



## ORIGINAL ARTICLE

## Accuracy of chest radiography for positioning of the umbilical venous catheter ☆,☆☆,☆☆☆

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### KEYWORDS

Newborn;  
Umbilical veins;  
Central venous catheter;  
Chest radiography;  
Echocardiography

### Abstract

**Objectives:** To evaluate the accuracy of the simultaneous analysis of three radiographic anatomical landmarks – diaphragm, cardiac silhouette, and vertebral bodies – in determining the position of the umbilical venous catheter distal end using echocardiography as a reference standard.

**Method:** This was a cross-sectional, observational study, with the prospective inclusion of data from all neonates born in a public reference hospital, between April 2012 and September 2013, submitted to umbilical venous catheter insertion as part of their medical care. The position of the catheter distal end, determined by the simultaneous analysis of three radiographic anatomical landmarks, was compared with the anatomical position obtained by echocardiography; sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were calculated.

**Results:** Of the 162 newborns assessed by echocardiography, only 44 (27.16%) had the catheter in optimal position, in the thoracic portion of the inferior vena cava or at the junction of the inferior vena cava with the right atrium. The catheters were located in the left atrium and interatrial septum in 54 (33.33%) newborns, in the right atrium in 26 (16.05%), intra-hepatic in 37 (22.84%), and intra-aortic in one newborn (0.62%). The sensitivity, specificity and accuracy of the radiography to detect the catheter in the target area were 56%, 71%, and 67.28%, respectively.

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☆☆ Study conducted at the Postgraduate Program in Health Sciences, Child and Adolescent Health Area, Faculdade de Medicina, Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, MG, Brazil.

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**PALAVRAS-CHAVE**

Recém-nascido;  
Veias umbilicais;  
Cateterismo venoso  
central;  
Radiografia torácica;  
Ecocardiografia

**Conclusion:** Anteroposterior radiography of the chest alone is not able to safely define the umbilical venous catheter position. Echocardiography allows direct visualization of the catheter tip in relation to vascular structures and, whenever possible, should be considered to identify the location of the umbilical venous catheter.

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**Acurácia da radiografia de tórax para o posicionamento do cateter venoso umbilical****Resumo**

**Objetivos:** Avaliar a acurácia da análise simultânea dos três marcos anatômicos radiográficos – diafragma, silhueta cardíaca e corpos vertebrais, na determinação da posição da extremidade distal do cateter venoso umbilical, utilizando ecocardiografia como padrão de referência.

**Método:** Estudo transversal, observacional, com inclusão prospectiva de dados de todos os neonatos nascidos em uma maternidade pública de referência, entre abril de 2012 e setembro de 2013, submetidos à inserção de cateter venoso umbilical como parte do atendimento clínico. A posição da extremidade distal do cateter, determinada pela análise simultânea dos três marcos anatômicos radiográficos, foi comparada com a posição anatômica obtida pela ecocardiografia e sensibilidade, especificidade, valor preditivo positivo, valor preditivo negativo e acurácia foram calculados.

**Resultados:** Dos 162 recém-nascidos avaliados por ecocardiografia, somente 44 (27,16%) estavam com o cateter em posição ótima, na porção torácica da veia cava inferior ou na junção da veia cava inferior com o átrio direito. Os cateteres foram localizados no átrio esquerdo e septo interatrial em 54 (33,33%), no átrio direito em 26 (16,05%), intra-hepático em 37 (22,84%) e na aorta em um recém-nascido (0,62%). A sensibilidade, especificidade e acurácia da radiografia para detectar cateter na zona alvo foi de 56%, 71% e 67,28%, respectivamente.

**Conclusão:** A radiografia anteroposterior de tórax isolada não é capaz de definir com segurança a posição do cateter venoso umbilical. A ecocardiografia permite a visualização direta da ponta do cateter em relação às estruturas vasculares e, sempre que possível, deve ser considerada para localização do cateter venoso umbilical.

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**Introduction**

The care of increasingly younger premature infants is a constant challenge for the clinical team. An effective vascular access that is as safe as possible is of utmost importance when caring for these children. The use of the umbilical vein, first reported in 1947 by Diamond,<sup>1</sup> constitutes a fast and easy option to obtain access to the systemic circulation.<sup>2-6</sup>

There are several complications resulting from the use of the umbilical venous catheter (UVC), including cardiac arrhythmia, infection, intracardiac and portal venous system thrombosis, embolism, myocardial perforation, pericardial and pleural effusion, pulmonary infarction and hemorrhage, hepatic erosion and necrosis, and portal hypertension.<sup>2,5,7-10</sup> The incidence of reported complications ranges from 20% to 35%, especially if the catheter is poorly positioned,<sup>9</sup> as it is essential to ensure the correct positioning of the catheter in the thoracic portion of the inferior vena cava (IVC) or at the junction of the IVC with the right atrium (RA).<sup>2,5,7,11-13</sup>

The catheter position is routinely assessed by anteroposterior chest radiograph, using the cardiac silhouette,

the diaphragm, and the vertebral bodies as anatomical landmarks.<sup>2,4,7,9,11-14</sup> The catheter should be at the diaphragm level or slightly above,<sup>4</sup> or between the vertebral bodies T8 and T9,<sup>12</sup> or at the cavoatrial junction obtained by extrapolating the curve of the RA medial border up to its intersection with the IVC or with the right border of the vertebral bodies.<sup>9</sup> However, various studies using imaging methods such as ultrasound and echocardiography to evaluate the UVC position have demonstrated the low accuracy of radiographic anatomical landmarks.<sup>2,4,7,9,12,14</sup>

It has been observed, when performing echocardiograms and especially in premature infants a significant number of catheters placed in the left atrium (LA), even though they were considered to be in the ideal position at the radiographic analysis. Catheters poorly positioned in the LA, is associated with thrombus formation.<sup>7</sup>

The aim of this study was to evaluate the accuracy of the anteroposterior chest radiography in determining the UVC position, performing a simultaneous analysis of the catheter projection in relation to the cardiac silhouette, the diaphragm, and the vertebral bodies. The authors also evaluated the performance of the vertebral level method in predicting the UVC position and the association of birth

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