Where is that hemodialysis catheter (superior vena cava or aorta)? A case of intraarterial catheter placement

Valerie Tan, MD, and John C. Schwartz, MD

We present a case of a previously unrecognized intraarterial placement of a central venous catheter (CVC)—in this case, a large-bore hemodialysis catheter in an 82-year-old woman. CVC insertions have become a common practice in hospitals due to a variety of indications, and tunneled CVCs still remain an important form of access in patients with end-stage renal disease. Intraarterial puncture is a common complication during CVC insertion, while intraarterial (mis)placement is fairly uncommon and if unrecognized can lead to significant morbidity and mortality.

Arterial puncture during central venous catheter (CVC) insertion is one of the most common complications related to CVC insertion, with an incidence varying from 1% to 11%. Catheter misplacement outside of the correct position (ideally a large central vein such as the superior or inferior vena cava or the right atrium) has been described with tips lying in aberrant sites in almost every possible anatomical position, including the arterial system, mediastinum, pleura, and pericardium. CVC misplacement depends on several factors such as site and technique of insertion, operator experience, number of needle passes, presence of unknown vascular or anatomic abnormalities, and patient body habitus and positioning (1, 2).

CASE REPORT

An 82-year-old black woman with recently diagnosed end-stage renal disease requiring hemodialysis was referred for further evaluation of her kidney disease. Her past medical history was significant for hypertension, hypothyroidism, and pulmonary hypertension. She initially presented to an outside hospital 1 month earlier for progressive edema, nephrotic-range proteinuria, marked hypoalbuminemia, and severe renal failure. Pertinent workup at the outside hospital revealed urinary protein excretion of 10 g/day and a serum albumin level of 0.9 g/dL. Routine serologies and urine and serum protein electrophoreses were normal. The specific cause of her end-stage renal disease was not known, as the patient refused to undergo a kidney biopsy. Her renal function rapidly deteriorated, and hemodialysis was started. She was placed on prophylactic anticoagulation because of her severe nephrotic syndrome.

Hemodialysis was performed using a central venous hemodialysis catheter. She was subsequently discharged to continue maintenance hemodialysis at an outpatient hemodialysis unit. Outpatient hemodialysis, however, was not tolerated due to frequent episodes of intradialytic hypotension. She had several catheter exchanges. The patient developed progressive anasarca and dyspnea prompting transfer for management of renal disease and refractory volume overload.

Her admission vital signs included a heart rate of 86 beats per minute; blood pressure, 103/57 mm Hg; respiratory rate, 18 breaths/min; and oxygen saturation, 96% on room air. She was in no acute distress at rest. Neck veins were prominent. Lung auscultation revealed decreased breath sounds at the bases. Cardiovascular examination revealed a systolic murmur over the right upper sternal border but no precordial heave. She had overt anasarca with swelling to the level of the hips. A dual-lumen dialysis catheter was located below the right clavicle.

Laboratory studies showed a hemoglobin of 12.5 g/dL; hematocrit, 37.7%; white blood cell count, 9200/uL; platelets, 392,000/uL; sodium, 148 mEq/L; potassium, 5.2 mEq/L; chloride, 111 mEq/L; bicarbonate, 27 mEq/L; blood urea nitrogen, 40 mg/dL; creatinine, 5.0 mg/dL; glucose, 106 mg/dL; albumin, 1.2 g/dL; and calcium, 8.2 mg/dL. Coagulation studies revealed a prothrombin time of 99.4 seconds with an international normalized ratio of 10.6. Urinalysis was significant for 3+ proteinuria, 2+ glucosuria, and 1+ blood with 15 to 30 red blood cells. A 24-hour urine collection revealed a creatinine clearance of 4 mL/min and a urine protein excretion of 18 g/day. A chest x-ray revealed small bilateral pleural effusions, and the right internal jugular dialysis catheter tip was reported to be in the superior vena cava (*Figure 1*). As part of the workup of pulmonary hypertension, a CT scan with pulmonary embolus protocol was done, which ruled out a pulmonary embolus. The study, however, revealed the dialysis catheter to actually be in the ascending aorta rather than the superior vena cava (*Figure 2*).

Because of the finding of arterial placement of the dialysis catheter, the vascular surgery service was consulted and

From the Division of Nephrology, Department of Internal Medicine, Baylor University Medical Center at Dallas.

Corresponding author: Valerie Tan, MD, 3600 Gaston Avenue, Barnett Tower, Suite 904, Dallas, TX 75246 (e-mail: Valerie.tan@baylorhealth.edu).

Figure 1. A chest x-ray showing small bilateral pleural effusions. Based on this image, the catheter tip was reported to be in the superior vena cava.

Figure 2. A CT scan with pulmonary embolus protocol showing the dialysis catheter to be in the ascending aorta.

hemodialysis temporarily held. Blood was drawn from the catheter and sent for blood gas analysis, which revealed pH 7.44, $p\text{CO}_2$ 38 mm Hg, and $p\text{O}_2$ 125 mm Hg, with an oxygen saturation of 97%. This confirmed the intraarterial position of the catheter. The patient's coagulopathy was corrected. She subsequently underwent surgical removal of the arterial dialysis catheter with repair of the carotid artery at the catheter insertion site. A new tunneled dialysis catheter was placed in the left internal jugular vein under ultrasound guidance with catheter tip placement confirmed by fluoroscopy.

During the hospital course, a kidney biopsy was attempted to determine the etiology of her nephrotic syndrome. The procedure was aborted due to technical difficulties. She was placed empirically on steroids for treatment of suspected glomerulonephritis. Residual kidney function never recovered where adequate volume management or solute clearance was possible. Thrice weekly hemodialysis was resumed while she continued steroids. Hemodialysis was initially tolerated with the help of intradialytic albumin, but the patient did not tolerate it over the succeeding sessions due to recurring hypotension. A right heart catheterization was ultimately done to evaluate her pulmonary hypertension. Results revealed mild pulmonary hypertension and a very low cardiac output. A repeat 24-hour creatinine clearance after 2 weeks of steroids revealed a clearance of 7 mL/min. Due to her poor cardiac status, advanced age, and inability to tolerate dialysis, the patient and family decided to pursue comfort care and to stop dialysis.

DISCUSSION

Hemodialysis catheters are large-bore CVCs that have remained a frequent modality of both acute and chronic dialysis vascular access in the United States. A large percentage (80%) of patients initiating dialysis do so via a catheter, with some continuing to chronically dialyze through it due to the inability to obtain or unavailability of an adequate arteriovenous access. Hemodialysis catheters are classified into two categories: acute or nontunneled and chronic or tunneled catheters. Insertion of these catheters follows the same principles of CVC insertion, with the right internal jugular vein being the preferred insertion site due to easier catheterization, a relatively straight path to the superior vena cava and right atrium, high rates of cannulation success, and low rates of central venous stenosis (3, 4).

As with CVC insertions, arterial puncture is a common complication of hemodialysis catheters, and arterial puncture can be recognized prior to insertion of the catheter by checking the color and pulsatility of the blood backflow. In certain cases, however, such as shock, hypotension, or hypoxemia, this check may be unreliable, and it may be difficult to distinguish between arterial and venous blood. In these cases, an arterial blood gas or pressure transducer monitoring may be used to detect misplacement (1). Use of ultrasound-guided cannulation compared with the landmark (blind) method has been proven to decrease the risk of procedural complications, including arterial puncture and misplacement, reduce the number of multiple attempts, and reduce the number of catheter placement failures (4–6).

When choosing the internal jugular or subclavian veins for CVCs, postprocedure films and fluoroscopy are useful in confirming catheter placement and tip location. These, however, are not foolproof, as evidenced by this case, where admission chest x-ray failed to recognize the arterial location of the catheter. In cases of internal jugular vein CVCs, intraarterial misplacement may not be apparent in routine x-rays when the CVC is in the ascending aorta because of overlap of the superior vena cava and the aorta. Anatomic vascular anomalies such as a right-sided aortic arch may also make radiographic recognition difficult. Fluoroscopic confirmation after a tunneled hemodialysis catheter insertion has the same limitation unless contrast is used to see actual blood flow (1).

Upon recognition of an intraarterial placement of a CVC, it should be left in place until further advice and management from surgery or interventional radiology is obtained. Rare but life-threatening complications include hematoma formation enough to compromise airway, hemorrhage with or without hemothorax, cerebrovascular accidents from thromboembolism, Horner's syndrome, pseudoaneurysm or arteriovenous fistula formation, arterial occlusion, and even death (2, 3, 7). Removal of large-bore hemodialysis catheters requires careful consideration and extensive operator experience. Treatment options vary from extrinsic compression if the artery is accessible (although

this risks brain ischemia), to surgical removal of the catheter with repair of the arterial defect, to endovascular repairs with or without stent placement (1). Due to the associated significant morbidity and mortality of CVC arterial puncture and catheter misplacement, prevention is key, and the best preventive strategies are adequate patient and operator preparation and use of real-time ultrasound-guided cannulation.

1. Gibson F, Bodenham A. Misplaced central venous catheters: applied anatomy and practical management. *Br J Anaesth* 2013;110(3):333–346.
2. Kusminsky RE. Complications of central venous catheterization. *J Am Coll Surg* 2007;204(4):681–696.
3. Choi YS, Park JY, Kwak YL, Lee JW. Inadvertent arterial insertion of a central venous catheter: delayed recognition with abrupt changes in pressure waveform during surgery—a case report. *Korean J Anesthesiol* 2011;60(1):47–51.
4. Schwab SJ, Beathard G. The hemodialysis catheter conundrum: hate living with them, but can't live without them. *Kidney Int* 1999;56(1):1–17.
5. Vats HS. Complications of catheters: tunneled and nontunneled. *Adv Chronic Kidney Dis* 2012;19(3):188–194.
6. Aydin Z, Gursu M, Uzun S, Karadag S, Tatli E, Sumnu A, Ozturk S, Kazancioglu R. Placement of hemodialysis catheters with a technical, functional, and anatomical viewpoint. *Int J Nephrol* 2012;2012:302826.
7. Göksel OS, El H, Onalan A, Alpagut U. Successful removal of a mal-positioned hemodialysis catheter into the aortic arch. *J Vasc Access* 2012;13(4):543.

Avocations

Spring flowers. Photos copyright © Rolando Solis, MD. Dr. Solis is an interventional cardiologist practicing at Baylor Medical Center at Garland and the Heart Hospital Baylor Plano (e-mail: rmsolis@me.com).