*Heart Surgery Forum* 2024; 27(11): E1258–E1263
doi: 10.59958/hsf.7945
https://journal.hsforum.com/

*Case Report*

# Pericardial Tamponade Two Years after Central Venous Catheter Implantation in a Patient with Breast Cancer: A Case Report

Tingqian Cao[1,2,†], Yahui Liu[3,†], Yuqiang Wang[2,4], Miao Chen[3], Yingqiang Guo[2,4,*]

[1]Integrated Care Management Center, West China Hospital, Sichuan University, 610041 Chengdu, Sichuan, China
[2]Department of Cardiovascular Surgery and National Clinical Research Center for Geriatrics, West China Hospital, Sichuan University, 610041 Chengdu, Sichuan, China
[3]Department of Cardiovascular Surgery, West China Hospital, Sichuan University, 610041 Chengdu, Sichuan, China
[4]Cardiovascular Surgery Research Laboratory, West China Hospital, Sichuan University, 610041 Chengdu, Sichuan, China
*Correspondence: drguoyq@wchscu.cn (Yingqiang Guo)
[†]These authors contributed equally.

Submitted: 31 July 2024 Revised: 22 August 2024 Accepted: 10 September 2024 Published: 14 November 2024

## Abstract

We report a rare and diagnostically challenging case of pericardial tamponade in a breast cancer patient, treated two years earlier. Echocardiogram and an enhanced computed tomography (CT) scan revealed a large mass in the right pericardium with indistinct borders. A positron emission tomography-computed tomography (PET-CT) scan showed no uptake of fluorine-18 fluorodeoxyglucose (18F-GDP) by the mass. Cardiac magnetic resonance imaging (MRI) with late gadolinium enhancement confirmed no signal enhancement within the mass and a clear border, decisively ruling out malignancy. This case highlights the importance of late gadolinium enhancement in this diagnostically challenging case and explores the pericardial tamponade development mechanism.

## Keywords

pericardial tamponade; central venous catheter; cardiac MRI; late gadolinium enhancement

## Introduction

Central venous catheters (CVC) are widely used for intravenous drug administration. However, improper use of CVCs has been implicated in iatrogenic injuries [1]. A severe mechanical complication of CVC insertion is pericardial tamponade, a condition with a mortality rate ranging from 65% to 100% [2]. In 80% of cases, perforations occur in the right atrium and right ventricle, followed by the superior vena cava [3]. Here we present a rare case of pericardial tamponade occurring two years after the placement of a CVC for administering postoperative chemotherapy in a breast cancer patient.

## Case Presentation

In mid-October 2023, a 50-year-old female presented to the emergency department with complaints of abdominal distension, difficulty breathing, and bilateral lower limb edema. Over the preceding two weeks, she experienced intermittent fever, severe cough, progressive fatigue, a weight gain of 5 kilograms, difficulty breathing, and palpitations. Upon reviewing the case records, emergency department physicians discovered a breast cancer diagnosis from November 2021 (staged as T2N1M0) leading to a modified radical mastectomy of the right breast combined with sentinel lymph node dissection. Regular follow-ups revealed no signs of tumor recurrence or lymph node metastasis. No further hospitalizations, invasive medical procedures, or trauma were noted.

The patient, unable to stand and restricted to a wheelchair, exhibited multiple systemic symptoms. Her vital signs were as follows: oxygen saturation of 92% in ambient air, a respiratory rate of 24 breaths per minute, a regular heart rhythm at 114 beats per minute, blood pressure of 107/83 mmHg, and a body temperature of 36.1 °C. Physical examination revealed mild jaundice of the skin and conjunctiva, absence of palpable superficial lymph nodes, and adequate jugular vein filling. Pulmonary assessment noted diminished bilateral lung breath sounds, scattered moist rales in the lower lung fields, and a difference in percussion tones, with dullness on the left side and normal resonance on the right. Cardiac auscultation detected faint heart sounds. The abdominal examination revealed distension with upper right quadrant tenderness without rebound. Positive shifting dullness was present, bowel sounds were reduced to 2–3 per minute, and severe edema was noted in both lower limbs.

The clinical presentation involved multiple systems with symptoms intensifying over the prior two weeks suggesting cardiovascular, respiratory, and digestive systems involvement. While indicators suggest a cardiovascular etiology, bacterial infections, cancer metastasis, and sys-

temic inflammatory processes should be considered. Given the patient's breast cancer history, it is crucial to ascertain whether pericardial metastasis led to effusion or if tumor-induced circulatory embolism occurred.

Guided by the patient's medical history and recent examination results, the attending physician performed a transthoracic echocardiogram and chest enhanced computed tomography (CT). The echocardiogram revealed an abnormal large "honeycomb-like" echo area (9.2 × 4.3 cm) in the right pericardium, compressing the right atrium and ventricle (Fig. 1A). The CT scan identified a similar mass in the right pericardium, exerting significant pressure on the adjacent cardiac structures (Fig. 1B). These findings suggested a lesion within the heart, although its nature and origin remained unclear.

Given the echocardiographic and CT findings, the physician considered metastatic cardiac tumors (MCT). Subsequently, positron emission tomography-computed tomography (PET-CT) revealed an irregular mass in the right ventricle with uneven density no contrast agent uptake. Metabolic activity increased in lymph nodes across the supraclavicular, axilla, para-tracheal area, and pulmonary hilum regions (Fig. 1C–E). The incomplete uptake of fluorine-18 fluorodeoxyglucose (18F-GDP) suggested a potential malignancy, although a definitive diagnosis remained elusive. There was an urgent need to alleviate heart failure symptoms, with surgical intervention considered to relieve the pressure. However, the significant risks associated with surgery, particularly if inoperable breast cancer metastasis is confirmed, necessitated cautious consideration.

The attending physician convened a multidisciplinary team with cardiac surgery, cardiology, radiology, and nuclear medicine experts to discuss the case. The nuclear medicine specialist noted observed no contrast agent distribution in the mass on PET-CT, suggesting potential resistance to 18-FDG uptake. The heightened metabolic activity in multiple lymph nodes complicated the exclusion of tumor metastasis. The radiologist recommended acquiring higher-resolution magnetic resonance imaging (MRI) to define the mass's borders. The cardiologist, skeptical of the rapid growth and breast cancer cardiac metastasis within the timeframe, suggested a cardiac lesion biopsy to establish a definitive diagnosis. The cardiac surgeon noted the severe right heart failure symptoms, indicating the need for surgical intervention to alleviate cardiac compression. However, the team recognized substantial surgical risks, particularly if breast cancer metastasis was confirmed during the operation, and found to be inoperable.

After careful discussion, the team unanimously agreed to proceed cautiously due to ongoing uncertainty surrounding the MCT diagnosis and unidentified mass. The planned diagnostic approach included a comprehensive cardiac contrast-enhanced MRI scan, cytological analysis of the abdominal fluid, and a biopsy of axillary lymph nodes.

Analysis of the abdominal fluid aspirant and cytological examination revealed numerous lymphocytes and proliferating mesothelial cells. Subsequently, fine needle aspiration cytology of the left axillary lymph node was performed under ultrasound guidance, revealing a minimal number of lymphocytes.

Cardiac MRI revealed an irregular heterogeneous mass within the right pericardium, with T2-weighted Imaging (T2WI) depicted a spectrum of pericardial signals, predominantly high in intensity (Fig. 1F). Late gadolinium enhancement indicated no signal enhancement within the mass, highlighting a distinct border between the mass and the adjacent right heart structures (Fig. 1G). The multidisciplinary team concluded that the high-resolution MRI outlined a distinct boundary between the pericardial mass and the right heart, without contrast signal enhancement, suggesting an extremely low probability of metastatic tumor involvement. The tumor's low malignancy, combined with systematic chemotherapy and radiotherapy following disease guidelines made the rapid development of a MCT to approximately 9 cm within the brief period highly improbable. Consequently, the team unanimously ruled out MCT, recommending urgent surgical intervention to relive cardiac compression. However, the mass's specific nature through intraoperative pathology was deemed necessary for an accurate diagnosis and appropriate management.

On November 25, 2023, the patient underwent a pericardial mass clearance procedure combined with pericardial stripping and excision. Upon exposing the pericardium, surgeons encountered a dark red gel-like substance. Examination of the atrial and ventricular structures revealed them to be normal, although the right heart activity was significantly restricted. Within the right pericardial cavity, a dark red, gelatinous mass measuring approximately 9 × 5 cm was identified (Fig. 1H). The surgical team successfully removed the foreign material, alleviating the right cardiac compression. They next confirmed the heart's structural integrity, with no significant breaches or hemorrhages (Fig. 1I). The thickened and abnormal pericardial tissue was submitted for pathological examination. The pathology report described the excised material as hemorrhagic necrotic tissue encased in proliferative fibrous tissue with infiltrating inflammatory cells. The pericardium exhibited signs of partial necrosis, fibrous tissue proliferation, and infiltration of inflammatory cells. Crucially, the sample was devoid of any tumor cells (Fig. 1J).

The patient was successfully discharged on December 5, 2023. During routine outpatient follow-up one month later, the patient reported significant symptom relief and had regained the ability to walk independently. Transthoracic echocardiography and contrast CT scans revealed the disappearance of the pericardial mass with minimal pericardial effusion.

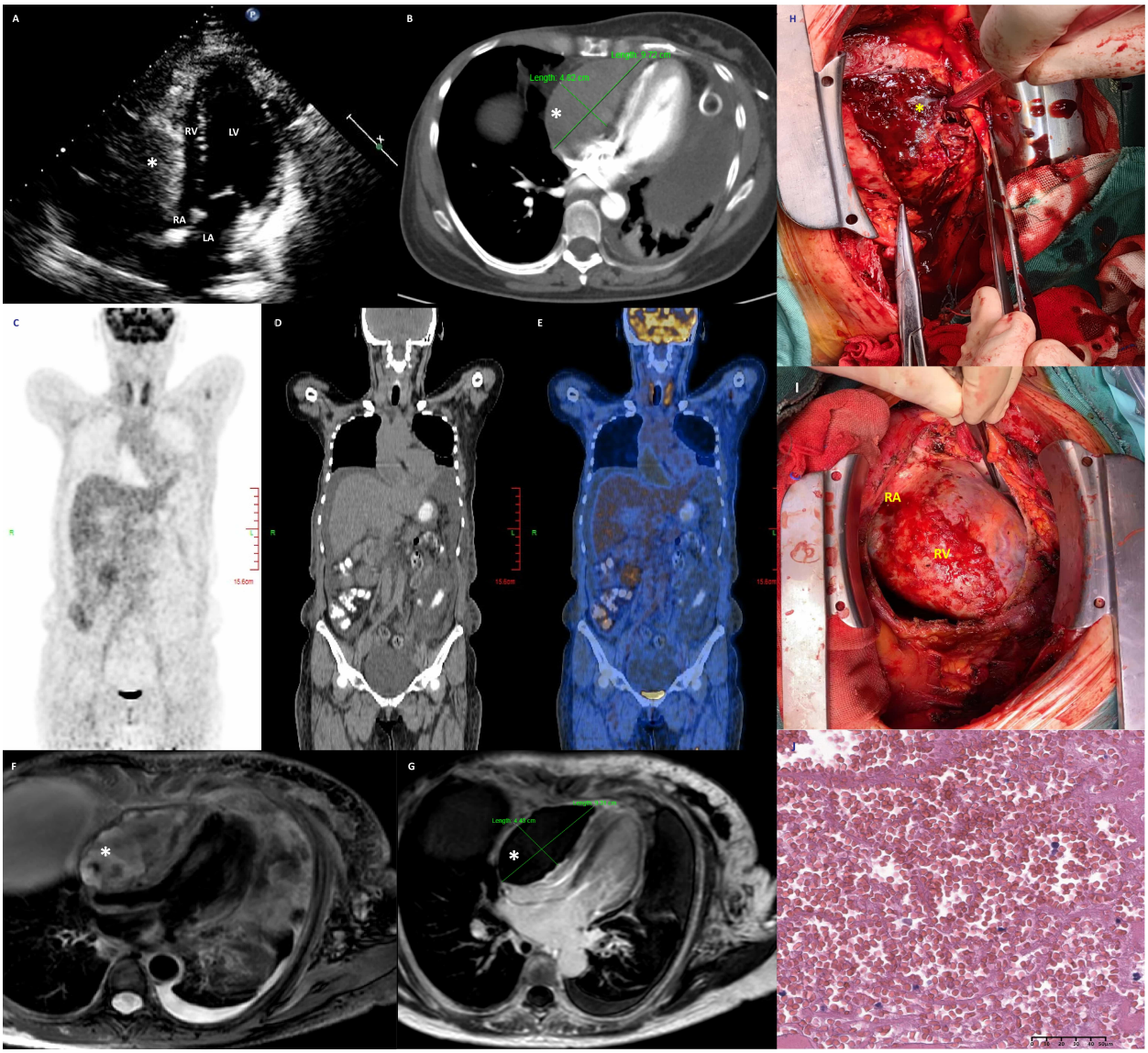


**Fig. 1. Comprehensive diagnostic and intraoperative findings of pericardial mass using multimodal imaging techniques.** (A) Transthoracic echocardiogram was utilized to visualize the initial presence and position of the pericardial mass affecting cardiac function. (B) Chest enhanced computed tomography (CT) provided detailed imaging that confirmed the extent and effects of the mass on the right heart structures. (C–E) positron emission tomography-computed to- mography (PET-CT) scan revealed an irregular mass shadow in the right ventricle characterized by uneven density and no evident contrast distribution, suggesting the absence of typical tumor characteristics. (F) Cardiac magnetic resonance imaging (MRI) T2WI imaging showed mixed signal intensities indicating the heterogeneous nature of the mass. (G) Cardiac MRI late gadolinium enhancement highlighted the mass's borders and lack of enhancement, further suggesting non-malignant pathology. (H) Upon surgical exploration of the pericardium, a dark red gel-like substance was observed. (I) Confirmation of the heart's intact structural integrity, with no significant breaches or hemorrhages. (J) The pathological analysis indicates the presence of bleeding, fibrin leakage, and infiltration by inflammatory cells, with no tumor cells detected, supporting a diagnosis of an inflammatory or benign etiology rather than malignancy. * Indicates the presence of a pericardial mass. RV, right ventricle; RA, right atrial; LV, left ventricle; LA, left atrial. 50 μm, divided into 5 sections of 10 μm each.

## Discussion and Conclusion

MCTs involving myocardium or pericardium are rare, with an incidence ranging from approximately 1.5% to 20%. The most common primary sources of these metastases include melanoma, leukemia, as well as lung, breast, and esophageal cancers [4]. Potential pathways for MCT metastasis include hematogenous, lymphatic, and direct spread. In the context of breast cancer, cardiac metastasis often occurs via lymphatic and direct routes, predominantly affecting the pericardium. While MCT can manifest

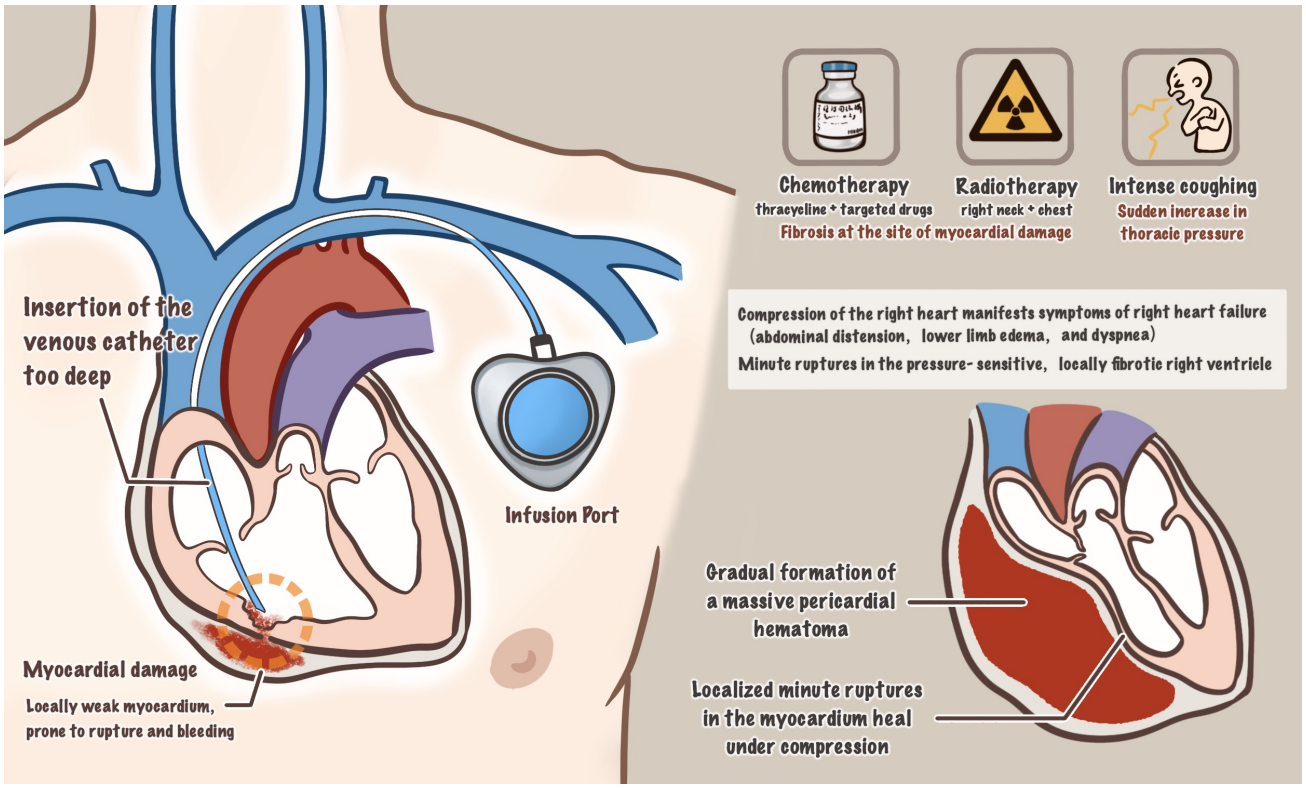


**Fig. 2. Formation and development of the pericardial mass.** Central venous catheter insertion induced an iatrogenic myocardial injury in the right ventricular myocardium. This was exacerbated by chemotherapy, radiotherapy, and intense coughing. Localized minute myocardial ruptures drove the development of a pericardial hematoma within the right ventricular myocardium. Subjected to sustained hematoma compression, the injuries gradually healed.

symptoms of congestive heart failure and may pose a life-threatening risk in some cases [5], over 90% of MCT cases remain asymptomatic and clinically silent [6]. Therefore, clinicians consider the possibility of cardiac metastasis and investigate when cancer patients present new cardiac symptoms.

While transthoracic echocardiography is the preferred initial diagnostic tool, in this particular case, lack of echocardiographic expertise and an oversight in non-contrast CT imaging led to the initial oversight of the cardiac mass diagnosis (Fig. 1B). Hence, supplementary diagnostic imaging methods including contrast CT, PET-CT, and contrast MRI should be employed to elucidate tumor characteristics including size, morphology, location, invasiveness, and vascularity [5]. Pericardial endoscopy, combined with pathological analysis, is particularly valuable for investigating unexplained pericardial conditions [7]. However, this invasive procedure carries a considerable risk of bleeding and should only be performed in well-equipped tertiary care centers with extensive experience.

The surgical team was perplexed by the absence of visible cardiac perforations or bleeding points, despite clear signs of cardiac involvement. A review of the patient's history identified a CVC insertion two years earlier as the only procedure capable of producing the cardiac injury. Early perforations (<24 hours) often result from direct trauma from direct trauma by guidewires, dilators, or catheters. Late perforations typically stem from ongoing mechanical damage and chemical catheter erosion, leading to tissue necrosis and subsequent perforation [1]. Following creation of an angle between the catheter tip and the vessel or cardiac wall, respiratory and cardiac muscle movement during contractions may lead to perforation. Contact with high-osmolarity fluids can result in chemical erosion and permeability-induced injury, leading to perforation [3]. Strict adherence to chest fluoroscopy during CVC placement is crucial to accurately position the catheter tip, preventing its advancement into the cardiac chambers [8].

Assessing catheter blood flow patency is crucial [8]. The patient underwent tumor chemotherapy and radiotherapy from December 2021 to March 2023. In February 2022, difficulties in aspiration before the fourth central venous catheter use raised concerns. Nonetheless, chemotherapy continued until the catheter required removal and treatment shifted to peripheral venous administration. The deep catheter placement and aspiration difficulties suggested potential catheter-related iatrogenic injury, likely contributing to subsequent cardiac perforation and hematoma development [2]. Although no pericardial tamponade symptoms appeared post-infusion, ongoing vigilance with transtho-

racic echocardiography is advised to check for pericardial effusion, and chest contrast CT to detect any vascular or cardiac wall ruptures.

Notably, the symptoms of pericardial tamponade did not manifest until in October 2023. Based on this delay, we speculate the patient's thoracic radiotherapy, targeting the right neck and chest [9], and chemotherapy regimen with anthracycline combined with targeted drugs [10], may have compounded the issue. It is plausible that these treatments exacerbated fibrosis around the myocardial damage initially induced by the CVT.

Of particular concern is the intense coughing the patient experienced in early October 2023 due to a cold, which was treated with cough suppressants, including compound methoxyphenamine capsules, during her hospitalization. The pronounced symptoms of pericardial tamponade emerged shortly thereafter. The physiological stages of coughing—namely inhalation, compression, and exhalation—generate high expiratory velocity to prevent foreign bodies from entering the lower respiratory tract and facilitate the expulsion of any existing foreign matter. However, this physiological process carries inherent risks; excessive intrathoracic pressure during intense coughing can potentially damage cardiovascular structures [11]. For instance, during intense coughing, intrathoracic pressure can spike up to 300 mmHg [12], impacting the normal blood flow within the circulatory system. Interestingly, the literature suggest the intrathoracic pressure generated during coughing may offer hemodynamic advantages over external chest compressions, thereby supporting the viability of cough-assisted cardiopulmonary resuscitation viable in controlled environments [13].

Excessive intrathoracic pressure from coughing may damage cardiovascular structures. Papadimos and Hofmann [14] documented a case in 2006 of a middle-aged man experiencing intense chest and back pain following forceful coughing triggered by a pickle lodged in his airway. The patient was subsequently diagnosed with aortic dissection. The authors hypothesized that the forceful coughing substantially increased transvalvular pressure in the chest, aorta, and ventricle, precipitating an aortic rupture [14].

In this case, we hypothesize the patient's vigorous coughing episode elevated intrathoracic pressure, causing minute ruptures in the locally fibrotic pressure-sensitive right ventricle. A large hematoma subsequently developed over two weeks, compressing the right heart (Fig. 2). This hematoma eventually caused the ruptures to heal, explaining the lack of visible rupture during surgery.

## Conclusion

This case highlights a pericardial hematoma causing tamponade in a cancer patient, two years after central venous catheter implantation. It offers diagnostic insights for future clinicians when evaluating malignancy patients with unexplained pericardial tamponade, cautioning against reliance on empirical factors alone for diagnosis. In cases of pericardial tamponade associated with malignancy, early utilization of late gadolinium enhancement in cardiac MRI can assist in accurately identifying pericardial metastases and malignant pericardial hematomas, enabling timely intervention to manage these life-threatening conditions. The CARE checklist was used when writing this case report (**Supplementary Fig. 1**).

## Availability of Data and Materials

The original contributions presented in the study are included in the article, and further inquiries can be directed to the corresponding author.

## Author Contributions

TQC and YHL conceived and wrote this case report. YHL, YQW, MC, and YQG participated in the surgical procedure of this case. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

## Ethics Approval and Consent to Participate

Normally, the case report requires ethical approval, but Biomedical Ethics Committee of West China Hospital of Sichuan University waive the case report to get the approval. Consent for publication was directly obtained from the patient. Patient agree to publish her photo and medical records online in the Journal. Patient have read the manuscript or understood a general description of what it contains and have reviewed all photographs, illustrations, video or audio files (if any) that refer to me for publication, knowing that her name will not be published, that articles published in the case base may be republished in other media and may be freely redistributed for any lawful purpose, including academic exchange, translation, commercial use, *etc*.

## Acknowledgment

Not applicable.

## Funding

This manuscript was supported by National Clinical Research Center for Geriatrics, West China Hospital, Sichuan University (No. Y2023YY007).

## Conflict of Interest

The authors declare no conflict of interest.

## Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.59958/hsf.7945.

## References

[1] Messina Alvarez AA, Bilal MA, Manasrah N, Chaudhary A. Iatrogenic Cardiac Tamponade Secondary to Central Venous Catheter Placement: A Literature Review. Cureus. 2023; 15: e37695.

[2] Kim MC, Kim KS, Choi YK, Kim DS, Kwon MI, Sung JK, *et al*. An estimation of right- and left-sided central venous catheter insertion depth using measurement of surface landmarks along the course of central veins. Anesthesia and Analgesia. 2011; 112: 1371–1374.

[3] Booth SA, Norton B, Mulvey DA. Central venous catheterization and fatal cardiac tamponade. British Journal of Anaesthesia. 2001; 87: 298–302.

[4] American Society of Anesthesiologists Task Force on Central Venous Access, Rupp SM, Apfelbaum JL, Blitt C, Caplan RA, Connis RT, *et al*. Practice guidelines for central venous access: a report by the American Society of Anesthesiologists Task Force on Central Venous Access. Anesthesiology. 2012; 116: 539–573.

[5] Burazor I, Aviel-Ronen S, Imazio M, Goitein O, Perelman M, Shelestovich N, *et al*. Metastatic cardiac tumors: from clinical presentation through diagnosis to treatment. BMC Cancer. 2018; 18: 202.

[6] Goldberg AD, Blankstein R, Padera RF. Tumors metastatic to the heart. Circulation. 2013; 128: 1790–1794.

[7] Al-Mamgani A, Baartman L, Baaijens M, de Pree I, Incrocci L, Levendag PC. Cardiac metastases. International Journal of Clinical Oncology. 2008; 13: 369–372.

[8] Asteggiano R, Bueno H, Caforio AL, *et al*. 2015 ESC Guidelines for the diagnosis and management of pericardial diseases–Web Addenda. European Heart Journal. 2015; 36: 2921–2964.

[9] Wang B, Wang H, Zhang M, Ji R, Wei J, Xin Y, *et al*. Radiation-induced myocardial fibrosis: Mechanisms underlying its pathogenesis and therapeutic strategies. Journal of Cellular and Molecular Medicine. 2020; 24: 7717–7729.

[10] Nishi M, Wang PY, Hwang PM. Cardiotoxicity of Cancer Treatments: Focus on Anthracycline Cardiomyopathy. Arteriosclerosis, Thrombosis, and Vascular Biology. 2021; 41: 2648–2660.

[11] Irwin RS, Dudiki N, French CL, CHEST Expert Cough Panel. Life-Threatening and Non-Life-Threatening Complications Associated with Coughing: A Scoping Review. Chest. 2020; 158: 2058–2073.

[12] Comroe JH. Physiology of respiration: an introductory text. Year Book Medical Publishers: Chicago. 1965.

[13] LoMauro A, Aliverti A. Blood Shift During Cough: Negligible or Significant? Frontiers in Physiology. 2018; 9: 501.

[14] Papadimos TJ, Hofmann JP. Aortic dissection after forceful coughing. Anaesthesia. 2006; 61: 71–72.