Case Report

Journal of INTERNATIONAL MEDICAL RESEARCH

Journal of International Medical Research
2019, Vol. 47(6) 2702–2708

DOI: 10.1177/0300060519843686
journals.sagepub.com/home/imr
SAGE

Therapeutic strategy of central vein perforation accompanied by a mediastinal lesion after catheterization

Chi-Chang Li, Wei Zhang, Xing-Jie Wu, Yang Bu and Zhi-Peng Zheng

Abstract

Central vein perforation associated with a mediastinal lesion is a rare complication of catheterization. A 50-year-old woman was diagnosed with chronic kidney disease and required hemodialysis treatment. The patient developed central vein injury during attempted placement of a double-channel catheter. A computed tomographic scan and venography showed that the catheter had punctured the mediastinum from the central vein. After comprehensive assessment and multidisciplinary consultation, percutaneous catheter thrombin injection with follow-up balloon dilatation under fluoroscopy guidance successfully fixed the perforation. We summarize the therapeutic strategy of this complication and other treatment options, and discuss the related literature of central vein injury.

Keywords

Catheterization, central vein injury, thrombin, mediastinum, hemodialysis, kidney disease, hemorrhage

Date received: 14 September 2018; accepted: 28 January 2019

Introduction

Central vein perforation accompanied by a mediastinal lesion is a rare complication of catheterization. This situation may lead to a large hematoma of the mediastinum. We report here an unusual case of a 50-year-old woman who developed brachiocephalic

Cardiovascular Department, The First Affiliated Hospital of Guangdong Pharmaceutical University, Guangzhou, Guangdong, China

Corresponding author:
Wei Zhang, Cardiovascular Department, The First Affiliated Hospital of Guangdong Pharmaceutical University, Guangzhou, Guangdong 510080, China.
Email: zhangweitlyy@126.com

vein perforation after catheterization. By comparing different treatments of catheter-related blood vessel injury, we attempted to identify a less damaging and effective treatment. We discuss the therapeutic strategy of central vein perforation.

Case report

A 50-year-old woman was diagnosed with chronic kidney disease. An attempt was made to place a central venous catheter via the internal jugular vein with ultrasound guidance. A left-sided temporary double-channel hemodialysis catheter (Quintiles, Durham, NC, USA) was inserted by using the subclavian vein, but it did not work well. This may have been due to inability of the patient to cooperate because she shook her body repeatedly during the puncture process. After the procedure, the patient developed dyspnea and felt pain on the catheter insertion site. Oxygen inhalation was immediately supplied to the patient, and the hemodialysis catheter was secured in place and covered by a sterile dressing. Computed tomographic (CT) scans evaluated the upper mediastinal vascular structure. CT showed that the hemodialysis catheter had perforated the subclavian vein, and it terminated in the anterior mediastinum with pneumatosis and hemorrhage (Figure 1). However, the middle of the catheter and the left brachiocephalic vein were not clearly observed, and we could not determine if there was damage to the aorta.

To prevent hemorrhagic shock, the patient had a blood transfusion, and her hemoglobin level increased from a baseline level of 56 to 75 g/L. After consultation with an interventional team, the patient was taken to the interventional radiology room for a contrast examination. Angiography through the venous channel showed that the catheter tip was located in the mediastinum with patency of the left subclavian vein, and contrast agent had regurgitated to the left brachiocephalic vein. The arterial channel was unobstructed. Finally, angiography confirmed that the aorta was not damaged by the catheter.

This case was discussed among the multidisciplinary team and we designed the following therapeutic strategy. (1) Continued attempts to securely tie and tape the tube in place should be made. (2) Blood pressure

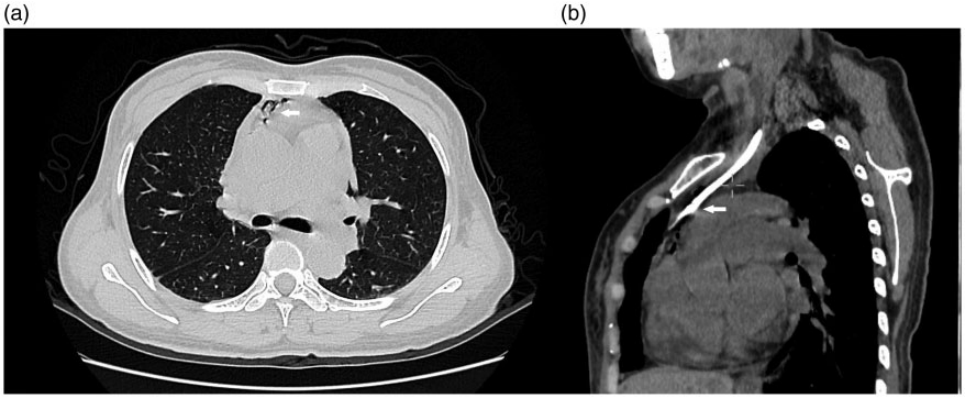

Figure 1. (a) Axial and (b) coronal computed tomographic images of the chest show the anterior mediastinum. There is a small amount of pneumomediastinum in the mediastinum, while the corresponding fat tissue is not clear. The lower part of the catheter (arrowhead) penetrates into the anterior superior mediastinum

should be controlled to reduce the probability of hemorrhage. (3) Regional heparinization should be performed in an indwelling catheter to reduce thrombosis. (4) Surgical options were not considered because of the unsuitable injury site and the patient suffered from hypoproteinemia with uremia. (5) Surgical planning was as follows: infuse with thrombin regionally through a percutaneous catheter to patch the perforation and simultaneously pull out the catheter; a balloon would be used for hemostasis if necessary. Thoracic surgery, anesthesiology, and blood transfusion were on standby for thoracotomy hemostasis if the patient developed acute hemorrhage.

Informed consent from the patient was obtained after explaining the steps, benefits, risks, and alternative of the procedure. Under fluoroscopic guidance, the guide wire was advanced into the channel of the hemodialysis catheter. When contrast agent was injected, slow flow accumulated in a false lumen, which was 2.2×7.64 cm, with delayed passage of the contrast to the main stream (Figure 2). Approximately 500 units of lyophilizing thrombin powder (Hacon Pharma, Hangzhou, China) and prothrombin complex (Hualan Biological Engineering, Inc., Henan, China), which contained thrombin 200 IU per 1 mL, were dissolved in 3 mL saline and injected into the false lumen through the catheter. This was performed with real-time fluoroscopy guidance until the contrast agent vanished in the false lumen, but was present in an anonymous vein. The catheter was pulled out after this procedure. A venogram of the left internal jugular vein was performed, which showed an approximately 8×7-mm thrombus in the plane of the brachiocephalic vein with a focal stenotic segment (Figure 3). A 16-mm balloon (MAXI LD 416-1640L LOT; Cordis, Miami, Florida, USA) was inserted along a guide wire into the brachiocephalic vein, and approximately four bars of pressure was pumped into the balloon catheter to compress the perforation. The signs of thrombosis and stenosis disappeared when angiography was repeated to assess the effect of the intervention and the degree of recanalization. After disinfection, the wound was compressed with a bandage and the patient was transferred to the intensive care unit for monitoring.

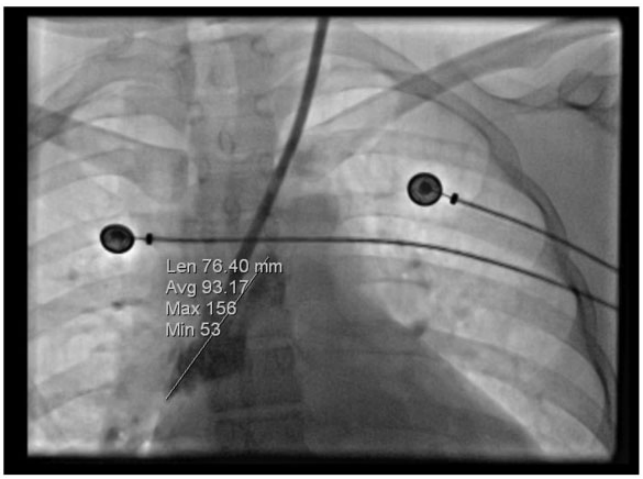

Figure 2. Angiography shows that the venous catheter tip is located in the mediastinum and a false lumen (arrowhead) is present in the interlayer of the left brachiocephalic veins (2.2×7.64 cm)

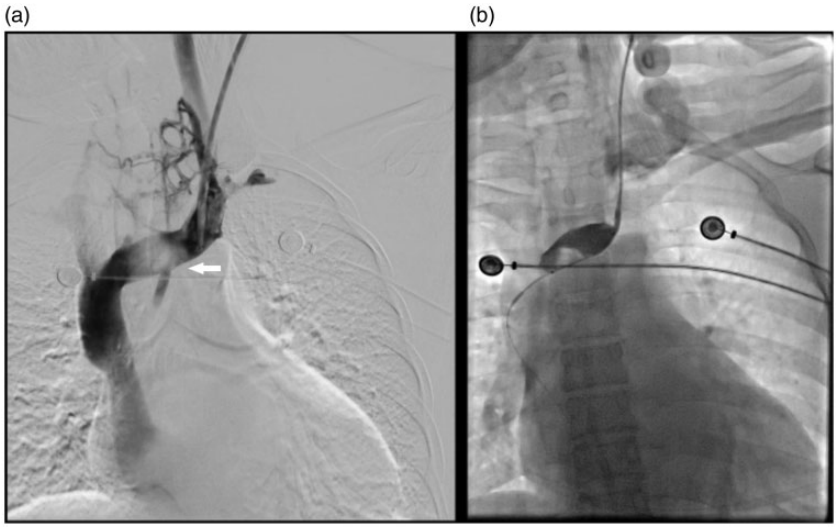

Figure 3. (a) Angiography shows (arrowhead) an 8 × 7-mm thrombus in the brachiocephalic vein with a focal stenotic segment. (b) Angiography show balloon dilatation for hemostasis by intravascular compression

Piperacillin-sulbactam was used for anti-infection and aggressive blood pressure-lowering therapy was applied after surgery. The patient's hemoglobin concentration dropped to 66 g/L with no symptoms or signs of persistent bleeding, which may have been due to dilution by a large amount of rehydration. Her hemoglobin was stabilized at 112 g/L after blood transfusion. Femoral vein puncture and catheterization were performed 1 day after surgery with no accidents. After hemodialysis and symptomatic treatment, the patient's edema, fatigue, and other symptoms had greatly improved.

The study protocol did not require approval by an ethics review committee. The patient signed informed consent.

Discussion

Central venous catheterization is a routine vascular intervention, but an improper operation can lead to a variety of complications. According to Kusminsky,[1] complications can be classified as secondary to insertion, indwelling, and extraction of catheters. Despite the difference in incidence of these complications, 4% of ultrasound-guided deep venous catheterization cases are estimated to be associated with complications. The incidence of complications based on experience and body surface markings can increase to 14.5%.[2] Pneumothorax and a misplaced catheter are the most common insertion complications. Other rare complications include carotid artery pseudoaneurysm,[3] thyroid neck stem injury, and puncture injury to the phrenic nerve[4] causing chylothorax[5] and pericardial tamponade.[6] Hematoma formation, arterial dissection, arteriovenous fistula, or pseudoaneurysm artery injury are termed catheter-related blood vessel injury. This type of injury generally presents as arteriovenous injury, but simply damaging the vein is rare. We report a case in which the catheter pushed through the brachiocephalic vein during deep venous catheterization and caused a mediastinal hematoma. We discuss the management strategy and treatment of this rare complication below.

Direct removal of a catheter can lead to a large hematoma of the mediastinum, without knowing if there is damage to an artery. This could cause compression of peripheral blood vessels, tracheal pressure, and pericardial tamponade because of loss of compression hemostasis of the catheter. According to other case reports of catheter injuries, despite different locations of the lesion, retention of the catheter is an important measure. A catheter provides a direct path for transcatheter angiography to determine injured blood vessels and activates the extrinsic coagulation pathway to close off lacerations. Exudation of fibrous protein occurs around the catheter, forming a false lumen. However, this also increases the risk of thromboembolism and venous obstruction. Regional heparinization in the indwelling catheter is necessary for reducing thrombosis. According to the guidelines on insertion and management of central venous access devices in adults,[7] removal should be undertaken by experienced personnel. The platelet count should be $>50 \times 10^9$/L and the international normalized ratio should be <1.5. Ideally, 12 hours should have elapsed after prophylactic low molecular weight heparin, and 18 hours after a therapeutic dose.

According to Ko et al.[8], patients with aneurysms and a mediastinal hematoma <5 cm in size may be treated conservatively under monitoring. However, if signs of instability are observed, emergency surgery should be performed in a timely manner. Afifi et al.[9] described an approach where sternotomy and cardiopulmonary bypass were used to allow for intraluminal repair of a huge venous aneurysm. Kuzniec et al.[10] reported the first case of videothoracoscopy-guided treatment for central venous perforation. Other surgical procedures for central venous reconstruction can be applied with a smaller incision or smaller sternotomy. However, because of the invasiveness of removing the first anterior rib and division of the pectoralis major to reveal the central vein, videothoracoscopy-guided treatment is still a limited option. In our case, the patient was intolerable to trauma of the thoracotomy because of suffering from anemia and uremia, and the cost of the operation was expensive.

Over the past few years, minimally invasive interventional treatments have partly replaced surgical repair of central vein injury. Choi et al.[11] used stent-assisted coiling to successfully eliminate a puncture-induced brachiocephalic venous pseudoaneurysm. However, the long-term implications of central venous stents are uncertain and have not been reported. In the venous system, stents easily fall off because of a lack of elasticity and a large lumen diameter. Blood flow is slower in the vein compared with the artery, and platelets tend to adhere to a stent after implantation to cause thrombosis. There have been two reports of percutaneous injection of thrombin with or without temporary balloon occlusion for cerebral protection to treat carotid artery injury.[12,13] These reports provided us with an idea for the subclavian vein injury. In our case, we injected thrombin into the interstitial space to seal the breakthrough of the hemodialysis tube. The absence of filters in surgery is due to their high cost, and the risk of embolism is still unknown and requires further evidence. In a prospective study, Schneider et al.[14] reported that embolic complications were highly infrequent, even though temporary balloon occlusion was rarely used during percutaneous thrombin injection of a femoral artery pseudoaneurysm. The amount of thrombin should be sufficient to seal the perforation until complete cessation of the contrast agent in the false lumen with real-time fluoroscopy or ultrasound guidance. However, an excess dose of thrombin may cause thrombosis. Balloon dilatation is used for hemostasis by intravascular

compression. The choice of the balloon and the pressure are based on the size of the venous cavity to ensure that the blood vessels can be fully compressed for hemostasis. In the present case, we performed thrombin injection with balloon dilatation, which successfully occluded the cavity and terminated the bleeding.

Conclusions

In the process of internal jugular venous catheterization, stabilization of the patient should be achieved as much as possible. Sedation can be used if necessary. Ultrasound-guided placement of the catheter can reduce the occurrence of complications from a puncture. Retaining and fixating the puncture tube when the puncture site and the risk of bleeding are not clear can provide a route for angiography to confirm the location of damage and to reduce secondary damage. Finally, thrombin injection with balloon dilatation is an effective and economical treatment for deep vein injury.

Authors' contributions

CCL designed the report and completed the manuscript. XJW operated on the patient and was responsible for the postoperative care. ZPZ consulted the relevant literature. WZ and YB revised the manuscript and WZ supervised all of the work. All authors read and approved the final manuscript.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ORCID iD

Wei Zhang https://orcid.org/0000-0001-5574-622X

References

1. Kusminsky RE. Complications of central venous catheterization. *J Am Coll Surg* 2007; 204: 681–696.
2. Sazdov D, Srceva MJ, Todorova ZN, et al. Comparative analysis of ultrasound guided central venous catheterization compared to blind catheterization. *Pril (Makedon Akad Nauk Umet Odd Med Nauki)* 2017; 38: 107–114.
3. Abdelhamid MF, Wall ML, Vohra RK, et al. Carotid artery pseudoaneurysm after carotid endarterectomy: case series and a review of the literature.*Vasc Endovascular Surg* 2009; 43: 571–577.
4. Shawyer A, Chippington S, Quyam S, et al. Phrenic nerve injury after image-guided insertion of a tunnelled right internal jugular central venous catheter. *Pediatr Radiol* 2012; 42: 875–877.
5. Jadhav AP, Stahlheber C, Hofmann H, et al. Traumatic chyle leak: a rare complication of left internal jugular venous cannulation. *Am J Med Sci* 2011; 341: 238–239.
6. dos Santos Modelli ME and Cavalcanti FB. Fatal cardiac tamponade associated with central venous catheter: a report of 2 cases diagnosed in autopsy. *Am J Forensic Med Pathol* 2014; 35: 26–28.
7. Bishop L, Dougherty L, Bodenham A, et al. Guidelines on the insertion and management of centralvenous access devices in adults. *Int J Lab Hematol* 2007; 29: 261–278.
8. Ko SF, Ng SH, Fang FM, et al. Left brachiocephalic vein perforation: computed tomographic features and treatment considerations. *Am J Emerg Med* 2007; 25: 1051–1056.
9. Afifi A, ElGuindy A, Farouk M, et al. Endoaneurysmorrhaphy of a giant aneurysm of the subclavian vein. *Glob Cardiol Sci Pract* 2012; 2012: 13.
10. Kuzniec S, Natal SR, Werebe Ede C, et al. Videothoracoscopic-guided management of a central vein perforation during

hemodialysis catheter placement. *J Vasc Surg* 2010; 52: 1354–1356.
11. Choi SJ, Do YW, Oh TH, et al. Central venous catheterization-induced right brachiocephalic vein pseudoaneurysm: successfully treated with stent-assisted coiling. *J Vasc Access* 2018; 19: 319–323.
12. Moller SM, Logason K, Karason S, et al. Percutaneous thrombin injection of common carotid artery pseudoaneurysm without cerebral protection. *Tex Heart Inst J* 2012; 39: 696–698.
13. Holder R, Hilton D, Martin J, et al. Percutaneous thrombin injection of carotid artery pseudoaneurysm. *J Endovasc Ther* 2002; 9: 25–28.
14. Schneider C, Malisius R, Küchler R, et al. A prospective study on ultrasound-guided percutaneous thrombin injection for treatment of iatrogenic post-catheterisation femoral pseudoaneurysms. *Int J Cardiol* 2009; 131: 356–361.