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SCIENTIFIC ARTICLE

Bedside prediction of right subclavian venous catheter insertion length

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KEYWORDS
Central venous catheter;
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Subclavian vein

Abstract
Background and objective: The present study aimed to evaluate whether right subclavian vein (SCV) catheter insertion depth can be predicted reliably by the distances from the SCV insertion site to the ipsilateral clavicular notch directly (denoted as I-IC), via the top of the SCV arch, or via the clavicle (denoted as I-T-IC and I-C-IC, respectively).
Method: In total, 70 SCV catheterizations were studied. The I-IC, I-T-IC, and I-C-IC distances in each case were measured after ultrasound-guided SCV catheter insertion. The actual length of the catheter between the insertion site and the ipsilateral clavicular notch, denoted as L, was calculated by using chest X-ray.
Results: L differed from the I-T-IC, I-C-IC, and I-IC distances by 0.14 ± 0.53, 2.19 ± 1.17, and -0.45 ± 0.68 cm, respectively. The mean I-T-IC distance was the most similar to the mean L (intraclass correlation coefficient = 0.89). The mean I-IC was significantly shorter than L, while the mean I-C-IC was significantly longer. Linear regression analysis provided the following formula: Predicted SCV catheter insertion length (cm) = $-0.037 + 0.036 \times$ Height (cm) $+ 0.903 \times$ I-T-IC (cm) (adjusted $r^2 = 0.64$).
Conclusion: The I-T-IC distance may be a reliable bedside predictor of the optimal insertion length for a right SCV cannulation.

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PALAVRAS-CHAVE
Cateter venoso central;
Entalhe clavicular;
Veia subclávia

Previsão do comprimento de inserção de cateter em veia subclávia direita à beira do leito

Resumo
Justificativa e objetivo: O presente estudo teve como objetivo avaliar se a profundidade de inserção de cateter em veia subclávia (VSC) direita pode ser prevista de forma confiável pelas distâncias do local de inserção na VSC até a incisura clavicular ipsilateral (I-IC), passando diretamente pela parte superior do arco da VSC ou da clavícula (denominadas I-T-IC e I-C-IC, respectivamente).
Método: No total, 70 cateterismos de VSC foram estudados. As distâncias I-IC, I-T-IC e I-C-IC de cada caso foram mensuradas após a inserção do cateter guiada por ultrassom. O comprimento do cateter entre o local de inserção e a incisura clavicular ipsilateral (L) foi calculado por meio de radiografia.
Resultados: As diferenças em centímetros de L em relação às distâncias I-T-IC, I-C-IC e I-IC foram de $0,14 \pm 0,53$; $2,19 \pm 1,17$ e $0,45 \pm 0,68$ respectivamente. A média de I-IC foi significativamente menor que L, enquanto a média de I-C-IC foi significativamente maior. A análise de regressão linear forneceu a seguinte fórmula: Comprimento previsto da inserção de cateter em VSC (cm) = $-0,037 + 0,036$ x Altura (cm) $+ 0,903$ x I-T-IC (cm) (r^2 ajustado = 0,64).
Conclusão: A distância I-T-IC pode ser um preditivo confiável do comprimento de inserção ideal para canulação em VSC direita.

Introduction

Several landmarks,[1,2] simple formulas,[3] and electrocardiography[4] have been used for the optimal insertion depth of the central venous catheter. However, for subclavian venous cannulations, such confirmatory techniques are of limited use.

A recent study[5] suggested that adding (i) the distance between the insertion point of needle and the ipsilateral clavicular notch to (ii) the vertical distance between the carina and the ipsilateral clavicular notch generates a reliable tip position near the carina level that guides suitable and safe positioning of the central venous catheter tip above the pericardial reflection.[1] However, this method has some limitations. This method requires a chest radiograph that is needed to evaluate the vertical distance between the carina and the ipsilateral clavicular notch. And, the subclavian vein follows a curved path.[6] Thus, this method may be shorter than the optimal insertion depth.

The aim of the present study was to evaluate whether several distances from the insertion point of needle to the ipsilateral clavicular notch, running directly (denoted as I-IC), via the subclavian vein top, or via the clavicle (denoted as I-T-IC and I-C-IC, respectively), are reliable bedside predictors of the optimal insertion length for ultrasound-guided right subclavian venous cannulation.

Method

Written informed consent was obtained from all patients after approval of the trial by the Institutional Review Board (2012−0104) and Clinical Research information Service (KCT0000612). All patients required subclavian venous cannulation over the course of a 6 month period. The patients who did not agree to participate in the study were excluded from this study, as were patients who had some spine or vessel deformities or in whom the positioning of the central venous catheter was inadequate.

Patient ages, gender, heights, and weights were recorded. On arrival in the operating room, the patients were monitored. After the induction of anesthesia, skin preparation and sterile draping were performed. Subclavian venous catheterization was performed by using a four-lumen central venous catheter (Arrow International Inc., Reading, PA, USA) and the infra-clavicular approach with a sonography-guided longitudinal view. The probe (SonoSite S-Series, Bothell, WA, USA) was placed parallel to the long axis of the subclavian vein and the needle was inserted adjacent to the short edge of the probe so that it remained visible as it traveled through the overlying tissues into the subclavian vein.[7,8] Subsequently, the catheter was inserted by using a guide-wire. To determine the correct depth of catheter insertion, the patient's head and neck were placed in the neutral position after insertion of the catheter and an intra-operative full-inspiration chest radiograph was taken to establish the fact that the central venous catheter tip was at the level of the carina.[2] To optimize the position of the catheter tip, the catheter was moved back and forth. Fig. 1 depicts the key landmarks and the each distance was measured. The needle insertion point is denoted as I in Fig. 1, while the ipsilateral clavicular notch is denoted as IC. The length of the catheter between the needle insertion point and the ipsilateral clavicular notch is denoted as L and was calculated by subtracting the measured length of the catheter between the ipsilateral clavicular notch and the catheter tip (this length is denoted as A), which was measured by using chest radiography, from the actual total length of catheter between the needle insertion point and the catheter tip. The I-IC, I-T-IC and I-C-IC distances were