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Persistent left superior vena cava and the correct interpretation of a peripherally inserted central catheter tip position

This article reports on a case of a preterm baby who, post-routine insertion of a peripherally inserted central catheter (PICC), showed an unusual catheter route and tip placement revealing an unsuspected cardiac variant of persistent left superior vena cava (PLSVC). We discuss the condition, our management and its effects on vascular access in this unusual case.

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Keywords

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Key points

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1. PLSVC is a rare cardiac venous anatomical variant that is usually encountered by chance.
2. Examination of PICC tip position and its vascular route confirms correct PICC placement. Practitioners should be aware that unusual anatomical variations in venous architecture can complicate PICC placement and tip position interpretation.

The case

A preterm male baby was born at 29 weeks and 5 days by emergency caesarean section to non-consanguineous parents for severe maternal pre-eclampsia. The mother was a 36-year-old woman of gravida 4, para 3 who presented with gestational diabetes and a history of placenta previa with her previous pregnancy. The infant was born in good condition and did not require resuscitation. At birth, his Apgar scores were 7 and 9 at one and five minutes, respectively. His birth weight was 1,170g and he had a head circumference of 25.5cm. Physical examination revealed bilateral congenital talipes equinovarus but nothing else of note.

On admission to the neonatal intensive care unit (NICU) all his vital signs were stable and within normal/expected ranges. He received short-term respiratory support (continuous positive airway pressure) and one dose of surfactant using the less invasive surfactant administration (LISA) technique for respiratory distress syndrome. Due to prematurity the need for long-term (>5 days) vascular access was indicated. As per local practice, an initial peripheral IV catheter was inserted, and the baby was scheduled for a PICC insertion on day two of life.

PICC insertion process

After obtaining informed consent from the parents, a dedicated PICC team trained for PICC insertion performed the actual insertion.[1] As planned, the insertion took place on day two of life using the modified Seldinger technique (MST) with a prepared Premistar (Vygon) 20cm PICC as per local evidence-based guideline.[2-4] After a standardised mandatory vascular assessment, the left cephalic vein was identified as the insertion vein of choice. A pre-measured length of 18cm was determined to enable the PICC tip to be as close as possible to the right atrium but remain outside the heart. The PICC insertion procedure itself was straightforward and seemingly successful, however, there was notably more bleeding at the site than was usual.

Anatomically the PICC should reside inside the superior vena cava and be seen on the right side of the vertebrae/spinal column. A review of the post-procedure X-ray (**FIGURE 1**) showed a descending

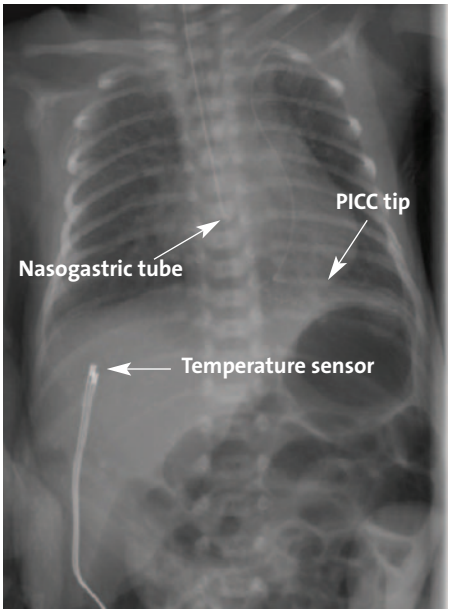


FIGURE 1 The misplaced PICC visualised by X-ray on the left side of the vertebrae. The nasogastric tube and PICC were repositioned after review of the X-ray.

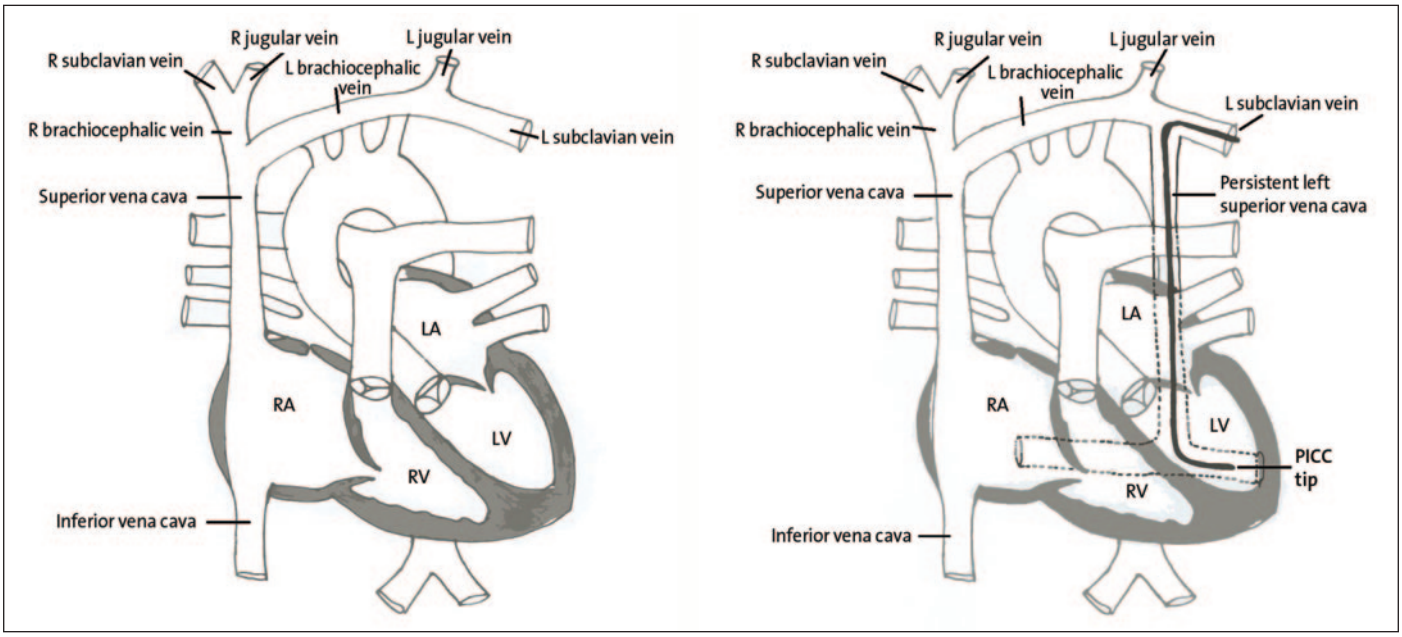


FIGURE 2 Anatomy of the heart: normal (left) compared with PLSVC (right), showing the route of the PICC due to abnormal venous anatomy. Key: RA=right atrium; LA=left atrium; LV=left ventricle; RV=right ventricle.

PICC on the left side of the vertebrae/spinal column. Based on this observation, a concern was raised as to the exact catheter placement. The radiologist's report described: "Left upper limb PICC line appears malpositioned overlying cardiac shadow." In view of this finding and based on the adage, 'if in doubt, take it out', the catheter was removed. A second PICC was inserted without incident into a different vein.

Discussion

Initial suspicions

During post-procedure debriefing, it was speculated that the PICC might have been accidentally inserted through the brachial artery, advancing through the subclavian artery and aorta with the tip residing in the left cardiac ventricle. The unusual bleeding seen during the insertion procedure was cited in support of this doubt. However, it was considered highly unlikely that the brachial artery was inadvertently cannulated. We routinely use a vascular visualisation device (VeinViewer, Christy Medical Corporation) as a part of pre-procedural site selection. With this device, clinicians can see peripheral veins, bifurcations and valves, and assess in real time the refill/flushing of veins and be confident they are accessing a vein. The infrared technology used by the device only provides information from desaturated blood, hence under normal circumstances only veins are projected. In this case the left cephalic vein was clearly visualised pre-procedure and during the entirety of the procedure itself.

While bleeding from the puncture site was more than usual (clotting was normal) the colour of the blood was a darker shade of red and not the typical hue of arterial.[5] Furthermore, tissue bleeding caused by an arterial puncture would have been observable by the projected image of VeinViewer as a 'blur'. This situation would have made it difficult to further visualise the insertion site. Consequently, the speculation that practitioners had inadvertently accessed the wrong blood vessel (brachial artery) was discounted. Nevertheless, the evident malposition of the PICC required explanation.

PLSVC

The route the PICC followed was abnormal. One possibility was that the PICC had deviated from the left upper extremity veins into the left-sided paraspinal hemiazygos venous system.[6] However, clinical and radiologist consensus was that a PLSVC (**FIGURE 2**) was the most likely explanation for the PICC's route.

PLSVC is a known vascular variant, although reports of its incidence vary. In a recent study Chao et al reported an incidence of 0.29% in a population of healthy neonates.[7] Others have observed rates of 0.5-2% among the general population[8] and 0.7-0.9% in fetuses.[9-12] The aetiology of the condition relates to a failure of early blood vessels to regress during embryonic development specifically, the right and left anterior cardinal veins. These vessels constitute the main venous drainage of the cephalic portion of the embryo. Normally, at around eight weeks of development the left anterior cardinal vein regresses (later becoming the ligament of Marshall); if this fails to happen, it leads to PLSVC.[7,13,14] Most often, when a PLSVC is present, a normal right superior cava is also present, though there is considerable variation in venous architecture.[14,15]

Isolated PLSVC is usually asymptomatic with few clinical features and is often detected as an incidental finding during other medical and surgical procedures (sometimes in adulthood).[12,14-16] The importance of PLSVC in neonatal care settings lies in a greater association with chromosomal congenital heart defects[8,10,12] and how it impacts upon central line placement when using the left arm. Therefore, the recognition of a PLSVC should alert healthcare professionals to these risks and the need for appropriate investigations (eg echocardiography).[9]

PICC insertions in neonates are considered safe and success rates of insertions are relatively high.[3-4] PICC insertion and ensuring correct tip positioning can be challenging in babies with abnormal venous anatomy. Misplaced catheters are a cause of concern due to them posing an increased risk of complications and adverse clinical events, which can be fatal. It is common that malpositioned catheters will either be removed (or repositioned to a midline position) to avoid these risks. Opinion, with the benefit of hindsight and more information about whether the catheter

should have been removed (as was the case) or retained in situ prior to further diagnostic investigations, differed. However, based on the information available at the time and on the principle of patient safety first, we believe that early removal was the safest course of action.

Afterword

After the initial 'failed' insertion a second PICC was inserted and by day 13 of life IV therapy was completed and the PICC successfully removed. The baby developed an IVH Grade II on day 6 of life but currently the baby is well and at home. Post-discharge management involves physiotherapy and orthopaedic management of the congenital talipes equinovarus and multi-professional developmental and cardiology follow up.

A further note needs to be made related to the congenital talipes equinovarus in relation to a potential PLSVC. While congenital talipes equinovarus may occur as an isolated birth defect with no other malformations (80% of cases), it also can be secondary or syndromic when its presentation is associated with another congenital disease (20% of cases).[13] In our case, aside from the PLSVC, we have found no other features to suggest a link between these two anomalies.

Conclusion

The case reported here of an infant with a PICC tip residing in a PLSVC posed local debate about the best course of action to take. Nevertheless, this experience has raised awareness of the need for practitioners to be aware of the potential for unusual features like PLSVC, to confound our practice expectations and prompted exploration of whether to adopt newer technologies (such as bedside ultrasound) into our PICC insertion practice portfolio.

Permissions and acknowledgements

This case report and its publication was approved by the local Institutional Review Board (MRC-04-20-629), as is the norm in this setting. As the case study has no identifiers, a written informed consent for publication of the case history was not requested.

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References

1. **Bayoumi MAA, Van Rens MFP, Chandra P, et al.** Effect of implementing an epicutaneo-caval catheter team in neonatal intensive care unit. J Vasc Access 2021;22:243-53.
2. **Gorski L, Hadaway L, Hagle ME, et al.** Infusion therapy standards of practice. J Infus Nurs 2016;39(S1):S1-S159.
3. **Mason-Wyckoff M, Sharpe EI.** Peripherally inserted central catheters: guideline for practice. 3rd ed. National Association of Neonatal Nurses; Chicago (IL): 2015.
4. **Hugill K, van Rens MFPT.** Inserting central lines via the peripheral circulation in neonates. Brit J Nurs 2020;29:S12-18.
5. **Park JS, Lee BK, Jeung KW, et al.** Reliability of blood color and blood gases in discriminating arterial from venous puncture during cardiopulmonary resuscitation. Am J Emerg Med 2015;33:553-58.
6. **Piciucchi S, Barone D, Sanna S, et al.** The azygos vein pathway: an overview from anatomical variations to pathological changes. Insights Imaging 2014;5:619-28.
7. **Chao Y-J, Chen R-R, Hung W-L, et al.** Impact of persistent left superior vena cava detection in a normal neonatal population through echocardiography. Acta Cardiol Sin 2019;35:600-04.
8. **Sheikh AS, Mazhar S.** Persistent left superior vena cava with absent right superior vena cava: review of the literature and clinical implications. Echocardiography 2014;31:674-79.
9. **Galindo A, Gutierrez Larraya F, Escribano D, et al.** Clinical significance of persistent left superior vena cava diagnosed in fetal life. Ultrasound Obstet Gynecol 2007;30:152-61.
10. **Berg C, Knuppel M, Geipel A, et al.** Prenatal diagnosis of persistent left superior vena cava and its associated congenital anomalies. Ultrasound Obstet Gynecol 2006;27:274-80.
11. **Du L, Xie HN, Zhu YX, et al.** Fetal persistent left superior vena cava in cases with and without chromosomal anomalies. Prenat Diagn 2014;34:797-802.
12. **Perles Z, Nir A, Gavri S, et al.** Prevalence of persistent superior vena cava and association with congenital heart anomalies. Am J Cardiol 2013;112:1214-18.
13. **Pavone V, Chisari E, Vescio A, et al.** The etiology of idiopathic congenital talipes equinovarus: a systematic review. J Orthop Surg Res 2018;13:206.
14. **Goyal SK, Punnam SR, Verma G, Ruberg FL.** Persistent left superior vena cava: a case report and review of literature. Cardiovasc Ultrasound 2008;6:50.
15. **Ucar O, Pasaoglu L, Cicekcioglu H, et al.** Persistent left superior vena cava with absent right superior vena cava: a case report and review of the literature. Cardiovasc J Africa 2010;21:164-66.
16. **Choi E-Y, Hong S-K, Jeong N-Y.** Clinical characteristics of prenatally diagnosed persistent left superior vena cava in low-risk pregnancies. Prenat Diagn 2016;36:444-48.

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