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CASE REPORT

Anesthesia and Perioperative Medicine

Transection of the Right Subclavian Artery by a Right Neck Central Venous Line, Resulting in Hemothorax and Need for Stenting by Interventional Radiology

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Summary

Central venous catheters (CVC) are used for management and treatment of patients in the operating room (OR). However, there are risks to the patient, including mechanical complications, deep venous thrombosis, and infection. In this case report we present a transfixion of the right subclavian artery (SCA), by a CVC placed into the right in-ternal jugular (IJ) vein. Ultrasound (U/S) guidance minimizes the risk of CVC mal-positioning during placement, and therefore has become standard of care in most institutions. However, U/S guidance presents a limited field of view and complications can still occur.

Background

The use of a central venous catheter (CVC) is common in the operating room (OR) for administering medications and fluid, as well as monitoring central venous pressure (CVP) [1]. While common, it is an invasive procedure, and there is a risk of complications, including: mal-positioning, bleeding, infection, pneumothorax, and hemothorax [2,3]. Ultrasound (U/S) guidance decreases, but does not eliminate, the risk of CVC mal-positioning [4,5]. As U/S guidance provides a limited field of view; mal-positioning can still occur. Here, we report the mal-positioning of a CVC that was inserted through and through a right internal jugular (IJ), and then transfixed the right subclavian artery (SCA). This resulted in right hemothorax and collapse of the lower lobe of the right lung. This case demon-strates that, even with the use of U/S guidance, CVCs can still be mal-positioned.

Case Presentation

A 52-year-old, 58kg female with a history of focal segmental glomerulosclerosis and end-stage renal disease was admitted for directed donor kidney transplantation. The patient had no known drug allergies, a creatinine of 9.1mg/dl and good cardiac function. The patient was anuric and underwent haemodialysis three times a week. The patient's past medical history was significant for hypertension and obstructive sleep apnea.

At the time of surgery, after induction of general anaesthesia, a right-sided CVC was inserted into the IJ using U/S guidance. The needle was observed entering the IJ and subsequent wire and catheter insertion were uncomplicated. The CVC was then visualized in the IJ with U/S. After placement, a normal CVP tracing was seen, but there was an inability to withdraw blood from the catheter. Therefore, the catheter was left in place, but not used during the sur-gery. The surgery proceeded without difficulty and the patient was extubated at the end of the procedure.

Investigations

Following the procedure, a chest radiograph was done to check CVC placement. At that time, the CVC was noted to take an abnormal course through the neck. There was also widening of the mediastinum and a pleural effusion was seen. Clearly the CVL was Mal-positioned, however prior to removal, the definitive course of the catheter needed to be determined to prevent further bleeding and/or lung collapse. Computerized tomography (CT) scan was recom-mended. The catheter was left in place and subsequent CT without contrast revealed that the CVC travelled from the right neck into the posterior portion of the right pleura. This was associated with a large right haemothorax and partial right lung collapse. The patient remained stable overnight in the intensive care unit.

On post-operative day (POD) one, thoracic surgery was consulted and recommended computed tomography (CT) of the chest with contrast to determine the course of the CVL and source of bleeding. As the patient was stable, they also recommended interventional radiology (IR) intervention, if possible, to stop the bleeding, prior to placement of a chest tube. The CT with contrast revealed that the CVC possibly transfixed the right SCA, resulting in the right haemothorax. (Figure 1) As no definitive diagnosis could be made based on the CT scan, angiography was recommended.

***Figure 1**. CT Angiogram showing catheter (long arrow) passing through SCA. Thyro-cervical trunk is also marked (short arrow)*

Treatment

On POD1, the patient was taken to the IR suite and angiography was performed. This study showed that the catheter transfixed the right SCA adjacent to the thryo-cervical trunk. The catheter was removed, a right SCA stent was placed, and the thryo-cervical trunk was embolized to prevent endoleak due to retrograde thryo-cervical trunk blood flow. A right-sided chest tube was then placed, resulting in 550ml of bloody output. The patient tolerated the procedure well

Outcome and Follow-Up

The patient had no further vascular issues. As the transplanted kidney was slow to function she remained in the hospital until POD 25, at which time she was discharged to home.

Discussion

Complications resulting from CVC placement are not rare. These include mal-positioning and resulting hemothorax, as occurred in this case. Several potential mechanisms of this injury have been proposed: failure to keep the tip of the needle in the U/S field of view, excessive insertion of the dilator resulting in arterial puncture, or excessive back-and-forth movements of the needle and/or dilator resulting in arterial puncture [6,7].

This case differs from previously reported cases as U/S guidance was used for placement and demonstrated the line in the IJ. In addition, transduction of the CVC resulted in a CVP waveform being seen on the monitor. Despite this, no blood could be drawn from the catheter and the line was not used. Chest radiography done postoperatively, showed that the line was mal-positioned. This was confirmed with CT scans and angiography.

To reduce complications and ensure appropriate placement of the catheter, several techniques have been suggested. [8]. The use of U/S guidance improves the safety and success of CVC insertion and therefore is often standard of care, but as it presents a limited field of view, it does not prevent mal-positioning or vascular perforation outside the field of view [9]. If the needle tip exits the field of view, complications can easily occur. Resistance during CVC insertion, poor blood aspiration after insertion, and abnormal waveform with transduction, are all signs that a CVC may be mal-positioned [10].

In this case, there was a through and through IJ puncture missed on U/S. The needle tip then presumably exited the U/S field of view and transfixed the SCA and entered the pleura. Despite the fact that a CVP like waveform was seen, the CVC was in the pleura. Intra-thoracic pressure waveforms can be similar to CVP waveforms, especially with positive pressure ventilation [11]. Esophageal pressure waveforms are a representation of intra-thoracic wave-forms and can be very similar to CVP waveforms.

When placing a CVC, there needs to be a high index of suspicion that the catheter is mal-positioned when the cathe-ter is not fully functional immediately after insertion. In this case, the failure to draw back blood easily from the catheter, was an indication that something was wrong. Despite the fact that an U/S was used for placement and a CVP waveform was seen.

In addition to radiography, there are other tests that can be done in an OR setting to determine if a CVC is in the right position. If blood can be drawn from the catheter, the color of the blood in comparison to a known arterial sample can be used. If the CVC is in an artery, the blood should be bright red. If the CVC is in a vein, the blood should be darker [12]. Blood gases can also be done to compare the pO2 of the two samples [13]. Remember that in an anesthetized patient with a high FiO2, the pO2 may be high and the sample will still be venous. This is why it is important to compare to a known arterial sample. If blood can be drawn from the catheter, a "drop test" can be done to determine if the catheter is venous or not. If blood in a 12-inch extension tubing connected to the catheter drops when the end of the tubing is open to air and significantly above heart level, the catheter is most likely venous. If it rises, the catheter is most likely arterial. Keep in mind, venous blood may rise if the patient has an elevated CVP, severe tricuspid regurgitation or an atrial or ventricular septal defect [14].

In summary, the use of U/S guidance does not preclude or prevent complications with CVC placement. One must have a high index of suspicion that a catheter is mal-positioned when there is failure to withdraw blood or other failure of a newly placed catheter. In this case, chest radiography, especially PA and lateral in the erect position, CT scan with contrast and angiography should provide confirmation of CVC placement and/or mal-positioning [14]. In this particular patient's case, the failure to draw back blood led the providers to suspect something was wrong and to not use the catheter. Further investigation resulted in the discovery of an arterial injury and the need for IR diagnosis and treatment.

Learning Points/Take Home Messages

- The use of ultrasound guidance in placing a central venous line, while very helpful, does not ensure that there will be no complications with line placement.
- Even with the use of ultrasound guidance, any abnormality in initial central line function, should lead to a high index of suspicion that the line is mal-positioned.
- If there is a concern that a central line is mal-positioned, it should not be used until correct positioning can be confirmed or ruled out.
- One test may not be sufficient to determine correct central line positioning or mal-positioning.
- If a central line is mal-positioned, other services may need to be consulted to remedy the situation. Lines should not be immediately pulled; this may result in increased harm to the patient.

Author's Contributions

- Chen-Carrington, MPH MBA, Ping-An: this author drafted the case report, made edits, and prepared the manu-script for submission
- Vincent MD, Anita: this author was involved in the placement of the central line as well as reviewed and edited the case report
- Pla MD, Raymond: this author reviewed and edited the case report
- Parr, K. Gage, MD FASA,: this author reviewed and edited the case report

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Rec: 18 Apr 2021; **Acc**: 04 May 2021; **Pub**: 07 May 2021

Anesth Periop Med. 2021;1(1):102
DOI: 10.36879/APM.2021.000102