OPEN

Cannulation of the Internal Mammary Vein With a Single-Lumen Infusion Catheter in a Patient With Portal Hypertension: A Case Report

Brian C. Tashjian, BA, Michael E. Schoor, MD, and Masilo Grant, MD

We present a central venous catheter misplacement case. A left internal jugular vein percutaneous introducer was inserted for fluid resuscitation with a single-lumen infusion catheter placed through the lumen for medication infusions. Placement was performed under ultrasound guidance, with confirmation of the wire within the venous lumen. Radiographs suggested that the introducer had perforated the innominate vein. Contrast was injected through the single-lumen infusion catheter and showed cannulation of the left internal mammary vein. The link between portal hypertension and increased risk of central line misplacement as well as diagnosis and potential methods to avoid this rare complication are discussed. (A&A Practice. 2019;12:122–4.)

Central venous catheter use is common practice in the operating room and intensive care unit. In 2008, 44% of intensive care unit patients had a central venous catheter placed.[1] Common indications for central venous catheter placement include volume resuscitation, hemodynamic monitoring, vasopressor administration, parenteral nutritional support, and the administration of chemotherapy.[2] Central venous catheter placement is not without risks, even with the implementation of protocols and ultrasound imaging techniques. The Anesthesiology Closed Claims database reports complication rates from central venous catheter placement to be as high as 15%, although the rate varies with patient characteristics and operator experience.[3] Complications can include arteriovenous fistula formation, breakage, or fragmentation of the catheter with subsequent embolization, pneumothorax, nerve injury, and catheter malposition; the most common being accidental vessel puncture or laceration.[2,4] Historically, exclusive use of external anatomical landmarks was the most common technique; however, ultrasound-assisted placement, first studied in 1984, has been shown to increase the accuracy and decrease the complication rate of this procedure.[5,6] It is standard practice at our institution to confirm appropriate placement of a central venous catheter with chest radiographs before the use of the catheter.

This case describes misplacement of a left internal jugular vein central venous catheter that resulted in cannulation of the left internal mammary (internal thoracic) vein. Portal hypertension and specific anatomical variations likely predispose patients to this complication.[7–9] This is not the first case report of this phenomenon in the literature: the first documented case was reported in 1974.[10–12] However, as the case report below illustrates, current standard practice guidelines can fail to precisely locate misplaced catheters.

The patient described has given written permission to present the following information.

PATIENT INFORMATION

A 45-year-old man with alcoholic cirrhosis was transferred from an outside hospital in hemorrhagic shock secondary to a recurrent esophageal varices bleed. The patient had been placed on massive transfusion protocol, and when banding via upper endoscopy failed to stop the hemorrhage, a Minnesota tube was placed to tamponade variceal and gastric bleeding. The patient required an urgent transjugular intrahepatic portosystemic shunt procedure to reduce portal pressure and variceal size, and thus, he was transferred to our tertiary care center.

DIAGNOSTIC ASSESSMENT AND THERAPEUTIC INTERVENTIONS

The patient arrived intubated on maximum doses of norepinephrine, epinephrine, octreotide, and vasopressin. The patient had poor peripheral venous access, and the right internal jugular vein was covered by the helmet used to hold balloon position and tension of the Minnesota tube. The decision was made to place a percutaneous introducer catheter in the left internal jugular vein. Ultrasound guidance was used to puncture the vessel with an angiocatheter. Sterile plastic tubing was connected to the angiocatheter and showed nonpulsatile flow and central venous pressure tracings 12 cm above the patient. Venous intraluminal position of the guidewire was then confirmed with ultrasound. A single-lumen infusion catheter was placed through the introducer to provide a dedicated central access for vasopressor infusions and medication. Although chest radiograph is the gold standard for confirmation of central line placement, radiographs were not obtained until the patient arrived in the interventional radiology suite due to the urgent need for the transjugular intrahepatic portosystemic

From the Department of Anesthesiology and Perioperative Medicine, University of Massachusetts Medical School, Worcester, Massachusetts.

Accepted for publication November 26, 2018.

Funding: None.

The authors declare no conflicts of interest.

Address correspondence to Michael E. Schoor, MD, Department of Anesthesiology and Perioperative Medicine, University of Massachusetts Medical School, 55N Lake Ave, Worcester, MA 01655. Address e-mail to michael.schoor@umassmemorial.org.

DOI: 10.1213/XAA.0000000000000956

shunt procedure. Scout radiograph films showed that both the introducer and the single-lumen infusion catheter were located centrally within the cardiac silhouette. The anesthesiology team was notified by the radiologists that the central line had been "placed into the mediastinum."

The anesthesiology team requested that contrast be injected through the main lumen of the introducer. This showed the central venous catheter within the innominate vein with the tip abutting the inner wall of the vessel and the single-lumen infusion catheter perforating through the wall of the vessel into the pericardium (Figure 1).

Subsequent discussion with the interventional radiology, intensive care, and cardiothoracic surgery teams yielded 3 possible interventions: removal of the catheter with resultant hemorrhage, placement of an endovascular stent, or immediate median sternotomy. Our anesthesiology team was doubtful that perforation had occurred based on initial ultrasound guidance, nonpulsatile flow, and central venous pressure tracings. To determine an intravascular versus extravascular location of the single-lumen infusion catheter before proceeding, computerized tomography angiography was considered. However, the patient's continued resuscitation needs and worsening renal function prohibited moving the patient and administering the large quantity of contrast dye necessary for computerized tomography angiography. Instead, a small dilute quantity of contrast was injected through the single-lumen infusion catheter port.

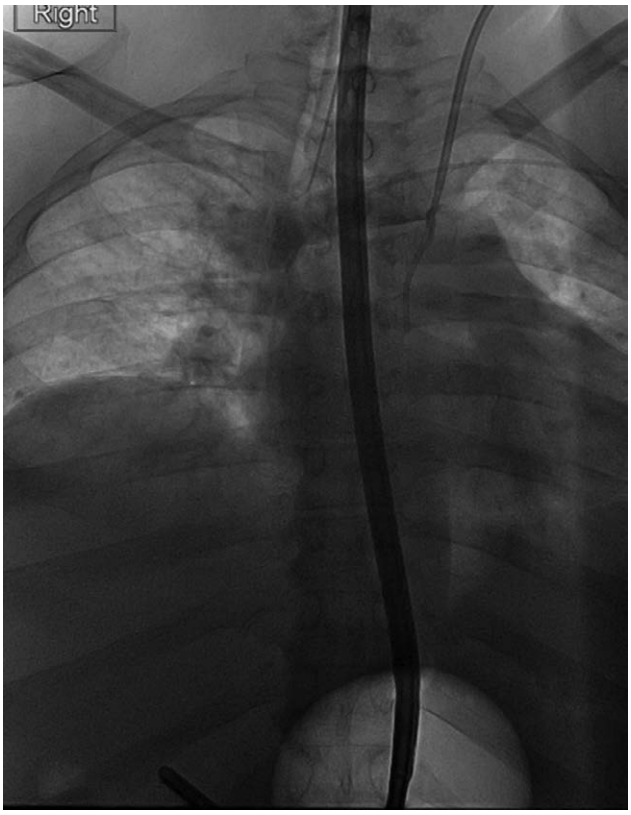

Figure 1. Radiographic sequence image of percutaneous introducer was displayed. Contrast outlines the innominate vein with the end of the percutaneous introducer abutting the wall and the single-lumen infusion catheter "extending into the mediastinum." Blakemore tube is also seen entering the stomach.

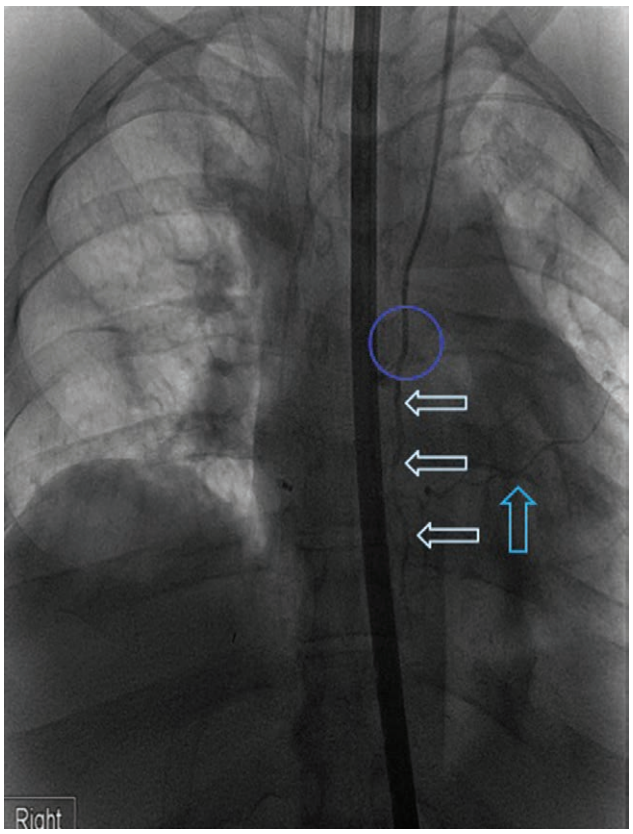

Figure 2. Contrast leaving the single-lumen infusion catheter and flowing through intercostal veins to reenter the inferior vena cava was displayed. Blue circle shows the end of the single-lumen infusion catheter, white arrows delineate the internal mammary vein, and the blue arrow marks an intercostal vein.

Fluoroscopy revealed contrast flowing through a small anterior thoracic wall vessel and returning to the heart via the intercostal vessels (Figure 2). This confirmed that the catheter was intravascular and had cannulated the left internal mammary vein. The single-lumen infusion catheter was removed without any further intervention and the introducer was left in place as the transjugular intrahepatic portosystemic shunt procedure was completed.

After a successful transjugular intrahepatic portosystemic shunt procedure, the patient returned to a hemodynamically stable state as bleeding was controlled. He was released 1 month after admission and is currently on the transplant list.

DISCUSSION

There are several points to consider when caring for patients with similar characteristics as the one presented. First, portal hypertension in conjunction with left internal jugular vein central venous catheter placement can increase the risk of central line misplacement. In portal hypertension, blood flow is diverted through anastomoses between the portal system and its collateral systemic circulation. This increases systemic circulation volume, dilating the small vessels in close proximity to these anastomoses. Commonly affected vessels include the esophageal, internal mammary, abdominal wall, hemorrhoidal, and intercostal veins. In addition,

when compared to the right side, the decreased slope of the left innominate vein creates a more perpendicular angle to the left internal jugular vein. Left-sided jugular venous catheters carry an increased risk of internal mammary vein cannulation because of the potential for the mammary vein to lie directly opposite the left internal jugular vein. This case demonstrates how dilated thoracic vessels in portal hypertension combined with vascular anatomy may increase the risk of catheter cannulation of the internal mammary vein.

Second, while ultrasound guidance during catheter introduction is useful in identifying anatomical landmarks and confirming intraluminal position of the guidewire, it is not sufficient in confirming the exact location of the catheter tip. Imaging beyond ultrasound guidance is required to locate misplaced catheters. Postprocedural chest radiography is the current gold standard for locating the catheter tip; however, radiographs can only approximate catheter position.[13] Amir et al[13] demonstrate that transthoracic echocardiography is noninferior to chest radiography in detecting catheter malposition and can be used to confirm normal catheter position. Transthoracic echocardiography confirmation of normal catheter position is achieved by visualizing a right atrial swirl both when the guidewire is in place and when saline is injected after catheter placement. However, with misplaced catheters, transthoracic echocardiography will only confirm the absence of right atrial swirl and has thus not been shown to be useful in locating the tip of a misplaced catheter. Computerized tomography angiography is often used to determine precise locations of catheters, but in this case, computerized tomography angiography was not possible due to the patient's unstable condition and worsening renal function.

This case illustrates the challenge of locating misplaced catheters and shows a potential method for using a small dilute quantity of IV contrast dye as a diagnostic tool. The quantity injected through this patient's single-lumen infusion catheter was significantly smaller than the amount computerized tomography angiography requires. Dye injection allowed the team to confirm the intravascular location of the single-lumen infusion catheter, facilitating initiation of the patient's urgent transjugular intrahepatic portosystemic shunt procedure without the need for central venous catheter replacement. In situations where chest radiography reveals an anomalous pericardial or mediastinal catheter location and there is a high degree of confidence for venous placement, fluoroscopy with small-dose radiocontrast dye may be considered as a diagnostic tool.

In future cases where a single-lumen infusion catheter and a percutaneous introducer are needed, concurrent use of vascular and transthoracic echocardiography may be useful. The vascular probe can be used for vessel entry and transthoracic echocardiography can then show the wire within the right atrium. Usually, the introducer is placed using the guidewire and then the wire is removed before single-lumen infusion catheter placement. Alternatively, once the introducer is placed over the wire, the single-lumen infusion catheter can also be guided over the wire within the introducer lumen. If transthoracic echocardiography confirms that the tip of the wire is in the right atrium and the single-lumen infusion catheter is placed through the introducer and over the wire, it may increase the probability that both the introducer and the catheter are positioned correctly.

In patients presenting with portal hypertension and need for central access, clinicians must account for collateral vessel dilation that may lead to cannulation of these vessels. In such cases, the use of radiography for central line position confirmation may be unreliable and further diagnostic modalities may be necessary. Using ultrasound for the initial cannulation improves the success rate of venous wire placement.[2,5] Guiding both the introducer and the single-lumen infusion catheter over the wire with concurrent use of transthoracic echocardiography may minimize the incidence of catheter malposition; however, this is not a standard of care and requires further investigation.

DISCLOSURES

Name: Brian C. Tashjian, BA.
Contribution: This author helped write and format the manuscript.
Name: Michael E. Schoor, MD.
Contribution: This author helped care for the patient, and edit the manuscript.
Name: Masilo Grant, MD.
Contribution: This author helped care for the patient, and prepare the manuscript.
This manuscript was handled by: BobbieJean Sweitzer, MD, FACP.

REFERENCES

1. Gershengorn HB, Garland A, Kramer A, Scales DC, Rubenfeld G, Wunsch H. Variation of arterial and central venous catheter use in United States intensive care units. *Anesthesiology*. 2014;120:650–664.
2. Randolph AG, Cook DJ, Gonzales CA, Pribble CG. Ultrasound guidance for placement of central venous catheters: a meta-analysis of the literature. *Crit Care Med*. 1996;24:2053–2058.
3. Domino KB, Bowdle TA, Posner KL, Spitellie PH, Lee LA, Cheney FW. Injuries and liability related to central vascular catheters: a closed claims analysis. *Anesthesiology*. 2004;100:1411–1418.
4. Bowdle A. Vascular complications of central venous catheter placement: evidence-based methods for prevention and treatment. *J Cardiothorac Vasc Anesth*. 2014;28:358–368.
5. Denys BG, Uretsky BF, Reddy PS. Ultrasound-assisted cannulation of the internal jugular vein. A prospective comparison to the external landmark-guided technique. *Circulation*. 1993;87:1557–1562.
6. Legler D, Nugent M. Doppler localization of the internal jugular vein facilitates central venous cannulation. *Anesthesiology*. 1984;60:481–482.
7. Stone PA, Hass SM, Knackstedt KS, Jagannath P. Malposition of a central venous catheter into the right internal mammary vein: review of complications of catheter misplacement. *Vasc Endovascular Surg*. 2012;46:187–189.
8. Liao HR, Li TS, Chen KB, et al. Rare malposition of a central venous catheter into the left internal mammary vein in a liver transplantation patient. *J Anesth*. 2011;25:462–464.
9. Sandroni C, Pirronti T, Tortora F, Santangelo S, Rinaldi P, Antonelli M. Unusual central venous catheter malposition into the left internal mammary vein: a case report. *Intensive Care Med*. 2003;29:2338–2339.
10. Angral R, Sabesan P, Natarajan K, Ninan B. Inadvertent placement of left central venous catheter into left internal thoracic vein: a case report. *Ann Card Anaesth*. 2012;15:165–166.
11. Quigley RG, Petty C, Tobin G. Unusual placement of a central venous catheter via the internal jugular vein. *Anesth Analg*. 1974;53:478.
12. Zaman MH, Mitra P, Bondi E, Gintautas J, Abadir AR. A rare malposition of the central venous catheter. *Chest*. 1990;98:768–770.
13. Amir R, Knio ZO, Mahmood F, et al. Ultrasound as a screening tool for central venous catheter positioning and exclusion of pneumothorax. *Crit Care Med*. 2017;45:1192–1198.