Hydrothorax After Retraction of a Subclavian Central Venous Catheter

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Introduction

Central venous catheters (CVCs) are frequently used in intensive care patients. However, their use is associated with mechanical and infectious complications. Most mechanical complications arise during insertion, rarely while the catheter is in situ or upon its removal.[1] The most frequent mechanical complications, arising mostly at the time of venopuncture or shortly after, are arterial malpuncture, malpositioning, hematoma, and pneumothorax. They occur in 5–19% of all cases.[2] Ipsilateral pleural effusions due to catheter misplacement, dislocation, or vessel wall penetration of the catheter tip can occur during placement or while the catheter is in situ. It has been suggested that the risk of these kinds of mechanical problems is increased if stiff catheter material is used.[1] Here we report the case of a unilateral hydrothorax caused by a partially retracted catheter.

Case Summary

A 70-year-old female patient was admitted to the ICU after coronary artery bypass surgery. The postoperative ICU stay was complicated by septic shock because of a ventilator-associated pneumonia and acute renal failure. The patient was tracheostomized on postoperative day 6. Additionally, the patient developed intestinal bleeding due to diverticulitis, and total parenteral nutrition (TPN) was started.

On ICU day 40 a 5-lumen CVC (Quinto S1220, B Braun Melsungen, Melsungen, Germany, 20 cm) was inserted into the right subclavian vein to replace a previously inserted right internal jugular catheter. Neither arterial malpuncture nor air aspiration was noted at the time of insertion. The catheter was sutured to the skin near the puncture site, using the manufacturer's locking system. The postprocedure chest x-ray showed a correct position of the catheter in the superior vena cava (Fig. 1A).

No problems were reported thereafter regarding the catheter. The distal lumen was continuously used for central venous pressure monitoring, and the other lumens were used for TPN and administration of medications and catecholamines. The next day the patient was transferred into the operating room for wound debridement. About 12 hours after readmission to the ICU we noted a successive CO_2-retention in the patient's arterial blood gases. This corresponded to decreasing tidal volumes in the pressure controlled ventilation of the patient over that time. Also lung recruitment maneuvers and an increase of PEEP did not improve pulmonary function substantially.

At the same time, despite increased volume administration, increased norepinephrine dosing was required to maintain an adequate mean arterial pressure. Physical examination was not suggestive at that time, since breath sounds were difficult to detect at any time during the ICU stay, due to morbid obesity of the patient. An emergency bedside chest x-ray was performed, which showed nearly complete opacity of the right hemithorax; a retraction of the CVC by about 2 cm, compared to the previous chest x-ray, was noted (see Fig. 1B). Bedside ultrasonography showed a massive pleural effusion, which was immediately drained by a chest tube, and 2.8 L of white, milky fluid was drained.

At this time the CVC still showed an immediate and unlimited backflow of blood through all distal lumens. Only through the most proximal lumen no aspiration of

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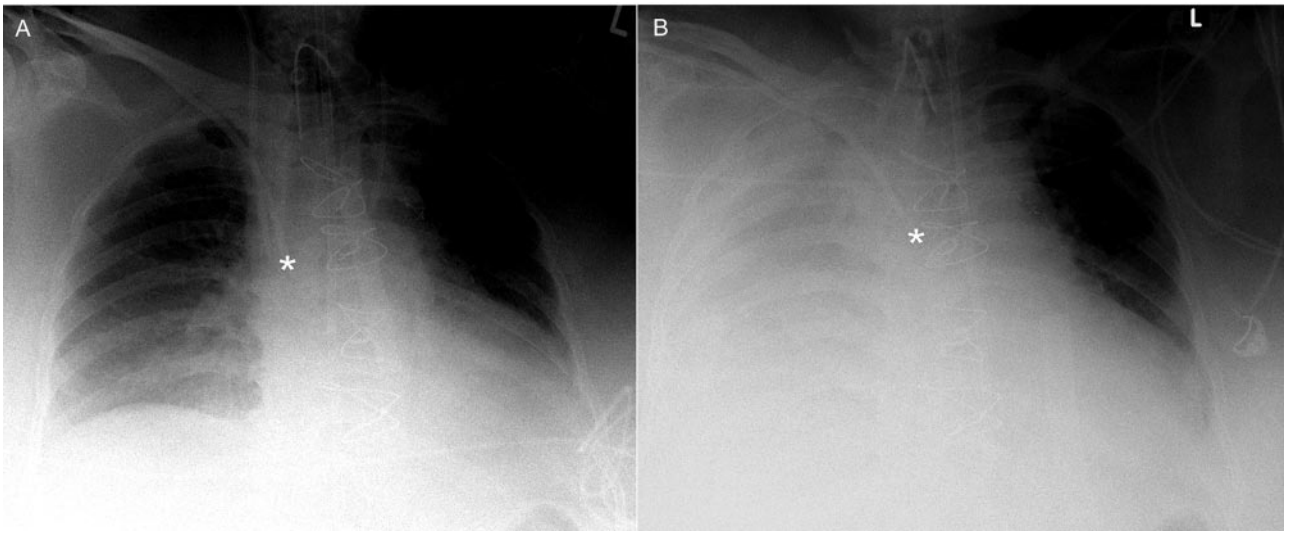

Fig. 1. A: Initial anterior-posterior chest x-ray in supine position. The central venous lines project in correct position on the superior vena cava. No pneumothorax or relevant pleural effusion can be found. Additionally, the tracheostomy tube and nasal tube can be seen. B: Follow-up chest x-ray after respiratory deterioration, showing progressive opacity of the right hemithorax. The tip of the central venous catheter inserted via the right subclavian vein is retracted, compared to the previous chest x-ray.

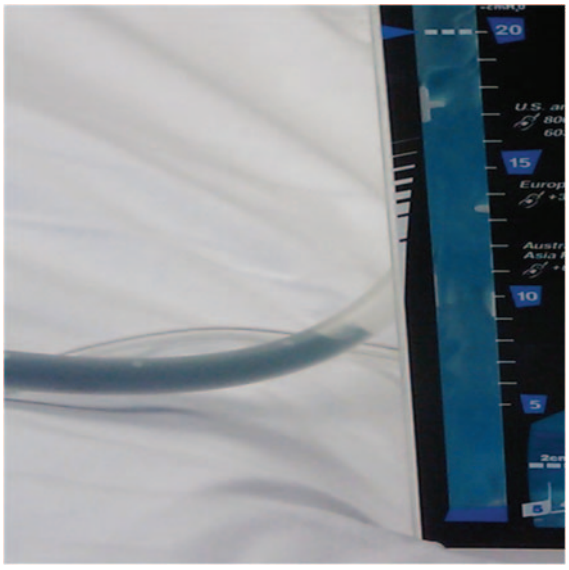

Fig. 2. Chest drainage tube with methylene blue stained pleural effusion.

blood was possible. After injection of 5 mL methylene blue via the proximal lumen of the catheter, the fluid drained through the chest tube turned blue immediately (Fig. 2). Concluding that at least this one lumen was communicating with the interpleural space, we decided to insert a new CVC to secure catecholamine therapy prior to further diagnostic workup, and since renal function had further declined overnight, we inserted both a 3-lumen CVC as well as a dialysis catheter via the right internal jugular vein at the same time. However, hemodynamics of this post cardiac surgery patient stayed unstable. Furthermore, it was impossible to rule out concomitant complications like intramediastinal or pericardial fluid, or a ventral pneumothorax, clinically or by ultrasound, due to the patient's massive obesity.

Therefore, a computed tomography (CT) scan with a single shot of contrast dye was performed to rapidly detect any potential damages to the main intrathoracal vessels. This scan also elucidated the exact location of the catheter. The CT scan showed the most proximal lumen of the right subclavian catheter ending in the perivascular tissue, whereas all other lumens were located in the vessel (Fig. 3). The fluid given over the proximal lumen had found its way into the pleural space, leading to the massive hydrothorax.

Discussion

This is a case of an ipsilateral hydrothorax induced by accidental retraction of a CVC. There are multiple ways in which a CVC can be dislocated. Despite the advances in the design, material, and technique of insertion of the catheter, there are several reports in the literature describing secondary perforation of the catheter tip through the vessel wall, causing paravenous infusion or bleeding into the pleural cavity or the mediastinum.[3-6] There are several reports also describing bilateral hydrothoraxes, with or without an additional hydromediastinum after the catheter had perforated the vessel wall.[7,8] Accidental retraction of CVCs are quite common in ICU patients; however, to our knowledge only one case has been reported in the literature in which an accidental retraction of a CVC might have led to a hydrothorax. However, the authors could not prove

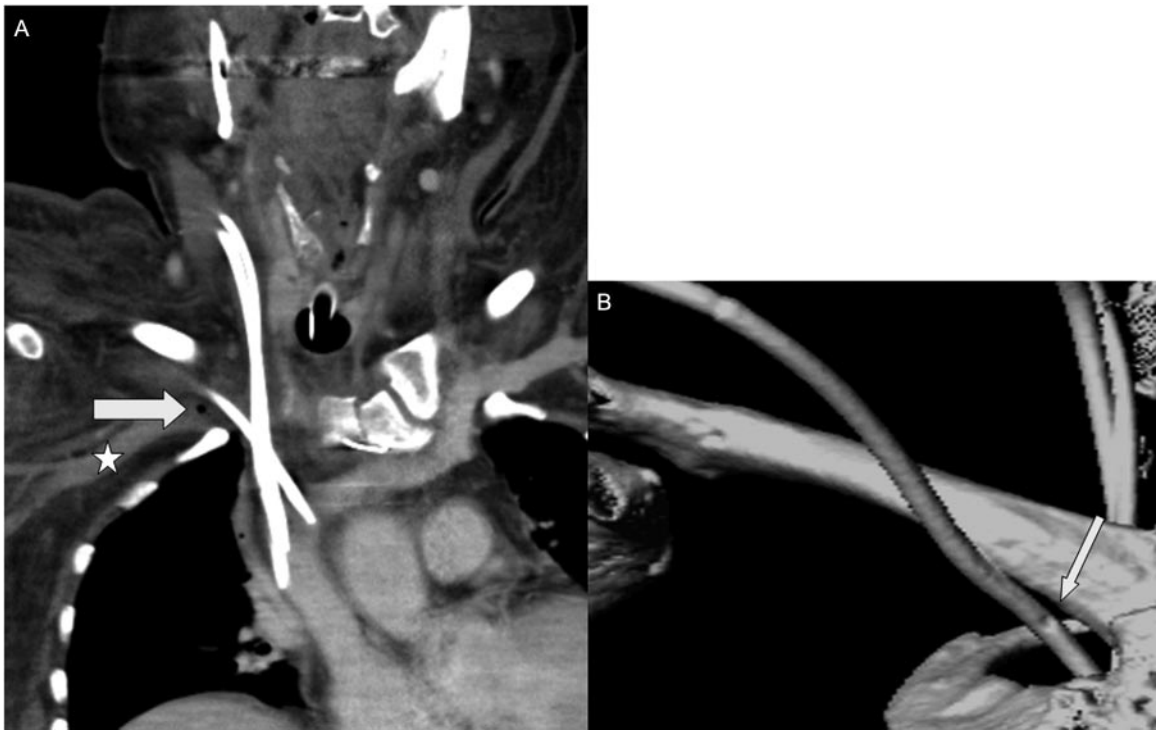

Fig. 3. A: Curved multi-planar average reconstruction (1.8 mm slice thickness, WL 210 WW 610) of a multi-slice computed tomography data set (Aquillion 64, Toshiba Medical Systems, Tustin, California), 2 min after bolus injection of 100 mL iobitridol). The right subclavian vein is marked with an asterisk. At the insertion point of the central venous line into the right subclavian vein an air bubble (solid arrow) and lack of a contrast filled vessel identifies the extravasation injury. B: Shaded surface reconstruction of the insertion point, which shows the proximal lumen of the catheter placed anteriorly in front of the right clavicle outside the venous vessel (solid arrow).

their hypothesis about the origin of the hydrothorax, since only plain chest x-ray was available.[9] In the case reported here we were able to detect both the dislocation of the proximal lumen (over which TPN was given) in the perivascular tissue, as well as the extravasation on CT scans, proving the pathomechanism of the hydrothorax.

In our ICU all lumens of CVCs except the catecholamine lumen are checked daily for a backflow of blood. However, this patient was transferred to the operating room in the afternoon, with the subsequent need to be transferred from the ICU bed to the operating room table and back, as well as multiple position changes. The catheter was used intraoperatively without any evidence for infusion problems. Back in the ICU it was not checked for backflow again; however, the distal lumen showed a proper central venous pressure curve at all times.

As in our case, hydrothorax in ventilated patients usually presents with a progressively worsening respiratory function and should always be in the differential diagnosis of a rapidly progressive pleural effusion detected on chest x-ray. In our case white, milky fluid that was drained from the chest tube narrowed the differential diagnosis of the underlying pathology. One potential reason for this effusion would be damage of the thoracic duct that drains into the left venous angle, usually projecting to the transverse process of the 6th or 7th cervical vertebrae. However, this happens predominantly with catheters that are placed into the left subclavian vein.[10] Effusions caused by chronic pleuritis or pleural empyema are clear or yellowish and usually do not progress that rapidly. Right sided, white, milky pleural effusion is highly suggestive for paravenous infusion of TPN or propofol. There are few reports of paravenous infusion of TPN into the pleural cavity, and most of them are associated with punctures of the internal jugular veins, predominantly on the left side.[5,7,11]

To discriminate between a chylothorax and a hydrothorax caused by a paravenous infusion, some authors recommended chemical analysis of that fluid.[7,8] Also, comparing blood and fluid glucose, especially when the effusion is suspected to be TPN, is an option of narrowing the diagnosis. We used a quicker "bedside test" using methylene blue injection over the suspected proximal lumen, over which TPN had been administered. Methylene blue is an injectable drug that inhibits guanylate cyclase and has been used to treat cyanide poisoning and to lower levels of methemoglobin. We used it because of its distinct blue color and the few side effects. Suspecting partial retraction of the CVC into the pleural cavity, methylene blue can be consecutively applied via the different lumens of the catheter to detect the lumen that is located extravascular. We

were able to show that the suspected most proximal lumen had access to the pleural cavity: the drainage from the chest tube turned blue within seconds.

Teaching Points

- Most mechanical complications of CVCs arise during placement; however, ICU staff must be aware that potential life threatening complications because of catheter migration can occur at any time.
- Damaging the pleura without violating the lung itself is a possible mechanical complication of CVC insertion. This can lead to pleural effusions without causing a pneumothorax.
- When reviewing chest x-rays of ventilated patients and comparing them to previous ones, ICU physicians should keep an eye on potential changes of line positions.
- Regular checks of the most distal and proximal lumens of the CVC for backflow of blood should be performed, especially after any transfer of the patient or any traction on the CVC. Inability to draw blood through one of those lumens as well as newly developing respiratory problems in patients with CVCs in place should lead to a prompt diagnostic workup. Especially in unresponsive, ventilated patients, an emergency chest x-ray should be performed to exclude major pulmonary pathology.
- In case of a hydrothorax with a chest tube in place, application of a bolus of methylene blue via the suspected catheter port might rapidly prove the catheter migration and the diagnosis of a hydrothorax.

REFERENCES

1. Polderman KH, Girbes ARJ. Central venous catheter use. Part 1: mechanical complications. Intensive Care Med 2002;28(1):1-17.
2. McGee DC, Gould MK. Preventing complications of central venous catheterization. N Engl J Med 2003;348(12):1123-1233.
3. Bach A. Complications of central venous catheterization. Chest 1993; 104(2):654-655.
4. Kunizawa A, Fuijoka M, Mink S, Keller E. Central venous catheter-induced delayed hydrothorax via progressive erosion of central venous wall. Minerva Anestesiol 2010;76(10):868-871.
5. Walshe C, Phelan D, Bourke J, Buggy D. Vascular erosion by central venous catheters used for total parenteral nutrition. Intensive Care Med 2007;33(3):534-537.
6. Duntley P, Siever J, Korwes ML, Harpel K, Heffner JE. Vascular erosion by central venous catheters. Clinical features and outcome. Chest 1992;101(6):1633-1638.
7. Paw HG. Bilateral pleural effusions: unexpected complication after left internal jugular venous catheterization for total parenteral nutrition. Br J Anaesth 2002;89(4):647-650.
8. Wildenauer R, Kobbe P, Waydhas C. [Bilateral hydrothorax and hydromediastinum after puncture of the right subclavian vein]. Unfallchirurg 2009;112(1):81-83. *Article in German.*
9. Maisniemi KJ, Koljonen vs Tension hydrothorax induced by central venous catheter migration in a patient with burns. Br J Anaesth 2006;97(3):423-427.
10. Schummer W, Schummer C, Hoffmann E. Chylothorax after central venous catheterization. Considerations to anatomy, differential diagnosis and therapy. Anaesthesist 2003;52(10):919-924.
11. Lee EK. An unexpected left hydrothorax after left internal jugular venous catheterisation for total parental nutrition and antibiotics. Ann Acad Med 2006;35(10):742-744.