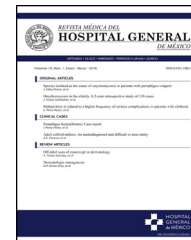




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REVIEW ARTICLE

## Proper electrocardiography-guided placement of a central venous catheter

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Received 15 June 2016; accepted 14 September 2016

### KEYWORDS

Central venous catheter;  
Placement;  
CVC tip;  
Electrocardiograph;  
P wave

**Abstract** The placement of central venous catheters (CVC) has become a common procedure. The position of the CVC tip may vary according to the intended use. Ideally it should be placed in the extra-pericardial vena cava due to the potential risk of vascular disruption, cardiac perforation, and/or thrombosis.

A simple, economical, little-used method with a high rate of accuracy for positioning the CVC tip is based on electrocardiographic changes in the P wave that occur as it advances towards the vena cava.

This article explains the procedure for correctly placing the catheter using the technique described.

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### PALABRAS CLAVE

Catéter venoso central;  
Posición;  
Punta de la CVC;  
Electrocardiografía;  
Onda "P"

### Colocación adecuada de catéter venoso central guiada con electrocardiografía

**Resumen** La colocación de catéteres venosos centrales (CVC) se ha convertido en un procedimiento común. De acuerdo con el uso previsto, la posición de la punta de la CVC puede variar. Idealmente, debería ser colocada en la vena cava extrapericárdica por el riesgo potencial de disrupción vascular, perforación cardíaca y/o trombosis. Un método poco utilizado, sencillo, económico, con una alta tasa de precisión para el posicionamiento de la punta del CVC se basa en cambios electrocardiográficos en la onda "P" que se producen durante su avance hacia

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<http://dx.doi.org/10.1016/j.hgmx.2016.09.007>

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Please cite this article in press as: Velasco YLA, et al. Proper electrocardiography-guided placement of a central venous catheter. Rev Med Hosp Gen Méx. 2016. <http://dx.doi.org/10.1016/j.hgmx.2016.09.007>

la vena cava. En este artículo se explica el procedimiento para la colocación correcta del catéter mediante la técnica descrita.

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## Introduction

A central venous catheter (CVC) is a catheter aimed at cannulating large veins to enable various medications to be perfused at an insertion site. They come with one to three lumens and are 20 cm long for insertion near large veins or for peripheral insertion, or as long as 50–60 cm which are usually placed in the basilic or cephalic vein in the arm.<sup>1</sup>

The placement of central venous catheters has become a common procedure due to its numerous indications such as: chemotherapy for cancer patients, amine administration, hyperosmolar solutions as well as parenteral nutrition or dextrose 50%, in addition to its utility for measuring central venous pressure, although this last use is widely debated.<sup>2</sup>

In the U.S., approximately 5,000,000 central lines are placed each year. The rate of mechanical complications during the procedure ranges from 6% to 19%, which accounts for 250,000 to 1,000,000 complications annually.<sup>3</sup> These can be classified as early (during puncture) and late (due to the duration of the catheter). The main complications in the first group are mechanical (pneumothorax, artery puncture) at 12% and increase six-fold after the third insertion attempt. The second group includes infections and thrombosis, with a frequency of 13%.<sup>4,5</sup>

Several methods have been used to calculate the distance at which the CVC should be inserted to achieve the desired position, although it is always confirmed with a chest X-ray after the procedure. In addition to confirming the catheter is correctly placed, this also serves to rule out potential complications such as pneumothorax and/or haemothorax.

In 1995, Czepizak et al. presented a series of formulas to estimate the optimum placement of a CVC according to the access point and based on the patient's height.<sup>6</sup>

Depending on how it will be used, the CVC tip position can vary. Most central catheters that are used to measure venous pressure or to infuse solutions function well when placed in a large vessel. If it is placed far from the right atrium (RA) in a small vessel, it is likely that the catheter will be obstructed against the vessel wall and will not function well.<sup>7</sup>

Vascular damage caused by an incorrectly positioned CVC tip, both during insertion or secondary to chronic injury, has been recognised as an initial event and as perpetuating thrombosis. Should the catheter tip remain positioned against the vessel wall, it can become a source of permanent damage. Correctly placing the catheter can minimise this injury. It should be parallel to the wall of the superior vena cava and the catheter tip should be able to move freely within the vessel lumen.<sup>8</sup>

## Methods used to optimise CVC placement

The veins most commonly used as CVC access routes are the internal jugular, subclavian, or femoral veins or the arm



Figure 1 CVC in SVC on X-ray.<sup>12</sup>

veins. There is a general evidence-based agreement for the preferential use of the right internal jugular vein based on its anatomy vis-à-vis the heart, as it presents a low risk of venous stenosis, thrombosis, and pneumothorax in that area. Traditionally, the central venous catheter insertion site has been determined by palpating anatomical references with a known relation to the vein to be cannulated.

The placement of the CVC tip is essential for it to work correctly. Ideally it should be placed in a vessel with a wide diameter, preferably outside the cardiac cavity and parallel to the vein axis to decrease the presence of lesions.

The ideal placement is in the extra-pericardial vena cava,<sup>8</sup> due to the potential risk of vascular disruption or heart perforation with tamponade that has been demonstrated in case reports.<sup>9,10</sup> Moreover, the high position of the catheter tip in the superior vena cava increases the risk of thrombosis.

The overall rate of complications is given by multiple factors, especially the experience of the medical staff, secondaries of percutaneous insertion, the catheter characteristics and type, the technique used, its indication and management while inserted.

Knowing at what distance the catheter tip will be inserted is necessary, since it can differ according to age, gender, or height. A series of formulas for positioning the CVC tip in adult patients according to height have been described.<sup>6</sup> In a 1995 study some formulas that are still used today were validated (Table 1):

A chest X-ray is considered the most commonly used method for verifying the CVC placement. The catheter tip should be above the carina, thus ensuring placement above the pericardial sac. It stands out for its simplicity, economy, and speed of use. A 95% general efficacy is reported independent of the puncture site, efficacy being understood as the ability to position the CVC tip in the superior vena cava (SVC) and not in the right atrium<sup>11,12</sup> (Fig. 1).

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