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Case Report

Assessing pripherally inserted central catheter tip location in multiple postures: A case report

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ABSTRACT

This report presents a case involving a 21-year-old male patient with acute promyelocytic leukemia, where the peripherally inserted central catheter (PICC) tip location was diagnosed differently using ultrasound and computed tomography. The PICC was inserted into the left upper arm via the basilic vein. Echocardiography performed in the left lateral recumbent position suggested the PICC tip to be in the right atrium, deepest at the level of the tricuspid annulus. However, trans-catheter contrast-enhanced echocardiography, performed with a different posture involving left shoulder abduction and slight external rotation, revealed the tip to be at the cavo-atrial junction. Additionally, chest computed tomography, conducted in the supine position with raised arms, indicated the tip to be located at the upper one-third of the superior vena cava. These contradictory diagnoses can be attributed to the use of different body postures during the assessments. Considering the clinical efficacy and safety, it is crucial to fully consider the influence of multiple postures on PICC tip location during placement and determination. We recommend incorporating at least two opposite extreme daily postures to assess the nearest and farthest positions of the tip, ensuring effective and safe PICC placement and reducing the risk of complications.

Introduction

The management of oncology patients usually requires a stable, secure, and long-term venous access for the direct transportation of medication into the cardiovascular system, mostly using a peripherally inserted central catheter (PICC). The correct PICC tip location is critical during insertion and subsequent nursing care, especially for outpatients receiving intravenous injection treatment. Malpositioning of the tip can fail to meet clinical demands or cause complications such as arrhythmia, bleeding, pneumothorax, and infection.[1] It is essential to ensure that the PICC tip is at the optimal location during nursing and care procedures for efficacy and safety. The ideal tip location has been reported to be at the cavo-atrial junction or in the lower one-third of the superior vena cava.[2] Most studies have focused on verifying the tip location by comparing several technologies, such as intracavitary electrocardiography, echocardiographic techniques, and chest radiography.[3–5] The former two methods are proposed in recent guidelines and widely used in clinical practice because of the fact that they are an intraprocedural method and are characterized by being safe, easy to use, feasible, and accurate.[6,7] However, few studies have focused on the role of posture during PICC placement or tip positioning.[8–10] We report a case of a conflicting diagnosis of PICC tip location by ultrasound and computed tomography (CT), which was probably due to differences in shoulder and arm postures, in an effort to draw the attention of clinicians and researchers.

Case presentation

A 21-year-old male patient with acute promyelocytic leukemia was admitted to our hospital for scheduled treatment. A PICC line (Groshong® NXT ClearVue™ Catheter, Bard Access Systems, Inc.) was placed in his left upper arm via the basilic vein for 2 months. The tip of the catheter was radiopaque and closed, with a Groshong valve opened at the side near the end that served as a channel for medication infusion. The PICC line was firmly attached to the arm using a film. The patient had no complaints related to the PICC line and no history of chest tightness, chest pain, or intracardiac intervention. The catheter had been used

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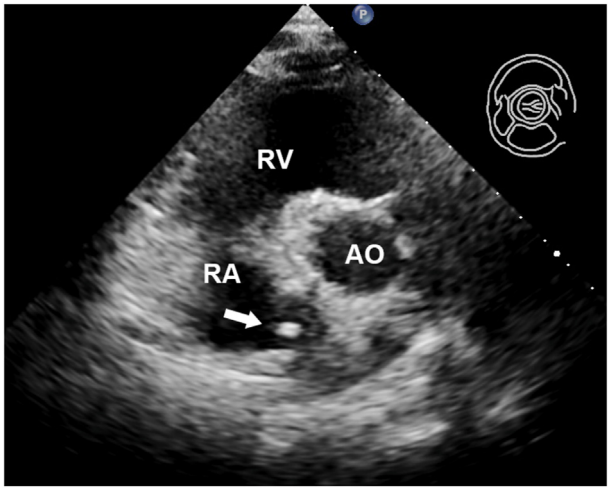

Fig. 1. Ultrasound manifestation of a suspicious peripherally inserted central catheter (PICC) tip in the aortic level of the parasternal long axis view. The patient adopts the left lateral recumbent position for echocardiography, with the left upper extremity close to the body and in internal rotation. A hyperechoic duct-like structure (white arrow) is floating in the right atrium. It is suspected to be the PICC tip that is inserted too deeply.

normally in the past without any abnormalities.

After hospitalization, the patient underwent echocardiography in the left lateral recumbent position, with the left upper extremity close to the body and internally rotated. A hyperechoic duct-like structure was observed floating in sync with the systolic and diastolic movements of the right atrium (Fig. 1), reaching the tricuspid annulus level at its farthest point. It was suspected that this was a part of the catheter that may have been inserted too deeply. However, a chest CT examination performed earlier on the same day indicated that the tip of the PICC was located in the upper one-third of the superior vena cava (Fig. 2), which contradicted the echocardiography results.

Trans-catheter contrast-enhanced echocardiography was performed to verify the tip location of the catheter and differentiate it from a possible thrombus and Chiari's network. The patient was maintained in the left lateral recumbent position. To facilitate injection of the contrast agent, the left shoulder was abducted at an angle of approximately 45°, and the upper arm was slightly externally rotated. Echocardiography revealed that the suspected tip had shifted around the cavo-atrial junction. The contrast agent was prepared by agitating 4.5 mL of saline with 0.5 mL of air, and a bolus was injected into the catheter 1.0 mL each time. Immediately after the injection, echocardiography showed a hyperechoic bubble jet (Fig. 3) originating from the side of the suspicious tip, which was irregularly swinging in the right atrium. The origin of the jet provided convincing evidence of the presence of the PICC tip. Furthermore, coincidentally, while the patient slightly adjusted his posture during repeated examinations, the tip shifted between the middle level of the atrium and the cavo-atrial junction. Based on the aforementioned ultrasound findings, the PICC was deemed to have been placed too deeply into the right atrium.

Fig. 2. Coronal plane of chest CT. The patient adopts the supine position with the arms raised above the head for chest CT earlier on the same day. The radiopaque tip (white arrow) is located at the upper one-third of the superior vena cava, indicating the peripherally inserted central catheter tip does not reach an ideal position. CT, computed tomography.

Discussion

In this case, both echocardiography and chest CT provided a definite diagnosis of the PICC tip location. However, the results were contradictory despite the exposed part of the catheter being firmly fixed according to the patient's complaint. The main potential causes of this discrepancy could be attributed to the different body postures used and the different imaging properties of ultrasound and CT.

Ultrasound is capable of obtaining dynamic images, whereas radiography or CT usually generates static images. Therefore, it is possible to observe the shifting of the PICC tip using ultrasound, rather than radiography or CT, when the body posture changes. It is worth noting that CT is not recommended for indicating the tip location because it risks being misleading, although it was one of the verification methods in this case. In terms of the examination posture, the supine position with arms raised above the head during chest CT scanning makes the basilic vein, axillary vein, subclavian vein, and superior vena cava appear S-shaped. In this case, the CT reconstruction clearly showed an S-shaped PICC line running inside the veins (Fig. 4). Because the catheter is not as flexible and malleable as blood vessels, it cannot always maintain a relatively parallel relationship with the vessel wall when running through a curved, relatively large lumen (Fig. 5A). Consequently, the PICC tip should travel a long distance and cannot reach as far away as possible. In contrast, echocardiography revealed that the left upper extremity was closer to the body, forming a U-shaped vein. This posture is commonly used in daily activities, and the catheter runs more physiologically and smoothly (Fig. 5B). Shoulder abduction and arm rotation can also cause slight shifts of the PICC tip. The

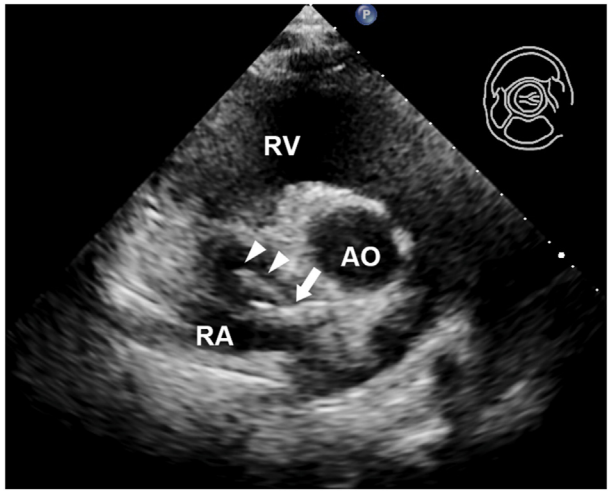

Fig. 3. Verification of the peripherally inserted central catheter (PICC) tip by trans-catheter contrast-enhanced echocardiography. The patient adopts the left lateral recumbent position, with the left shoulder abducted approximately 45° and the upper arm in slight external rotation. Contrast-enhanced echocardiography shows a hyperechoic bubble jet (white arrowheads) in the right atrium, originated from the side of the PICC tip (white arrow) that has shifted to around the cavo-atrial junction.

Fig. 4. CT reconstruction of the peripherally inserted central catheter (PICC) line. The PICC line runs in the basilic vein, axillary vein, subclavian vein, and superior vena cava with an S-shape during chest CT scanning. CT, computed tomography.

echocardiography and CT results indicated that the examination posture had a significant influence on the tip position. In addition, unintentional shifting inside or outside the basilic vein could have contributed to the conflicting diagnosis, although the patient did not complain.

To achieve better clinical efficacy and safety, the influence of multiple postures on tip location should be fully considered during PICC placement and determination of tip location. Inspired by this case, we recommend that at least two opposite extreme daily postures are considered when determining the tip location, as they can bring the tip to its nearest and farthest positions, respectively. In a study in which the tip positions of 200 PICCs were evaluated according to arm and body positions, 114 caudal dislocations were found when the positions were compared with the abducted and adducted arms in the supine position, and 176 cephalad dislocations were found when the supine abducted position was compared with the upright position.[11] Because the most common position in life outside the hospital is the upright position with the arm adducted and the application of venotoxic substances that need to enter the body in large-diameter vessels usually takes place in the upright and adducted positions, it is necessary to monitor the tip location in the upright-adducted position of the arm.

Combining electrocardiography, ultrasound, radiography, or other methods may provide a more thorough assessment of PICC tip location. This would help ensure that the tip is in an effective and safe range and

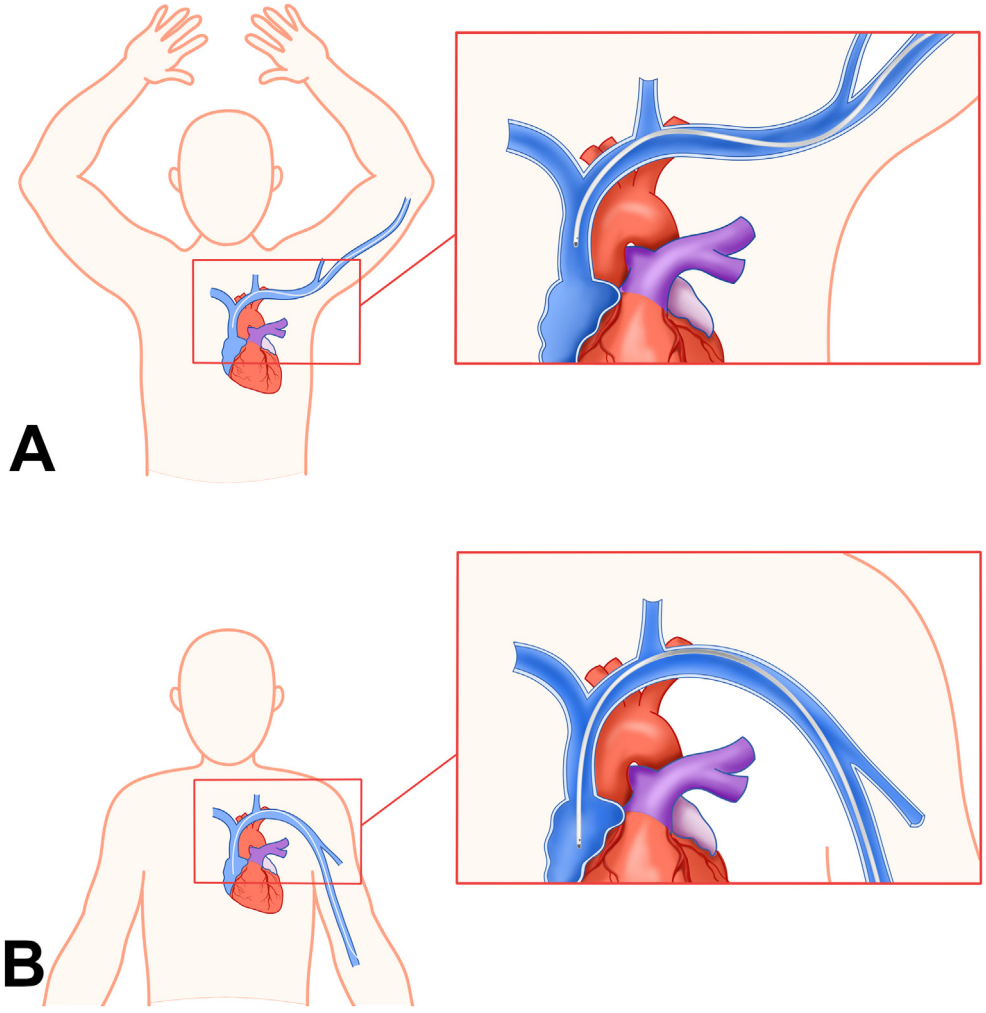

Fig. 5. Schematic diagram of a peripherally inserted central catheter (PICC) line running through the vascular lumen in different postures. (**A**) The PICC has to travel longer distances when it bends across the curved veins during chest CT scanning. (**B**) The PICC arrives at a farther site once it passes through the physiological veins. CT, computed tomography.

enable patients to continue with their daily activities while reducing the risk of complications.

Credit author statement

Xining He: Writing - Original draft preparation, Formal analysis. **Shengzheng Wu**: Conceptualization, Methodology, Writing - Review and editing. **Fan Zhang**: Conceptualization. **Wenhao Ge**: Software. **Dudu Wu**: Formal analysis. **Mei Chen**: Visualization. **Keyan Li**: Formal analysis. **Xiuyun Ren**: Methodology. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Declaration of competing interest

The authors declare no conflict of interest.

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Ethics statement

Patient consent for publication.

References

1. Duwadi S, Zhao Q, Budal BS. Peripherally inserted central catheters in critically ill patients - complications and its prevention: a review. *Int J Nurs Sci*. 2018;6(1):99–105. https://doi.org/10.1016/j.ijnss.2018.12.007.
2. Albrecht K, Nave H, Breitmeier D, et al. Applied anatomy of the superior vena cava—the carina as a landmark to guide central venous catheter placement. *Br J Anaesth*. 2004;92(1):75–77. https://doi.org/10.1093/bja/aeh013.
3. Yu C, Shulan L, Juan W, et al. The accuracy and safety of using the electrocardiogram positioning technique in localizing the peripherally inserted central catheter tip position: a systematic review and meta-analysis. *Nurs Open*. 2022;9(3):1556–1563. https://doi.org/10.1002/nop2.932.
4. Millington SJ, Hendin A, Shiloh AL, et al. Better with ultrasound: peripheral intravenous catheter insertion. *Chest*. 2020;157(2):369–375. https://doi.org/10.1016/j.chest.2019.04.139.
5. Dong H, Zhu Y, Zhang X, et al. Chest CT tomography vs. intracavitary electrocardiogram guidance in predicting the length of PICC placement. *BMC Surg*. 2022;22(1):197. https://doi.org/10.1186/s12893-022-01604-0.
6. Pittiruti M, Pelagatti F, Pinelli F. Intracavitary electrocardiography for tip location during central venous catheterization: a narrative review of 70 years of clinical studies. *J Vasc Access*. 2021;22(5):778–785. https://doi.org/10.1177/1129729820929835.
7. Stefano E, Dario D, Silvia C, et al. Impact of distance of the catheter tip from cavo-atrial junction on bubble test (delay) time: a prospective study. *J Vasc Access*. 2023 Feb 10, 11297298231153517. https://doi.org/10.1177/11297298231153517 [Epub ahead of print].
8. De Carvalho BR, Eagar GM. Immediate post-insertion tip migration of peripherally inserted central catheters dependent on arm position and depth of inspiration. *J Med Imaging Radiat Oncol*. 2018;62(3):324–329. https://doi.org/10.1111/1754-9485.12698.
9. Forauer AR, Alonzo M. Change in peripherally inserted central catheter tip position with abduction and adduction of the upper extremity. *J Vasc Intervent Radiol*. 2000;11(10):1315–1318. https://doi.org/10.1016/s1051-0443(07)61308-6.
10. Connolly B, Amaral J, Walsh S, et al. Influence of arm movement on central tip location of peripherally inserted central catheters (PICCs). *Pediatr Radiol*. 2006;36(8):845–850. https://doi.org/10.1007/s00247-006-0172-8.
11. Cho CH, Schlattmann P, Nagel S, et al. Cephalad dislocation of PICCs under different upper limb positions: influence of age, gender, BMI, number of lumens. *J Vasc Access*. 2018;19(2):141–145. https://doi.org/10.5301/jva.5000809.