CASE REPORT

Incidental finding of persistent left superior vena cava after 'bubble study' verification of central venous catheter

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SUMMARY

We report a case of a patient with septic shock who underwent central venous catheter placement in the left internal jugular vein, and a bedside ultrasound 'bubble study' revealed venous cannulation. A chest X-ray postprocedure revealed concern for arterial system catheterisation. However, the possibility of a persistent left superior vena cava was discussed and confirmed with a formal transthoracic echocardiogram and CT. This case demonstrates the importance of ultrasound-guided visualisation of anatomical structures in real time during central venous catheterisation. Other similar cases from the literature are briefly described.

BACKGROUND

This is a relevant case report because it confirms the importance of ultrasound-guided visualisation of anatomical structures in real time during central venous catheterisation (CVC). In addition, the use of a 'bubble study' to confirm the placement of a CVC within the venous side of the circulation may as in our case, allow for faster initiation of vasopressors while waiting for a chest X-ray (CXR) and alert the treating team of the presence of a persistent left superior vena cava (PLSVC) when the CXR appears to course over the aorta.

CASE PRESENTATION

A 61-year-old man with medical history significant for traumatic brain injury complicated by hydrocephalus and ventriculoperitoneal (VP) shunt placement, benign prostatic hyperplasia, chronic kidney disease stage 4, chronic obstructive uropathy and chronic indwelling urinary catheter, presented to the hospital complaining of gross haematuria and had laboratory evidence of urinary tract infection. He was admitted to the medical floor and started on ceftriaxone. One day into his hospitalisation, his course was complicated by hypotension unresponsive to 2 L of crystalloid resuscitation, and he was transferred to the medical intensive care unit (MICU) for the management of septic shock.

On transfer to the MICU, a CVC placement was attempted. The left internal jugular vein was chosen as the appropriate site in the setting of his VP shunt coursing over the right side of his neck. The left internal jugular vein (LIJV) was localised and cannulated with ultrasound guidance. The position of the guidewire in the venous system was confirmed

again with ultrasound. Due to the long wait times at our institution with night-time portable CXRs and the need to start the patient on vasopressor therapy immediately, a 'bubble study' with agitated saline was performed at bedside after the catheter was placed, which showed bubbles in the right-sided chambers, confirming the appropriate site of the catheter (supplementary video file 1). The routine CXR to rule out pneumothorax revealed the catheter coursing on the left side of the mediastinum over the course of the descending aorta (figure 1). Although pressure transduction readings from the catheter were much less than the simultaneously obtained invasive systemic blood pressures, there was significant pulsatility on the tracings and vascular surgery booked the patient for the operating room (OR). Once the night team was informed of the CXR findings and vascular surgery's plan to take the patient to the OR, the possibility of a PLSVC was discussed given the bubble study done during catheter placement. Review of a formal transthoracic echocardiogram with agitated saline revealed a dilated coronary sinus, but no other cardiac anomalies (figure 2). A CT chest confirmed a PLSVC with the catheter tip at the entrance of the coronary sinus likely explaining the unusual pulsatility (figure 3).

DIFFERENTIAL DIAGNOSIS

Inadequate central venous catheter placement in the arterial system.

Figure 1 Chest X-ray demonstrating the left internal jugular central line coursing on the left side of the mediastinum either in the descending aorta or in a left superior vena cava.

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Figure 2 Transthoracic echocardiogram, parasternal long-axis view, showing the abnormally dilated coronary sinus.

TREATMENT

- Discontinuation of central venous catheter after resolution of septic shock.
- The PLSVC is usually asymptomatic when isolated and does not affect prognosis.¹

OUTCOME AND FOLLOW-UP

After confirmation of the anatomic anomaly, the LIJV catheter was discontinued and the patient had an uneventful hospital

course. He responded adequately to resuscitation measures and antibiotics. He remained in the MICU for 3 days. After being transferred to the regular medical floor, he was discharged with appropriate follow-up outpatient.

DISCUSSION

PLSVC is a common anomaly of the thoracic venous system present in 0.3%–0.5% of the general population and 12% in patients with congenital heart disease.^{1,2} The embryological drainage of the venous system is mainly composed of the common cardinal veins formed by the anterior and superior cardinal veins. The cephalic portions of the superior cardinal veins form the internal jugular veins. The caudal portion of the right superior vein forms the normal SVC, while the caudal portion of the left superior cardinal vein regresses to become the 'ligament of Marshall', failure of this regression results in a PLSVC, which drains in the coronary sinus.³

The PLSVC includes distinct variations: PLSVC that drains into the coronary sinus and persists with a right SVC, PLSVC that drains into the left atrium via a fenestrated coronary sinus, PLSVC with absent right superior vena cava.⁴ This anomaly is usually asymptomatic and does not affect prognosis when it is not associated to other cardiac defects.⁵ Detection usually occurs while performing invasive procedures on systemic veins, such as, central venous cannulation, implantable cardioverter defibrillator implantation, pacemaker insertion or cardiopulmonary bypass. The presence of PLSVC should be confirmed with saline contrast echocardiography.⁶

Troubleshooting during central venous catheterisation is important for placement and verification. We should familiarise with the three different variants of PLSVC and the tests to confirm the diagnosis, which includes determining that the PLSVC drains into the right atrium, as described by Mabry *et al* in the *Journal of the Association for Vascular Access* in 2014.⁷

Verification of the proper CVC insertion is a mandatory step. CXR is the gold standard to confirm the location of the catheter and to rule out complications, such as pneumothorax. Radiation exposure and long waiting times when using CXR to rule out CVC malposition or to evaluate for mechanical complications has created the need for a quicker, less invasive and accurate tool. Bedside ultrasound for CVC verification is faster and has been shown to have a sensitivity of 94%, a specificity of 89% when compared with CXR.⁸ A useful technique using bedside ultrasound is the echocardiographic 'bubble test' which consists of visualising air bubbles directly in the right atria and ventricle that are mixed with normal saline and injected through the inserted CVC. Review demonstrates a specificity of 99% to 100% to identify CVC malposition.⁹ It is clear that ultrasonic diagnostic of CVC malposition and complications is a fast and accurate tool that can be easily performed by ICU and emergency department physicians.¹⁰

In our patient, the 'bubble test' was able to reliably show that the PLSVC drained into the right and not the left atrium. It was used to identify catheter position due to the urgency of starting therapy in an intensive care setting; in this case, vasopressors in a patient with septic shock in the middle of the night when other confirmatory tests would not be as feasible to obtain. Phlebography and eventually repositioning under fluoroscopy is a more accurate method, unfortunately, not as readily available in a community hospital and for this reason would probably not have been the ideal test in an emergent case.

On review of the literature, we found one similar case that used 'bubble test' to confirm central venous catheter placement

Figure 3 (A and B) Two transverse views of the CT scan confirming the placement of the left internal jugular vein catheter in a persistent left superior vena cava.

and was later found to have PLSVC.¹¹ Another case by Ghadiali *et al.*, a chest radiograph showed abnormal positioning of the central venous catheter and the bedside 'bubble test' was performed afterwards to confirm PLSVC.¹² Other cases in the literature describe incidental detections of PLSVC after central venous catheterisation but not specifically after having performed a bedside 'bubble test' for confirmation of catheter placement.^{13–15} There is also a retrospective study by Leibowitz *et al.* that describes five patients discovered to have PLSVC after central venous or pulmonary artery catheterisation. The cardiac anomaly was confirmed by bolus contrast injection in two of these patients, transoesophageal echocardiography, CT scan and intraoperative inspection in the other three patients.¹⁶

Learning points

- ▶ Ultrasound is an increasingly used tool in the intensive care unit (ICU), which allows visualisation of anatomical structures in real time during central venous catheterisation.
- ▶ Using 'bubble study' for confirmation of central venous catheterisation placement allows faster initiation of vasopressors in an emergent case.
- ▶ Bedside ultrasound does not yet obviate the need of chest X-ray for postprocedure complications or catheter positioning.
- ▶ Knowledge of cardiovascular anatomy is especially relevant during ICU procedures and when confirming catheter placements.
- ▶ We should familiarise ourselves with the different variants of persistent left superior vena cava to allow for appropriate verification and troubleshooting during central venous catheterisation.

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REFERENCES

- 1 Bisoyi S, Jagannathan U, Dash AK, *et al.* Isolated persistent left superior vena cava: a case report and its clinical implications. *Ann Card Anaesth* 2017;20:104–7.
- 2 Kumar D, Shafiq F. Successful management of septic patient with concealed left persistent superior vena cava: anaesthetic perspective. *J Pak Med Assoc* 2016;66:1179–81.
- 3 Goyal SK, Punnam SR, Verma G, *et al.* Persistent left superior vena cava: a case report and review of literature. *Cardiovasc Ultrasound* 2008;6:50.
- 4 Earl Choi Y, Jin Cho H, Sook Ma J. Incidentally detected persistent left Superior Vena Cava with an absent Right Superior Vena Cava in a Neonate. *Iran J Pediatr* 2016;26:e4692.
- 5 Esmer AC, Yüksel A, Calı H, *et al.* Prenatal diagnosis of persistent left superior vena cava and its clinical significance. *Balkan Med J* 2014;31:50–4.
- 6 Steckiewicz R, Kosior DA, Rosiak M, *et al.* The prevalence of superior vena cava anomalies as detected in cardiac implantable electronic device recipients at a tertiary cardiology centre over a 12-year period. *Hellenic J Cardiol* 2016;57:101–6.
- 7 Mabry VL, Mancino AT, Sullivan SC. Persistent left superior vena cava. *JAVA* 2014;19:84–5.
- 8 Zanobetti M, Coppa A, Bulletti F, *et al.* Verification of correct central venous catheter placement in the emergency department: comparison between ultrasonography and chest radiography. *Intern Emerg Med* 2013;8:173–80.
- 9 Meggiolaro M, Scatto A, Zorzi A, *et al.* Confirmation of correct central venous catheter position in the preoperative setting by echocardiographic 'bubble-test'. *Minerva Anesthesiol* 2015;81:989–1000.
- 10 Maury E, Guglielminotti J, Alzieu M, *et al.* Ultrasonic examination: an alternative to chest radiography after central venous catheter insertion? *Am J Respir Crit Care Med* 2001;164:403–5.
- 11 Prekker ME, Chang R, Cole JB, *et al.* Rapid confirmation of central venous catheter placement using an ultrasonographic "Bubble Test". *Acad Emerg Med* 2010;17:e85–e86.
- 12 Ghadiali N, Teo LM, Sheah K. Bedside confirmation of a persistent left superior vena cava based on aberrantly positioned central venous catheter on chest radiograph. *Br J Anaesth* 2006;96:53–6.
- 13 Azocar RJ, Narang P, Talmor D, *et al.* Persistent left superior vena cava identified after cannulation of the right subclavian vein. *Anesth Analg* 2002;95:305–7.
- 14 Higgs AG, Paris S, Potter F. Discovery of left-sided superior vena cava during central venous catheterization. *Br J Anaesth* 1998;81:260–1.
- 15 Lönnqvist PA, Olsson GL. Persistent left superior vena cava—an unusual location of central venous catheters in children. *Intensive Care Med* 1991;17:497–500.
- 16 Leibowitz AB, Halpern NA, Lee MH, *et al.* Left-sided superior vena cava: a not-so-unusual vascular anomaly discovered during central venous and pulmonary artery catheterization. *Crit Care Med* 1992;20:1119–22.

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