



Accuracy of Electrocardiography-guided PICC in Atrial Fibrillation Patients

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Arab J Intervent Radiol 2023;7:35–38.

Abstract

Objectives We conducted this study to review our experience performing electrocardiography-guided peripherally inserted central catheter insertion in patients with atrial fibrillation.

Materials and Methods This is a retrospective study of PICC insertions performed by interventional radiology technologists using electrocardiogram guidance in patients with atrial fibrillation. The study included 99 PICCs inserted using electrocardiography guidance in 79 patients diagnosed with atrial fibrillation. Chest X-ray is used to confirm tip position.

Results We reviewed all PICCs inserted in patients with atrial fibrillation using electrocardiography guidance between September 2017 and June 2022. The review process included success and malposition rates using X-ray correlation. Ninety-four out of 99 PICCs were successfully inserted, and 5 cases required repositioning.

Conclusion Our study suggests that electrocardiography navigation can be safely used for PICC insertion in patients with atrial fibrillation with high success rate.

Keywords

- ▶ atrial fibrillation
- ▶ echocardiography guided PICC
- ▶ interventional radiology technologist
- ▶ PICC

Introduction

Identifying the P-wave is essential for successful electrocardiography (ECG)-guided peripherally inserted central catheter (PICC). Performing ECG-guided PICC insertion in patients with arrhythmias such as atrial fibrillation requires utilizing both ECG navigation and external measurement to overcome the technology limitation. Chest X-ray is usually required to confirm tip location of the PICC in atrial fibrillation patients.^{1,2} Malposition of the tip of the PICC is lower with increasing operator experience in ECG-guided PICC insertions.³ Several studies excluded atrial fibrillation cases from ECG-guided because of the inability to detect the P-wave.^{4–8} The intracavitary and modified electrocardiogram can be used to increase the accuracy of PICC in atrial fibrillation patients.^{9–13}

Our study aims to provide easily adaptable method of ECG-guided PICC insertion in atrial fibrillation patients using electromagnetic navigation without relying on the ECG signal.

Materials and Methods

ECG-guided PICC is the primary method in our institution unless there is suspicion of venous stenosis or occlusion. The study was conducted following hospital ethics committee approval. All ECG-guided PICCs were performed in the interventional radiology ultrasound room. The electrocardiography guidance system is the Sherlock 3CG (Bard Access Systems, Salt Lake City, UT, USA) which consists of ultrasound integrated with an ECG monitor and Y-shaped tip tracking navigation system (▶ **Fig. 1**).

article published online
April 11, 2023

DOI <https://doi.org/10.1055/s-0043-1764199>.
ISSN 2542-7075.

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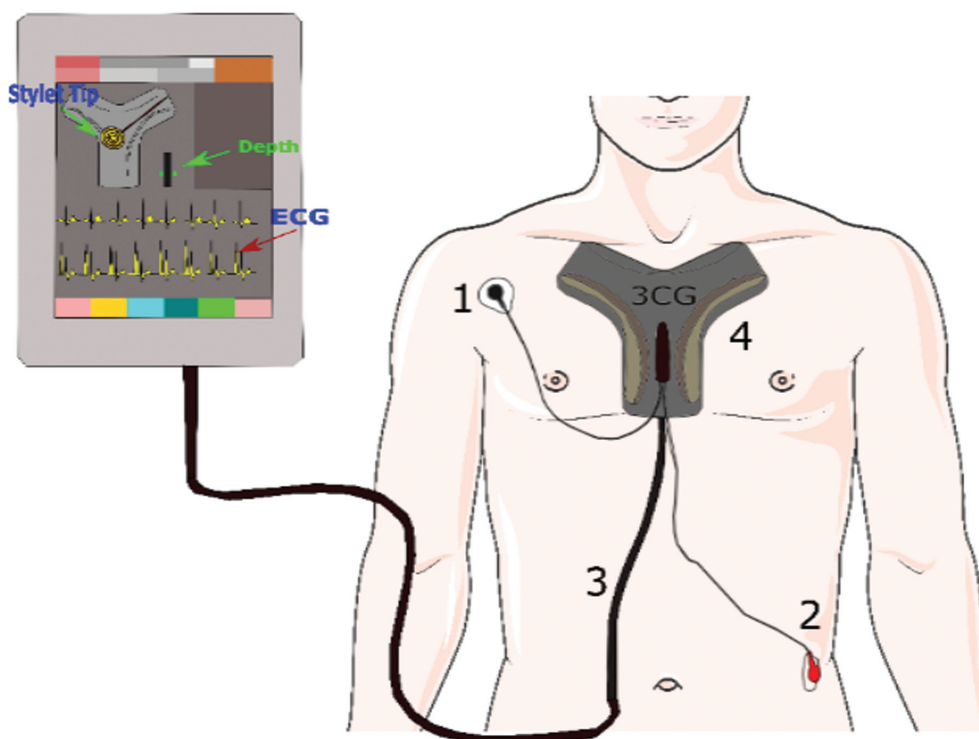


Fig. 1 The Y-shaped “tip tracking navigation system” setup. (1) Black electrode on the right shoulder. (2) Red electrode on the left anterior axillary line around the umbilical level. (3) Wire connection to the electrocardiography monitor. (4) Electromagnetic detector.

All PICCs inserted were 5 Fr. valved double-lumen (Bard Access Systems). Venous punctures were done with real-time freehand ultrasound-guided technique using General Electric LOGIQ E9 (Diagnostx; Benjamin Center, FL, United States). Post-insertion, chest X-rays were performed using Siemens Ysio Max (Siemens Healthcare GmbH Henkestr.127, 91052, Erlangen, Germany). Any malpositioned catheter that required manipulation was corrected under fluoroscopy using the Philips Allura FD20/20 C-Arm (Philips, Andover, MA, United States).

The measurement of the catheter length was performed on the patient in the supine position before the procedure, using anatomical landmarks, measuring the distance between the intended insertion site to the right sternoclavicular joint and from the right sternoclavicular joint to the third intercostal space. The tip-tracking navigation system was positioned on the patient’s chest, and a tourniquet was placed in the upper arm. The arm is prepared and draped in sterile fashion. The PICC is flushed and trimmed according to the measurement performed earlier. After applying the tourniquet, local anesthetic (xylocaine 1%) was injected into the skin and subcutaneous tissues. The venous puncture was performed using 22 g micropuncture needle under ultrasound guidance. The tourniquet was released after venous puncture and free backflow of the blood through the needle. Also, 0.018 inches guidewire is inserted into the needle, a skin incision is performed, and the peel-away sheath is introduced over the guidewire. The stylet inside the catheter is connected to the electromagnetic sensor; then the PICC is inserted through the peel-away sheath after removing the dilator and guidewire.

Results

All patients who went for PICC line insertion and were diagnosed with atrial fibrillation were included in the study. Patients with normal heart rhythm or no ECG record in the chart were excluded.

Between September 2017 and June 2022, 99 PICCs were inserted in 79 patients with atrial fibrillation using ECG guidance. There were 37 males (47%) and 42 females (53%). The age distribution was between 41 and 93 years. The vein selection was basilic in 70 cases (70.7%), brachial in 24 cases (24.2%), and cephalic in 5 cases (5.1%). The PICCs were inserted in the left arm in 93 cases (93.9%) with catheter lengths between 41 and 56 cm. In six cases (6.1%), the PICCs were inserted in the right arm with catheter lengths between 35 and 40 cm. Ninety-four PICCs (94.9%) were successfully inserted with optimum tip location in the lower SVC. Five cases (5.1%) had malposition of the catheter tip. These were repositioned under fluoroscopy.

Discussion

It is imperative to have a technique of PICC insertion that can be used in all patients, including those with arrhythmia such as atrial fibrillation, as this is a relatively common condition. Recent studies estimated the prevalence of atrial fibrillation in Saudi Arabia is 13.45% and 14.9%.^{14,15}

Hecht, in 1946, described one of the early use of ECG in antecubital catheter insertion on five subjects.¹⁶ Hellerstein et al in 1949 looked into the reliability of P and QRS complex in catheter tip location compared to fluoroscopy.¹⁷ Moureau et al in 2010 found that atrial fibrillation was one of the reasons for

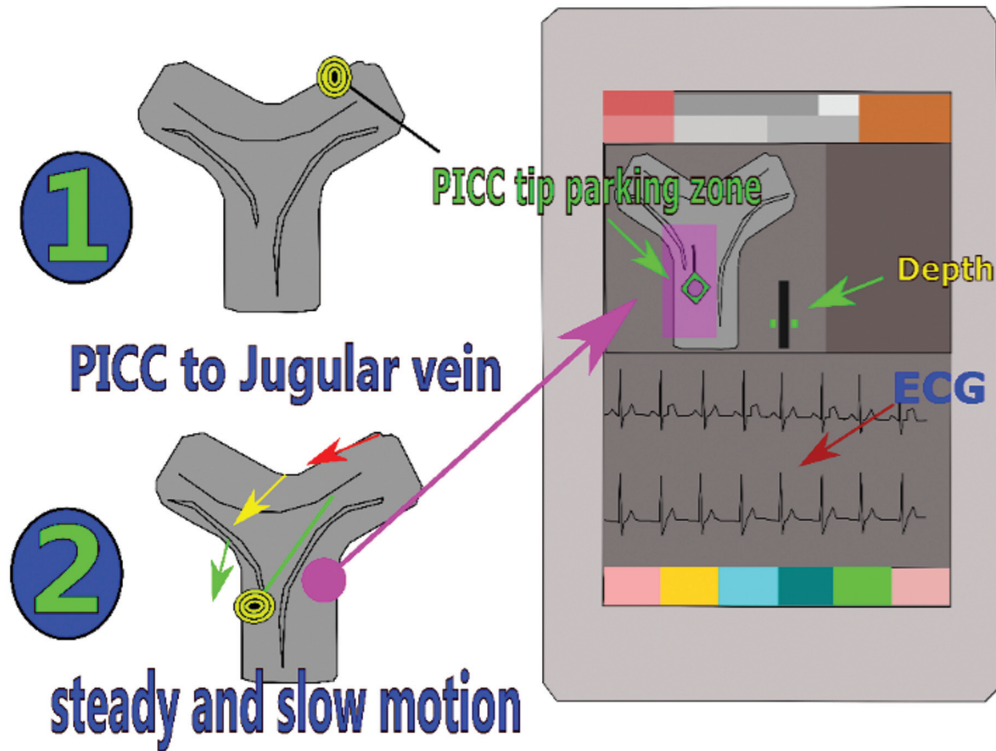


Fig. 2 Electrocardiography machine monitor. The stylet tip generates a magnetic field detected by the electromagnetic detector as a lollipop. (1) The lollipop indicates that the stylet tip inside the catheter is going to the jugular vein (2). The lollipop indicates the correct tip position in the lower SVC.

the inability to use electrocardiography in PICC placement.⁹ The principle of intracavity ECG in atrial fibrillation patients uses the F wave amplitude change to determine the tip location. Gao et al in 2018 used the change in the F wave of intracavity ECG to park the tip of PICC in 188 patients with atrial fibrillation. They concluded that it is safe to use ECG guidance for tip confirmation in atrial fibrillation patients.¹⁰ Liu et al in a meta-analysis of five studies in 2019 concluded that intracavity ECG guidance had more favorable positioning accuracy than the traditional X-ray method.¹⁸

The electromagnetic device (the Y-shaped “tip tracking navigation system”) is designed to detect the tip of the stylet as a third ECG lead. This allows real-time navigation showing the sensor in the stylet tip as lollipop. The tip of the catheter should be in the SVC when the lollipop points and moves in inferior direction while advancing the catheter (►Fig. 2).

Our study suggests that ECG-guided navigation technique can be used safely in atrial fibrillation patients with 95.9% accurate positioning of the PICC tip in the SVC. Malposition in the jugular vein can be diagnosed and corrected during insertion. The ultrasound transducer can compress the jugular vein while advancing the catheter to the SVC.

Conclusion

Our study suggests that PICC insertions can be performed successfully and safely in patients with atrial fibrillation using ECG-guided navigation.

Conflict of Interest

None declared.

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