



Should We Expand the Use of Intracavitary ECG Guidance for Insertion of Peripherally Inserted Central Catheters?

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Editorial

The incidence of cancer is increasing every year and the treatment of tumors is currently the focus of considerable medical research. Peripherally Inserted Central Catheters (PICCs) have been widely used for a variety of indications in oncology patients, including medium- or long-term chemotherapy, parenteral nutrition and home IV medications [1-3]. Compared with other central venous access devices, PICCs demonstrate reduced central line associate-complication rates, increased safety and efficiency for long-term use. Therefore, PICCs have been recognized as an alternative to large-bore central venous catheters such as subclavian or internal jugular central venous catheters [4]. The estimate use of PICC has been reached to 5000,000 in 2017 all over the world. Despite the numerous benefits, PICCs also could develop central line associate-complication such as exit site infection, Deep Venous Thrombosis (DVT), Central Line Associate Blood Stream Infection (CLABSI), phlebitis, occlusion and mechanical complications such as catheter malposition and breakage [5-6]. These complications may lead to the removal for the current PICC line and reinsertion of other central venous access devices exposing the patients to further risks of complications, increasing the economic burden, clinical resources and suffering. Recent studies estimated many potential risk factors influencing the development of complications, namely, the procedure of PICC placement, the sterile barrier, catheter size, and choice of vein, malignancy, Body Mass Index (BMI), and prior DVT et al. [7-13]. Inaccurate PICC tip positioning is no doubt a common risk factor for catheter-related complications [14]. In the USA, the Intravenous Nurse Society (INS) recommends that the tip of a central venous access device should be preferably placed either in the lower third of the Superior Vena Cava (SVC) or at the transition between the SVC and right atrium [i.e., the Cavo-atrial Junction (CAJ)] [15]. If the tip of the catheter is placed too high (in the middle or upper third of the SVC, or in the brachiocephalic, the internal jugular or the subclavian vein), there is an increased risk of malfunction and/or venous thrombosis. If the tip is positioned too low (RA, right ventricle or inferior vena cava), there is a risk of arrhythmia, heart cavity lesions, tricuspid valve dysfunction or lesions, or atrial thrombosis [14]. Researchers are looking for the more accurate method for PICC placement for years. Recent findings have indicated that the first-attempt success rate of tip location estimated by chest X-ray was approximately 80% when only relying on the conventional anatomical landmark method, which may not be regarded as a satisfactory outcome [16-18]. The Intracavitary Electrocardiogram (IC-ECG) method has been used for the tip location of central venous access devices since the 1960s in European countries [19]. The IC-ECG was performed to guide the positioning of the PICC tip while using a column of saline contained in the catheter as an intracavitary (endovascular) electrode. A meta-analysis of ECG applied to PICC catheter tip positioning included 16 random tests [20]. The results show that compared with the traditional X-ray chest radiograph location method, the ECG method can increase the accuracy rate of the location of the catheter tip [RR=1.13, 95% CI (1.07, 1.19), P<0.00001]; it can decrease the incidence rate of related complications [RR=0.37, 95% CI (0.21, 0.66), P<0.0008]; and it can save the catheter placing time [RR= -12.56, 95% CI (-18.56, -6.57), P<0.0001]. The IC-ECG method is proved to be safe, accurate and highly cost effective, because it saves the expenses related to post-procedural X-ray confirmation and possible repositioning of malpositioned catheters. In our recent randomized multicenter study, significant benefits of IC-ECG guidance versus anatomical landmark guidance were reported [21]. Our study enrolled a total of 2,250 adult patients in ten different hospitals. The patients were randomly assigned to either the

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study group (IC-ECG) or the control group (anatomical landmark guidance) in a 2:1 allocation. Ultrasound was used in both groups for venipuncture and tip navigation. All patients underwent chest X-ray after the procedure to verify the position of the catheter tip. In the IC-ECG-guided group, the first-attempt successful tip location was 91.7% (95% CI: 90.3% to 93.1%), significantly higher than 78.9% (95% CI: 76.0% to 81.9%) observed in the landmark group ($P<0.001$). As evaluated by post-procedural chest X-ray, tip location in the study group had a sensitivity of 99.3% (95% CI: 98.8% to 99.7%), significantly higher than 86.8% (95% CI: 84.4% to 89.2%) observed in the anatomical landmark group ($P<0.001$). Besides, the tip-conductive PICC acting in concert with EDUG, a new device including both ultrasound and IC-ECG technologies, can greatly promote the convenience of IC-ECG imaging, without the need for saline infusion. No insertion-related complications were reported in either group. Long-term clinical follow-up to 6 months showed the rate of complications inserted by IC-ECG was significantly lower than that of the traditional anatomical landmarks method, but the specific results haven't been reported.

But the IC-ECG method has some limits. The patients must have normal P-wave appearance on the surface ECG recordings. The patients who have the following cardiovascular conditions such as valve heart disease, atrial fibrillation, supraventricular tachycardia, pulmonary heart disease, pacemaker implantation, history of cardiac surgery, etc., which may affect P-waves must be excluded. Despite these, approximately 7% of patients whose P-wave was apparently normal at baseline ECG [14,21], the intracavitary ECG did not show any significant P-wave, while the chest X-ray showed no evidence of malposition. The reasons for such false negative results are not clear so far; inappropriate placement of the electrodes may be a possible explanation. But the overall rate of false negative in the ECG group was nonetheless extremely low (0.7%), and no false positive results [21]. As so far, chest X-ray is still regarded as the gold standard for confirming the tip position in China. However, the position method of chest X-ray is not completely accurate, as many factors such as artifacts, errors of perspective, and technical difficulties may alter interpretation of the radiologic image, leading to a significant incidence of false positives and false negatives [14]. Besides, the chest X-ray brings too much radiologic pollution, especially to the pregnant and children.

In conclusion, the IC-ECG method is more safe and accurate than the traditional landmark methods for achieving a rapid and satisfactory tip location during PICC placement in adult patients. It may replace the chest X-ray gradually followed by intensive training. The adoption of an integrated device which combine the ultrasound technology and IC-ECG may yield several clinical benefits because it allows the simultaneous use of ultrasound technology (for vein assessment, venipuncture and to rule-out gross malpositions) and the IC-ECG method (for a rapid, safe, and accurate tip location, while reducing the costs, time and X-ray exposures required for radiology-based tip location).

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