

Optimal Insertion Depth of Central Venous Catheter Through the Right Internal Jugular Vein, Verified with Transesophageal Echocardiography

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Background: Previous studies have presented some guidelines for ideal depth for central venous catheterization through the right internal jugular vein. Some guidelines are formulas such as 'height(cm)/10' by Peres, 'height(cm)/10 – 1' by Czepizak et al., 'height(cm)/10 – 1.3' by Lum, or a fixed depth of 15 cm. Other guidelines recommended clinicians to check the depth of central catheter inserted with carina on X-ray as a landmark. However, there has been not consensus for the ideal depth yet. The purpose of this study was to measure ideal insertion depth of central venous catheter using transesophageal echocardiography and to find out an equation predicting the ideal depth on the basis of patient's height. The secondary aim was to compare a new simple formula from our data with guidelines introduced in previous studies.

Methods: Adult patients (> 18 years old) scheduled for elective open heart surgery requiring right internal jugular venous catheterization and intraoperative transesophageal echocardiography (TEE) at Dongsan Medical Center were screened for eligibility. Before the initiation of trial, we defined that the optimal point of the catheter tip should be 2 cm above upper margin of crista terminalis. Also, we defined the optimal zone for the catheter tip should be within 1 cm from the optimal point. After induction of anesthesia, a probe for TEE was inserted through esophagus for evaluating the heart during the surgery. Next, central venous catheterization through the right internal jugular vein was performed by an anesthesiologist with the modified Seldinger's maneuver. When the catheter was being inserted, an investigator observed the tip of catheter using TEE on bicaval view. At first, the investigator confirmed the tip of catheter was located at the upper margin of crista terminalis using sterile agitated saline. Next, the anesthesiologist withdrew the catheter 2 cm backward. And then, depth of inserted part of the catheter inserted was recorded. After surgery, the length between the catheter tip and carina on chest X-ray was measured in each patient. The optimal depth was calculated, and an equation was derived through regression analysis. Also, we made a new formula from our data. And, we compared this new formula and some formulas introduced in previous studies to find out which formula would be best fit for optimal zone.

Results: Eighty-nine patients were enrolled in this trial. The mean (SD) of patient height was 160.4 cm (9.3). The mean (SD) of inserted depth of catheter was 14.5 cm (1.6). The optimal length for each patient could be predicted using the equation: optimal depth (cm) = 0.117 × height (cm) – 4.3 ($r^2 = 0.494$, $P < 0.001$). Also, we made a new formula of 'height(cm)/10 –

1.5 cm', named 'J-J formula'. The accuracy rates of each formula or guideline for optimal zone in our study population was 34.8% (Peres), 67.4% (Lum), 58.4% (Czepizak), 50.6% (15 cm), 40.0% (to carina), and 71.9% (J-J formula).

Conclusion: When the tip of inserted catheter was evaluated with real-time transesophageal echocardiography, it seemed that it would be difficult to find out a perfect formula or guideline for optimal depth of central venous catheter through the right internal jugular vein. In our study population, we found a new formula of 'height(cm)/10 – 1.5' for the optimal depth was better than other guidelines.