To all the patients' clinical
106 diagnosis tests were performed to verify the correct placement of the CVC, 18(58%)
107 were women and 13(42%) were men. The more frequent site of puncture was the left
108 side with 65% and right side with 35%.

109 The average age was 55.77 (minimum 18, maximum 79) \pm 19.46 years; 1(3.22%)
110 patient was in the range of age of 14 to 20 years, 7(22.58%) patients between 21-40,
111 8(25.8%) between 41-60 and 15(48.38%) patients between 61-80 years old.

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

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

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

116 The arrhythmias were presented in 3(9.67%) patients, with a sensitivity of 10%,
117 specificity of 90%, positive predictive value of 30% and negative predictive value of
118 90%. The variations in central venous pressure were presented in 10(32.25%) patients,
119 the sensitivity was 20%, the specificity 60; the positive predictive value of 20% and
120 negative predictive value of 60%.

121 The central venous return was presented in 10(32.25%) patients, the sensitivity was
122 50%, specificity of 70%; while the positive predictive value was 50% and negative
123 predictive value 80%. Regarding the external length catheter variation, this was
124 presented in 9(29.03%) patients, this test had a sensitivity of 30%, specificity of 70%;
125 positive predictive value 30% and negative predictive value of 70%. (Table 1 to table 5)

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

128 Discussion

129 The correct performance of the CVC depends among other things to the right location of
130 its tip. It is fundamental to consider the potential complications that may be associated
131 to the catheter mal position, therefore the length of insertion of the CVC must be
132 rigorous^{1,11,16}.

133 The clinical tests for correct placement of the CVC are useful, may prevent severe
134 complications in patients, and their results may show a incorrect position of the
135 CVC^{1,8,11}.

136 These tests evaluate the results of the clinical tests in the placement of the CVC, its
137 central position and its limitations in the correct position. There are studies that evaluate
138 the clinical tests for placement of the CVC in critically ill patients, however, clinical
139 studies that evaluate the utility of these tests in overweight population are needed, for
140 this reason we decided to perform this study in population with a BMI between 25 and
141 29.9.

142 We must have in consideration that the results of these tests in terms of sensitivity,
143 specificity are low for the location of the CVC. This disagrees with the findings of
144 Martínez et al, who found greater sensitivity and specificity for these tests in population
145 healthy-people^{8,9}.

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

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

155 Regarding the specificity of the measure of central venous pressure, venous return and
156 measure of external length catheter, the capacity of these tests to determine that the
157 position was not central was greater compared with the capacity to determine that the
158 patient have positive results.

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

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

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

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

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

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

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

185

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238
 239 Tables
 240 Table 1 totable 5 demonstrate validity of the clinical tests to determine the position of the
 241 catheter

242
 243 Table 1.
 244

Simple Chest X Ray		Simple Chest X Ray		Sensitivity	Specificity	PPV	NPV	Accuracy
		+	-	%	%	%	%	%
	+	9	22	1.0	1.0	1.0	1.0	1.0
	-	0	0					

245 Abbreviations: PPV=positive predictive value, NPV=negative predictive value,
 246 %=percentage.

247
 248
 249
 250

251 Table 2
252

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

253 Abbreviations: PPV=positive predictive value, NPV=negative predictive value,

254 %=percentage.

255

256 Table 3

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

257 Abbreviations: PPV=positive predictive value, NPV=negative predictive value,

258 %=percentage.

259

260 Table 4

Venous return in the catheter		Simple Chest X Ray		Sensitivity	Specificity	PPV	NPV	Accuracy
		+	-	%	%	%	%	%
	+	5	5	50	70	50	80	0.70
-	4	17						

261 Abbreviations: PPV=positive predictive value, NPV=negative predictive value,

262 %=percentage.

263

264 Table 5

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

265 Abbreviations: PPV=positive predictive value, NPV=negative predictive value,
266 %=percentage.