Received: 16 May 2022 | Revised: 10 September 2022 | Accepted: 16 January 2023

DOI: 10.1002/ccr3.6911

CASE REPORT

Clinical Case Reports Open Access WILEY

Potentially fatal atrium perforation due to right jugular vein catheterization recognized by venography: A case report

Fatemeh Jahanshahi[1,2] | **Amirhossein Parsaei**[3] | **Delaram Naderi**[4] | **Sam Zeraatian Nejad Davani**[5,6] | **Mohsen Khaleghian**[7]

[1]Faculty of Medicine, Iran University of Medical Science, Tehran, Iran

[2]Urology Research Center, Tehran University of Medical Sciences, Tehran, Iran

[3]School of Medicine, Tehran University of Medical Science, Tehran, Iran

[4]Allied Medical Sciences, Iran University of Medical Sciences, Tehran, Iran

[5]Rockingham Medical Research Center, ADKWA Medical, Perth, Western Australia, Australia

[6]Department of Cardiovascular Surgery and Faculty of Transplant and Organ Donation, Iran University of Medical Science, Tehran, Iran

[7]Department of Vascular Surgery, Iran University of Medical Science, Tehran, Iran

Correspondence
Sam Zeraatian Nejad Davani, Department of Vascular Surgery, Iran University of Medical Science, Rasool Akram Medical Complex, Niayesh St., Sattarkhan Ave., Tehran, Iran.
Email: s.zeraatiannejaddavani@gmail.com

Abstract

Central venous catheters are the prevalent path for dialysis. Our case was a 54-years-old male with a new case of end-stage renal disease with a complaint of right jugular hemodialysis catheter dysfunction. In our case, the early dysfunctional catheter should be evaluated with contrast studies to achieve accurate information.

KEYWORDS

central venous catheterization, chest x-ray, jugular vein, venography

1 | INTRODUCTION

Central venous catheters (CVC) are commonly employed for assessing hemodynamic variables, delivering fluids, medications, and blood products, providing total parenteral nutrition, and performing ongoing renal replacement treatment and hemodialysis.[1] CVC is the second most prevalent path for dialysis after fistula. It is estimated that about 20% of patients with end-stage renal disease receive central venous catheters for dialysis.[2] The incidence of perioperative venous catheterization complications is reported in up to 10% of all procedures, even for the most experienced clinicians.[3,4] There are early problems and late complications. Early problems occur during insertion or the first 24 h following insertion and are typically mechanical, including hemothorax, hydrothorax, and pneumothorax. Infections and thrombotic embolisms are the most prevalent late consequences, which develop after 24 h and are typically caused by the catheter's extended use.[5] Other reported complications include arrhythmias, hematoma, brachial plexus injury, and rarely cardiac perforation.[1] Although rare, cardiac perforations due to catheter insertion are highly lethal. Cardiac perforation may lead to life-threatening conditions such as pericarditis, bleeding, hematoma, and cardiac tamponade.[6] In the current study, we report a scarce 54 years old male case that

endured atrium perforation for over 1 month and then led to tamponade.

2 | CASE PRESENTATION

A 54-years-old male, as a new case of end-stage renal disease, was presented to the hospital with the complaint of right jugular hemodialysis catheter dysfunction. He explained that there was no sufficient extracorporeal blood flow for adequate hemodialysis from the beginning. He had no history of discharge, erythema, and tenderness of insertion site, chills, and fever. Moreover, in the examination, none of the mentioned symptoms was observed. According to the patient, the catheter was inserted with an ultrasound-guided procedure 4 weeks ago. At the patient arrival time, he was hemodynamically stable with blood pressure 125/75 mmHg, pulse rate 78/min. For further investigation, a chest x-ray (CXR) was requested. Both the control CXR of 4 weeks ago and requested CXR in this admission were normal (Figure 1). The patient underwent venography for more investigations. During venography, when contrast dye was injected into the catheter line, diffuse pericardial enhancement was observed which demonstrated the tip of the catheter perforated the right atrium and placed it into the pericardium (Video S1) (Figure 2). After venography, the patient experienced chest pain and discomfort, shortness of breath and dyspnea due to tamponade caused by injected contrast solution into the pericardium space. The patient underwent an emergency

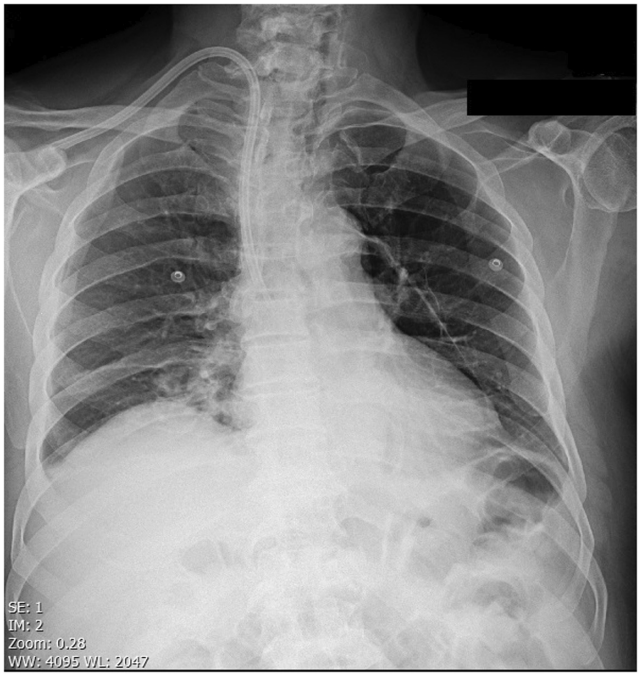

FIGURE 1 Requested posteroanterior CXR in the present admission.

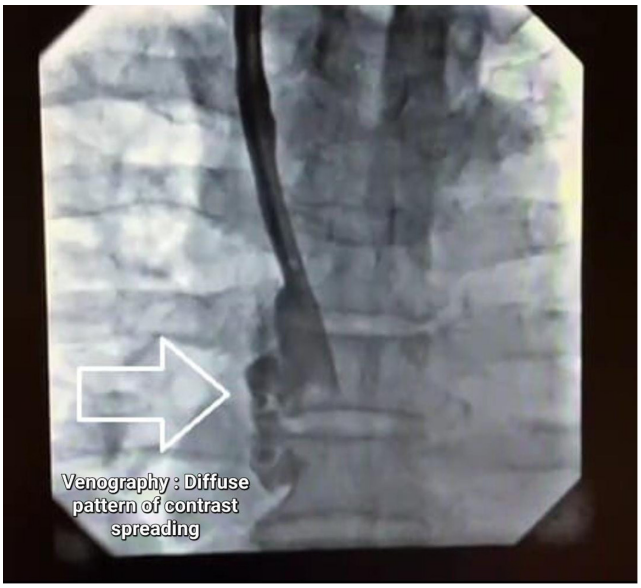

FIGURE 2 Venography with diffuse pattern of contrast spreading within pericardial space.

right thoracotomy in which the right atrium was explored and the tip of the catheter was found on the atrium wall. The perforation was repaired with a purse-string suture (Figure 3) and the catheter was fixed into the atrial cavity. He spent the postoperative course uneventfully and underwent hemodialysis with this access without any complication (Video S1 and S2).

3 | DISCUSSION AND CONCLUSION

Cardiac perforation is an uncommon yet severe consequence of CVC. The incidence ranges between 0.25 and 1.4%, and the fatality rate can reach as high as 85 percent. In total, 53% of diagnoses are made through postmortem examination, frequently correlated with a high mortality rate of 3.9%. The right atrium, right ventricle, and SVC are the most common perforation sites, with incidence rates of 43%, 27%, and 4%, respectively. It has been established that malposition of a central venous catheter is a substantial risk factor for cardiac and artery wall perforation. The theorized mechanism for these injuries is that the guide wire obtains lodged against the vascular wall, and the subsequent insertion of a dilator or catheter results in harm. As the catheter or dilator is advanced, the wire begins to "bend" and push against the vessel wall, potentially generating a linear laceration that is significantly greater (and potentially fatal) than a simple puncture. Chemical injuries and catheter migration are possible mechanisms.[7–9] In most adult patients, the current recommendation for inserting a central venous catheter via the subclavian or

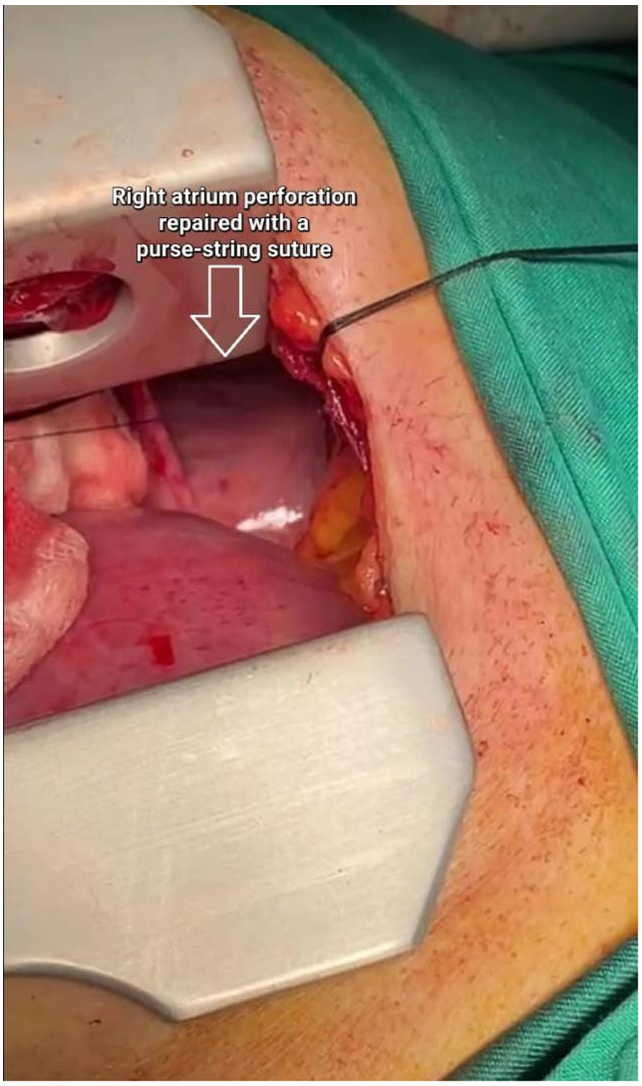

FIGURE 3 The perforation was repaired with a purse-string suture.

jugular veins is 20 cm for the left side and 16 cm for the right side. Other critical considerations include:

1. The kind and size of the catheter,
2. The catheter's angle concerning the vascular wall,
3. The osmolarity of the fluid being infused, and
4. Anatomical differences.

The erosion of the myocardial wall due to catheter malposition, catheter migration, and direct trauma during CVC are hypothesized as contributing mechanisms to perforations. In abrupt clinical deterioration, failure to include cardiac and vascular wall perforations as differential diagnoses may result in severe clinical repercussions, including death.[10–13] Cardiac perforation after central venous catheter placement occurs at a low rate, but it is highly life-threatening due to rapid bleeding, pericardial effusion, and cardiac tamponade. Complications related to cardiac perforation are usually followed by a rapid decline in the patient's condition and urge immediate action by the physicians.

In the current case, we assume that the perforation occurred during placement. The sharp tip of the guide wire might be responsible for the perforation, followed by occlusion of the gaping hole by the catheter, and finally, blockage of the bleeding. This process eventually precluded the accumulation of blood in the pericardium and subsequent cardiac tamponade. Vedran P. et al. reported a case of similar perforation due to central venous catheter placement for dialysis. The perforation was in the right atrial wall and led to pericardial effusion. Finally, the hole was closed spontaneously by forming scar tissue covering the epicardium. They explained that several factors might have contributed to the preclusion of bleeding and tamponade, including low central volume pressure due to dehydration, intensified dialysis, and insufficient hydration, resulting in decreased proper atrial pressure and reduced chance of bleeding.

Clinicians verify the correct placement of the catheter via chest radiographs. When the tip of the catheter is outside of the pericardial shadow or its silhouette, they should suspect perforation.[6] By this measure, our case had a normal control chest radiograph, and the perforation was missed. Repeated chest radiography can be performed due not to miss this case.[14]

Patients with cardiac tamponade (due to perforation) represent rapid unexplained hypotension, shortness of breath, chest pain and tightness, and air hunger within the first hour post-operation. But in our case, despite perforation of the atrium, the tip of the catheter was trapped in pericardial space, and no cardiac tamponade occurred. The symptoms remained silent until the hemodialysis sessions. The ineffective correction of hemodialysis parameters raised suspicion about catheter insufficiency. Only after venography was the perforation revealed to the physicians. Our case implies that the primary post-operative chest radiograph study might be misleading. Clinicians should be aware that angiographic studies can be lifesaving when the patient is free from signs of acute complications but fails to achieve hemodialysis adequacy.

CT diagnosed the presence of the catheter tip in the pericardial cavity.[7] Medical conditions like infectious pericarditis, acute myocardial infarction (Dressler's syndrome), congestive heart failure, uremia, inflammatory bowel disease, hypothyroidism, connective tissue disease, metastases, and drug side effects were ruled out as potential causes of subacute CT due to the lack of objective clinical, analytical, or imaging criteria supporting these possibilities.[15]

When the perforation is confirmed via imaging, clinicians should avoid manipulation or removal of the

misplaced catheter. The catheter itself acts as a barrier to bleeding, while the catheter removal might result in bleeding, cardiac tamponade, hematoma, and rapid deterioration of patient blood pressure and lead to more critical status. In the case of large-bore catheter penetrations, the caring team should consider aggressive monitoring and subsequent preparations for open thoracic surgery.[7]

Due to the specific situations in this case and the risk of massive bleeding and cardiac tamponade, the physicians chose open thoracic surgery over other non-invasive options. Vedran P et al. chose the non-invasive method using fluid administration and antibiotics use; in their case, the formation of scar tissue over the epicardium and spontaneous recovery from perforation eased the way toward a non-operative treatment. When physicians decide to use open surgery as the treatment, a precise plan is necessary for any bleeding or other complications during removal.

This article reported a case of right atrium perforation due to right jugular vein catheterization with a stable hemodynamic condition for almost a month that presented with just a complaint of catheter dysfunction. In this case, manipulating the catheter by opening the gaping hole blocked with the catheter tip could cause massive life-threatening pericardial hemorrhage. Furthermore, in early dysfunctional jugular vein access, even with normal chest x-ray, contrast studies before blind replacement of catheter and after replacement series imaging and venography for dysfunctional catheter are recommended to prevent fatal accidents as we saw in this case, such complications like atrium perforation can be asymptomatic and dysfunctional catheter could be its sign and considering it as a vital sign.

AUTHOR CONTRIBUTIONS

Study concept and design: FJ, SZ, MK; Acquisition of data: FJ, SZ; Drafting of the manuscript: FJ, AP; Critical revision of the manuscript for important intellectual content: SZ, MK, DN; Study supervision: AP, SZ; Gathering information, searching the literature, and editing the paper grammatically: DN; All authors read and approved the final manuscript.

ACKNOWLEDGMENTS

The authors would like to show our gratitude to staff of the Rasool Akram Medical Complex Clinical Research Development Center (RCRDC), especially Mrs. Farahnaz Nikkhah for their technical and editorial assists.

FUNDING INFORMATION

This study has no financial source and support.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data in the current study are available from the corresponding author upon reasonable request.

ETHICAL APPROVAL

The present study complies with ethical standards and standards of research involving humans. This article does not contain any studies involving animals performed by any of the authors.

CONSENT

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

ORCID

Fatemeh Jahanshahi https://orcid.org/0000-0002-1941-7370
Sam Zeraatian Nejad Davani https://orcid.org/0000-0003-4267-054X

REFERENCES

1. Kingdon EJ, Holt SG, Davar J, et al. Atrial thrombus and central venous dialysis catheters. *Am J Kidney Dis*. 2001;38(3):631-639.
2. Tokars JI, Miller ER, Alter MJ, Arduino MJ. National surveillance of dialysis associated diseases in the United States, 1995. *ASAIO J*. 1998;44(1):98-107.
3. Scott WL. Central venous catheters: an overview of Food and Drug Administration activities. *Surg Oncol Clin*. 1995;4(3):377-393.
4. Nizameddin KO, Kanat S. Fatal central venous catheterization complication: right ventricular rupture and hemopericardium. *Turk J Intern Med*. 2019;1(1):26-29.
5. dos Santos Modelli ME, 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(1):26-28.
6. Collier PE, Blocker SH, Graff DM, Doyle P. Cardiac tamponade from central venous catheters. *Am JSurg*. 1998;176(2):212-214.
7. Wetzel LR, Patel PR, Pesa NL. Central venous catheter placement in the left internal jugular vein complicated by perforation of the left brachiocephalic vein and massive hemothorax: a case report. *AA Practice*. 2017;9(1):16-19.
8. Kornbau C, Lee KC, Hughes GD, Firstenberg MS. Central line complications. *Int J Crit Illn Inj Sci*. 2015;5(3):170.
9. Azevedo AC, Lima IF, Brito V, Centeno MJ, Fernandes A. Cardiac tamponade: a rare complication of central venous catheter–a clinical case report. *Braz J Anesthesiol*. 2018;68(1):104-108.
10. Wong K, Marks BA, Qureshi A, Stemm JJ. Migration of a central venous catheter in a hemodialysis patient resulted in left atrial perforation and thrombus formation requiring open heart surgery. *A&A Practice*. 2016;7(1):21-23.

11. Sandhu J, Dean RK, Landsberg D. Right atrial perforation leading to cardiac tamponade following Veno-venous extracorporeal membrane oxygenation cannulation. *Cureus*. 2021;13(2):13157.
12. Premuzic V, Katalinic L, Pasalic M, Jurin H. Nonfatal cardiac perforation after central venous catheter insertion. *Saudi J Anaesth*. 2018;12(1):118-120.
13. Butt MU, Gurley JC, Bailey AL, Elayi CS. Pericardial tamponade caused by perforation of Marshall vein during left jugular central venous catheterization. *Am J Case Rep*. 2018;19:932-934.
14. Lee YM, Kim HJ, Lee JE, et al. Cardiac tamponade following insertion of an internal jugular vein catheter for hemodialysis. *Clin Nephrol*. 2009;72(3):220-223.
15. Schiavone WA. Cardiac tamponade: 12 pearls in diagnosis and management. *Cleve Clin J Med*. 2013;80(2):109-116.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Jahanshahi F, Parsaei A, Naderi D, Zeraatian Nejad Davani S, Khaleghian M. Potentially fatal atrium perforation due to right jugular vein catheterization recognized by venography: A case report. *Clin Case Rep*. 2023;11:e6911. doi:10.1002/ccr3.6911