

Management of venous perforation during central venous catheterization in hemodialysis patients

Three case reports

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Abstract

Rationale: In recent years, central venous catheterization (CVC) has become widely used for hemodialysis patients. Based on 3 cases, we discussed the detection and management of venous perforation at an early stage.

Patients concerns: Patients 1 (male, 77 years), 2 (male, 82 years), and 3 (male, 30 years) were diagnosed with uremia and underwent hemodialysis.

Diagnoses: Computed tomography suggested pneumomediastinum in patient 1 and pneumothorax in patient 2 after a replacement of the temporary hemodialysis catheter. In patient 3, X-ray suggested that the tip of the catheter was approximately at the plane of the fifth thoracic vertebrae after the temporary catheter was placed.

Interventions: In patients 1 and 2, the catheters were maintained where they were for about 2 weeks until a false lumen formed outside the catheter. In patient 3, the catheter was withdrawn at once when vein perforation was observed.

Outcome: In patients 1 and 2, the catheters were adjusted successfully under digital subtraction angiography (DSA) guidance 2 weeks later. In patient 3, hemothorax developed, and a total of approximately 1000 mL of bloody fluid was drained.

Lessons: When venous perforation occurs during CVC, it is safer and more reliable to adjust or withdraw the catheter under DSA guidance after a false lumen forms outside the catheter.

Abbreviations: CVC = central venous catheterization; DSA = digital subtraction angiography.

Keywords: central venous catheterization, complication, digital subtraction angiography, venous perforation

1. Introduction

Hemodialysis catheters are one method of vascular accesses for hemodialysis patients and have 2 types: temporary (non-tunneled catheter) and long term (tunneled cuffed catheter).^[1] Central venous catheterization (CVC) is an invasive operation. With the wide use of imaging equipment, particularly the ultrasound-guided puncture technique, the incidence of the complications has

been reduced dramatically.^[2] However, accidents involving the catheter piercing through the central vein into the pleural cavity or mediastinum still occur; thus, we discuss the detection and management of such accidents at an early stage based on three cases. Informed written consent was obtained from the patients for the publication of this case report and accompanying images, and the study design was approved by the appropriate ethics review board.

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2. Case reports

2.1. Case 1

Patient 1 (male, 77 years) was diagnosed with uremia and was emergently treated with hemodialysis by placing temporary hemodialysis catheter (Bard, Salt Lake City, UT) in the right jugular vein. After 1 week, the temporary catheter was replaced with hemodialysis tunneled cuffed catheter (Bard). During the operation, the temporary catheter was removed after a guidewire was inserted through the venous lumen of the temporary catheter. Dilators were used for gradual dilation. Obstruction was encountered when the splittable sheath was inserted into the vein for about 5 cm. Then, a medium-sized dilator, together with the splittable sheath, was pushed until the splittable sheath entered the vein totally. Then, the tunneled cuffed catheter was placed. No blood could be drawn from either lumen of the catheter. The patient underwent emergency computed tomography (CT), which showed that the tip of the catheter pierced into the mediastinum and pneumomediastinum was observed (Fig. 1A).

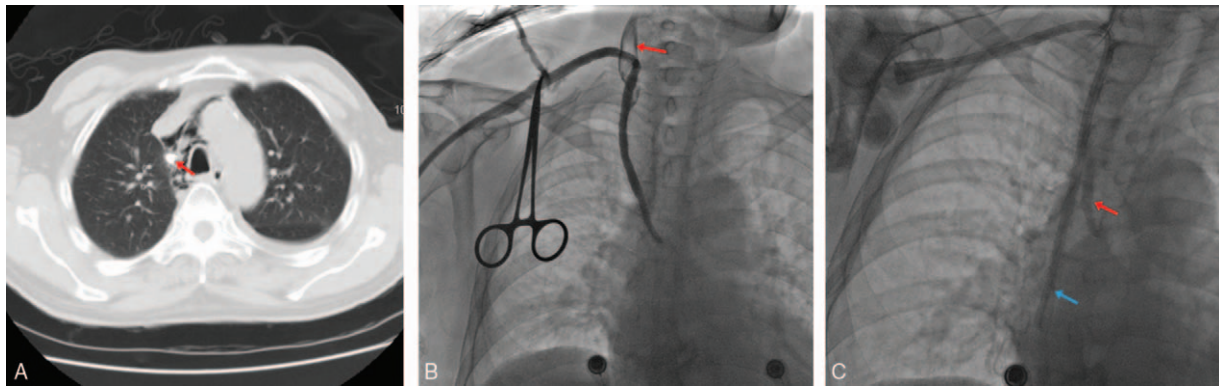


Figure 1. Patient 1. A. Computed tomography showed that the tip of the catheter (red arrow) pierced into the mediastinum and pneumomediastinum was observed. B. Under digital subtraction angiography (DSA), iodixanol was injected through the venous lumen of the catheter, flowed into a false lumen, and soon returned to the right internal jugular vein (red arrow). C. Under DSA, the tip of the tunneled cuffed catheter (blue arrow) was placed in the right atrium following a guidewire (red arrow shows the false lumen).

The catheter was maintained where it was, and the patient underwent hemodialysis through a temporary catheter into the femoral vein. Two weeks later, the patient underwent operation performed under digital subtraction angiography (DSA). The contrast agent iodixanol (GE Healthcare, Chicago, IL) was injected through the venous lumen of the catheter. The contrast agent flowed into the false lumen and soon returned to the right internal jugular vein (Fig. 1B), confirming the formation of the false lumen. A 0.035-in (0.89-mm) stiff wire (Terumo, Hanoi, Vietnam) was inserted through the venous lumen, and the catheter was pulled back gradually to the position where the contrast agent flew backward. Iodixanol was used again which revealed a stenosis in the right jugular vein and many types of collateral at the entrance of the vein. Then the stiff wire was inserted smoothly into the superior vena cava, right atrium, and inferior vena cava, and the tunneled cuffed catheter was adjusted properly following the stiff wire. Dark red blood smoothly flowed in and out of the 2 lumens, and the tip of the catheter was seen in the right atrium under DSA (Fig. 1C).

2.2. Case 2

Patient 2 (male, 82 years) was diagnosed with uremia, his temporary catheter was replaced with hemodialysis tunneled cuffed catheter after 1 week of hemodialysis. During the operation, obstruction was encountered when the splittable sheath was inserted initially. Then, the splittable sheath was pushed forcibly until the sheath entered the vein totally, and the catheter was placed. Dark red blood could only be drawn from the arterial lumen. The patient underwent CT, which showed that the catheter pierced into the right pleural cavity at the plane below the clavicle. Pneumothorax was observed in the right thoracic cavity.

Like patient 1, the patient’s catheter was maintained for 2 weeks, and then he underwent operation guided by DSA. After conforming a false lumen was formed (Fig. 2A), a 0.035-in stiff wire was inserted through the venous lumen, and the tunneled cuffed catheter was pulled back gradually to the position where the contrast agent flew backward. Then the catheter was inserted smoothly into the superior vena cava following the stiff wire. Dark red blood smoothly flowed in and out of the two lumens, and the tip of the catheter was seen in the right atrium under DSA

(Fig. 2B). The patient’s postoperative recovery was uneventful, and underwent hemodialysis until now.

2.3. Case 3

Patient 3 (male, 30 years) was diagnosed with uremia and hyperkalemia and underwent emergency hemodialysis. After a temporary hemodialysis catheter was placed into the right jugular vein, no blood could be drawn from the catheter. Immediate X-ray suggested that the tip of the catheter was approximately at the plane of the fifth thoracic vertebrate. Temporary catheterization in the right femoral vein was performed for hemodialysis. The next day, under DSA, iodixanol was injected through the venous lumen of the catheter. The contrast agent diffused in the extravascular tissue (Fig. 3), and the catheter was withdrawn at once. Gradually, the patient’s right pleural effusion increased and the right lung became blurred. Thoracic puncturing drainage was

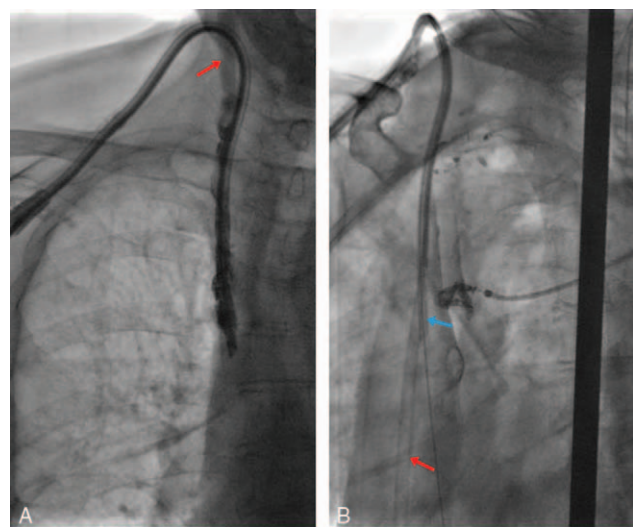


Figure 2. Patient 2. A. Under digital subtraction angiography (DSA), iodixanol was flowing into a false lumen and soon returned to the right internal jugular vein (red arrow). B. Under lateral DSA, the tunneled cuffed catheter (blue arrow) was inserted into the superior vena cava, and a false lumen (red arrow) was observed.

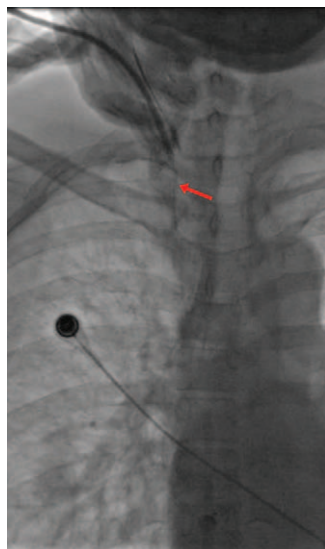


Figure 3. Patient 3. Iodixanol was injected through the temporary hemodialysis catheter and diffused in the extravascular tissue (red arrow).

performed immediately for the right thoracic cavity, and 100 mL of bloody fluid was drained. The drainage tube was withdrawn 7 days later, when no more fluid was draining, and a total of approximately 1000 mL bloody fluid was drained. The patient received transfusion. After that, the patient was treated with peritoneal dialysis.

3. Discussion

Complications of central venous catheterization include pneumothorax, arterial perforation, mediastinal hematoma, hemothorax, and so on.^[3,4] Owing to the lack of medical resource, performing hemodialysis catheterization under DSA is impractical in China currently. Real-time ultrasound guidance of the placement of the hemodialysis catheter can reduce the incidence of these complications.^[5,6] However, the central vein below the clavicular plane could not be imaged. Hence, accidental piercing of the pleural cavity or mediastinum by the catheter still occurs. In our study, when poor blood drawing after catheterization was encountered and the possibility of catheter bending was ruled out, the possibility of the catheter entering the pleural cavity or mediastinum was considered, and chest CT was conducted immediately to determine the position of the catheter tip, as previous studies suggested, because chest X-ray could not accurately show the position of the catheter tip.^[7,8]

Accidental vein perforation or injury to adjacent structures often results in catastrophic results, even death, and usually these patients were treated with embolization, spring coil or stent graft blocking, thoracoscopy, or open heart surgery.^[7,9–13] In our study, when venous perforation was confirmed in patients 1 and 2, the catheter was maintained for 2 weeks and then adjusted under DSA guidance after the false lumen outside the catheter formed, and both patients underwent uneventful hemodialysis later. When the catheter was withdrawn immediately after venous perforation was confirmed in patient 3, massive hemorrhage and hemothorax occurred. Based on the treatment procedures and outcome of our cases, we recommended that the catheter should not be pulled out when vein perforation was

confirmed; it is better to adjust or withdraws the catheter under DSA guidance after a false lumen outside the catheter.

However, this study has its limitations. First, only a small number of patients have been treated with this method; therefore, it is possible that rare situations may not have been observed in our study. Since the complication is rare, a prospective study with multicenter data is needed in the future. Second, our therapy is not suitable for patients with unstable vital signs, atrial perforation or cardiac arrest, as resuscitation and emergency surgery are needed in such situations.

In conclusion, when venous perforation occurs during central venous catheterization, it is safer and more reliable to adjust or withdraw the catheter under DSA guidance after a false lumen forms outside the catheter.

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