Original research article

Evaluation of the Tip Position of Right-Sided Internal Jugular Venous Catheters Using Peres Height Formula

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Abstract:
Central venous catheters are inserted in patients undergoing major surgeries where hemodynamic disturbances are likely consequences and in many critically ill patients for parenteral nutrition and antibiotic therapy as well as patients who require haemodialysis, and patients with difficult peripheral venous access. There are several ways to calculate the depth at which a catheter should be inserted, but the Peres formula—height in centimetres divided by 10—is the most commonly used approach. This yields the depth at which the catheter should be fixed.
Aims and objectives: The purpose of this study was to ascertain how accurate Peres' height formula was at estimating the proper CVC insertion depth.

Materials and Methodology: This prospective observational study was conducted at our rural tertiary care hospital between 1st January 2023 till 30th October 2023 following approval from the ethical committee

Results: The study had 100 patients in all. Out of these 57 percent belong to the age group of 51-75 yrs,24 percent in 36-50 years, and 19 percent in 18-35 yrs. of age. In the Surgical ICU, 30 CVPs were installed. Of these, 22 had the proper tip location; in the Medicine ICU, 70 CVPs were placed, 53 of which had the proper tip placement. Nine individuals had a BMI of more than 35 kg/m 2. Four (44.4%) out of the 9 patients had their CVC tips positioned incorrectly.

Conclusion: Peres' formula can be easily used for the correct position of CVC tips with a success rate of 75% in the Indian population.

Keywords: Right internal jugular vein, central venous catheterization, chest x-ray, peres height formula, carina.

Introduction:

Central venous catheters (CVC) are inserted in patients undergoing major surgeries where hemodynamic disturbances are likely consequences, or for multiple infusion administration during surgery and in many critically ill patients for parenteral nutrition and antibiotic therapy as well as patients who require chemotherapy, haemodialysis, patients with difficult peripheral venous access.[1] To avoid potentially fatal consequences including arrhythmias and erosion of

the right atrium (RA) or right ventricle, which can result in haemothorax, hydrothorax, or cardiac tamponade, it is crucial to position the catheter tip correctly.[2] The main drawback of this procedure is that it is an invasive procedure that till recently was done solely on palpation and landmark guidance. The Peres formula, which takes height in centimetres /10 and returns the depth at which the catheter should be secured, is the most commonly used method for measuring the depth of catheter insertion. Various landmarks simple formulae, and sophisticated techniques like right atrial ECG and transoesophageal echocardiography have been developed to ensure correct placement of the CVC tip. [3-7] Peres utilized the patient's height to predict the optimal length of the catheter to be inserted by different approaches and demonstrated that 24% terminated in the right atrium.

Patients within the height range of 140-160cm were chosen for the study as due to their height and the central line being an average of 15cm in length we could estimate the accuracy of the central line depth in this height range. The right internal jugular vein is the most used route for the insertion of central venous catheters in our hospital. The purpose of this study was to ascertain how accurate Peres' height formula was at estimating the proper CVC insertion depth.

Materials and Methods:

This prospective observational study was conducted at our rural tertiary care hospital between 1st January 2023 till 30th October 2023 following approval from the institutional ethical committee. Here in this study, we included patients of both genders, aged 18 years and above, height range of 140-160cm. The patients and their relatives provided written informed consent. Patients with a history of previous neck surgery, local infection of the neck, chest deformities (e.g., pectus carinatum, pectus excavatum), pacemakers, and coagulopathy were excluded. Age, gender, weight (kg), height (cm), and body mass index (BMI) (kg/m2) were recorded as demographic data. Patients were divided into four groups according to the BMI: BMI Group 1: 18.5- 24.9 kg/m2, BMI Group 2: 25- 29.9 kg/m2, BMI Group 3: 30.0- 34.9 kg/m2, and BMI Group 4: ≥35 kg/m2. All CVCs were placed with aseptic precautions, using the Seldinger method by an intensivist in the intensive care unit (ICU) or an anaesthesiologist in the operating room (OR). Peres' formula was used for the depth of insertion. According to this formula, the lengths for CVC insertion should be height/10 cm for the right internal jugular vein. The patient's head was turned to the opposite side from the site of insertion. The insertion point was at the level of the cricoid cartilage, and the level of the apex of the two heads of the sternocleidomastoid muscle when IJV catheterization was performed. This calculation states that the right internal jugular vein's length for a CVC insertion should be height/10 cm. The head of the patient was turned away from the insertion location. When IJV catheterization was done, the insertion point was at the level of the cricoid cartilage and the apex of the two heads of the sternocleidomastoid muscle aiming just lateral to the carotid artery pulse.

Postprocedural anteroposterior (AP) CXR was taken in a supine position with the patient's arms beside the chest to assess the CVC tip position and complications such as arrhythmia, sepsis, vessel perforations, cardiac tamponade, embolism, thrombosis, and pneumothorax have been reported due to incorrect placement of CVCs.[8,9] The vertical distance between the CVC tip and the carina was measured in order to evaluate the CXR pictures obtained from the Picture Archiving & Communication System (PACS).

The CVC tip was defined as being positioned one centimetre above and below the carina in order to represent the "correct" tip position. If necessary, the catheter was moved by pulling it back or inserting a new one through a guide wire to reach a new location.

Results:

The study had 100 patients in all. There were 38 female patients and 62 male patients (Fig1a). Out of these 57 percent belong to the age group of 51-75 years,24 percent in 36-50 years, and 19 percent in 18-35 years of age (Fig1b). Based on their BMI, the patients were categorized into four groups: BMI Group 1: 18.5–24.9 kg/m2, BMI Group 2: 25–29.9 kg/m2, BMI Group 3: 30.0- 34.9 kg/m2, and BMI Group 4: ≥35 kg/m2. Group 2 consisted of the majority, 25–29.9 (Fig1c). In female patients, the rate of incorrect CVC tip placement was 31.5% (n=12), whereas in male patients, it was 24.1% (n=15). The proper positioning of CVC differs significantly in male patients compared to female patients. In the Surgical ICU, 30 CVPs were installed. Of these, 22 had the proper tip location; in the Medicine ICU, 70 CVPs were placed, 53 of which had the proper tip placement. Nine individuals had a BMI of more than 35 kg/m 2. Four (44.4%) out of the 9 patients with a BMI of more than 35 kg/m 2 had their CVC tips positioned incorrectly. The proper positioning of CVCs does not significantly correlate with BMI. During insertion, 35 patients (10.5%) had arrhythmias. There was no evidence of hematoma, subcutaneous emphysema, or pneumothorax.

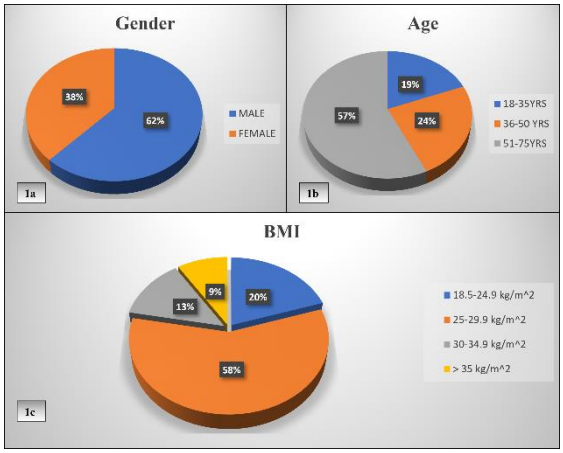

Fig 1: Patient Gender (1a), Age (1b) and BMI (1c).

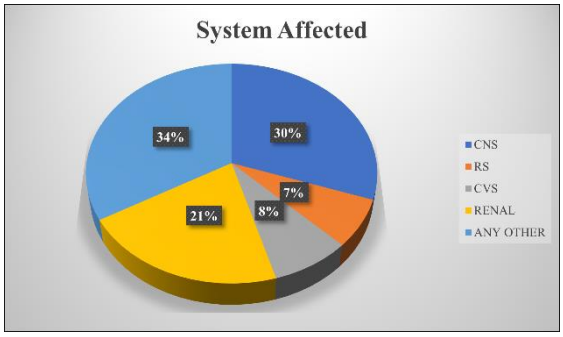

Fig 2: The patient distribution according to different systems affected in which CVPs were placed.

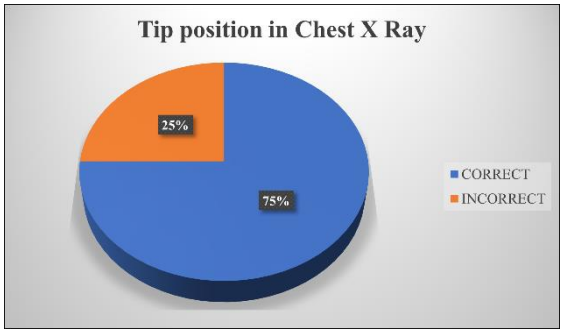

Fig 3: The patient distribution according to correct tip position in chest Xray.

Discussion:

The ideal location for the CVC tip varies depending on the point of entry. Nonetheless, recommendations for CVC placement state that the catheter tip should be positioned above the pericardial reflection to avoid major and potentially fatal consequences such as tricuspid valve damage, cardiac tamponade, malignant arrhythmias, etc. Although the upper limit of the pericardial reflection is widely believed to be below the carina, it is not visible on a conventional chest X-ray. Both fresh and preserved cadavers have been used to evaluate this.[10] In anesthetized children undergoing cardiac surgery, and in adults using computerized tomograms. Furthermore, because of its fixation with connective tissue, its localization is maintained even in pulmonary pathology; the parallax effect is restricted because of its central location and the short sagittal distance between it and SVC; and it is clearly visible even on a subpar portable anteroposterior chest X-ray. Therefore, we used the carina as a radiological landmark to determine the position of the CVC tip.

To determine the anticipated length of the CVC at the moment of insertion, several techniques have been proposed. Pere P.W. studied the correlation between the length of a catheter inserted and the patient's height and observed that catheters inserted through right IJV from mid cervical point or lower puncture to Height/10cm ended in SVC, while those inserted more than Height/10 + 1cm, 47% ended in the right atrium. In our investigation, we found that 25% of cases of incorrect tip position using the Height/10cm formula with cricoid level insertion occurred. This might be the case because, in contrast to Pere PW., who thought that the SVC/RA intersection was the ideal tip placing, we used the carina as a reference point for accurate positioning.

Czepizak verified the CVC tip location on CXR using Peres' formula in his study on the Caucasian race. It was claimed that accuracy may be increased even further by changing the formula to (height/10)-1 cm, even though RIJV catheters had 90% accuracy. On the other hand, Joshi et al.'s investigation of Indian participants revealed a 28% accuracy rate when comparing Peres' formula to intra-atrial ECG-guided implantation. They suggested changing Peres' formula to height/10-2 cm to achieve the ideal CVC tip placement. The disparities in anthropometry (particularly height) amongst each race and population may be the cause of the inconsistent findings from various investigations.

75% of all CVC tips in the Indian population were positioned correctly, according to the results of our study, which employed Peres' formula to determine the insertion depth. These findings

are consistent with those of a previous study conducted by Halide et al, which reported success rates are 84.7% for the right IJV CVP insertion using Peres' formula.
The strength of our study lies in the fact that our suggested modified formula can be used in emergencies or when equipment like ECG adaptors, preoperative and CXR transoesophageal echocardiography, and so on, are unavailable.

Limitation of the study:
In the first place, various specialists installed CVCs. Though the surface features served as a guide, the insertion positions might have changed depending on the patient's and the practitioner's head position. The Joshi et al. study's height-based formula did not undergo appropriate standardization for the insertion point. Secondly, Variations in technique, exposure, and clarity can also alter the accuracy of measurements on portable chest radiographs. The fact that all CVCs were inserted via the RIJV, which is a more popular access artery for CVC insertion than the left internal jugular vein (LIJV), is one of the study's drawbacks.

Conclusion:
Peres' formula can be easily used for the correct position of CVC tips with a success rate of 75% in the Indian population. Practitioners should be aware of the low accuracy rate of Peres' formula in female patients (31.5%) and patients with BMI over 35 kg/m 2 (44.4%).

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