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Case Report

Right Ventricular Perforation and Subsequent Cardiac Tamponade Caused by IVC Filter Strut Fracture Migration

Mina Makaryus[1], Sonu Sahni[1,2], Arjun Kumar[3], Rakesh D. Shah[4], Stuart L. Cohen[4], Sandeep Mehrishi[1], Arunabh Talwar[1,*]

[1]Department of Pulmonary, Critical Care, & Sleep Medicine, Northwell Health, New Hyde Park, NY
[2]Department of Primary Care, Touro College of Osteopathic Medicine, New York, NY
[3]College of Arts and Sciences, New York University, New York, NY
[4]Department of Radiology, Northwell Health, Manhasset, NY

Cardiac tamponade, if not recognized and treated immediately, is a life threatening condition with various etiologies. Most common causes of cardiac tamponade encountered in emergency rooms are due to trauma, post myocardial infarction wall rupture, cancer and all other causes of pericardial effusion. Iatrogenic causes of cardiac tamponade include anticoagulation and procedures related. Currently there is a general comfort level amongst physicians that inferior vena cava (IVC) filters are not associated with significant complications. However, one of the feared life-threatening immediate complications of IVC filter placement is complete migration of the filter to the heart, with possible risk for cardiac arrhythmia, cardiac tamponade, and death. IVC filter strut fracture and migration to the heart and pulmonary arteries is another possible cause of cardiac tamponade and needs to be added to the differential diagnosis in the setting of tamponade signs and symptoms in a patient with history of IVC filter placement. We present a case of IVC filter strut fracture and migration to the right ventricle with penetration of the free wall causing cardiac tamponade with subsequent successful percutaneous retrieval. We hope to raise awareness through this case of the rare but potentially fatal complications of IVC filter placement and to advise regarding the judicious use of IVC filters.

Key words: *cardiac tamponade, deep venous thrombosis, inferior vena cava filter, IVC strut fracture*

Introduction

Cardiac tamponade occurs when fluid trapped in the pericardial space compresses the heart, compromises ventricular contraction leading to a decrease in cardiac output.[1] If not recognized and treated immediately, cardiac tamponade is a life-threatening situation. Most common causes of cardiac tamponade encountered in emergency rooms are due to trauma, post myocardial infarction wall rupture, cancer and other causes of pericardial effusion. Iatrogenic causes of cardiac tamponade include anticoagulation and procedure related. Anticoagulation remains the first line therapy for treatment of DVT and prevention of pulmonary embolism.[2] Inferior vena cava (IVC) filters are often used in patients with have contraindications to anticoagulation, fail anticoagulation therapy, or develop life-threatening bleeding secondary to anticoagulation that require the use of IVC filters.[2]

Although significant advancement has been made in vena cava filter placement, there are several known immediate and long-term potential complications.[3-5] Very rare complications of IVC filters have been reported in the literature, including filter migration and filter strut fracture and migration into various

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*Corresponding author: Arunabh Talwar, MD, FCCP, Northwell Health, Department of Pulmonary, Critical Care and Sleep Medicne, 410 Lakeville Rd., New Hyde Park, NY 11040, USA. E-mail: arunabhtalwar1@gmail.com

organs.[6] Given all these known complications, vena caval filter placement is still considered a safe procedure with very low mortality.[3] We present here a case of right ventricular perforation and cardiac tamponade caused by IVC filter strut fracture migration with successful percutaneous retrieval of the strut fragments.

Case Presentation

A 77-year-old female presented to the emergency department with progressive dyspnea over the past 12 hours. The patient also reported severe, crushing, left-sided chest pain beneath the left breast that started on the evening prior to admission after supper and woke the patient up several times during the night. On examination she was noted to have pursed lipped breathing, a respiratory rate of 24 breaths per minute, blood pressure of 140/100 mmHg, a pulse of 110 beats per minute and a SpO_2 of 92% on room air. On deep inspiration the patient's blood pressure dropped to 110/90 mmHg, consistent with presence of pulsus paradoxes. Cardiac exam revealed muffled heart sounds. Abdominal exam revealed hepatomegaly, lung examination revealed bilateral basilar crackles and examination of the extremities revealed 2+ pedal edema. She had a past medical history of asthma, multiple pulmonary emboli with history of IVC filter placement 3 years prior to admission.

Bedside echocardiogram revealed a linear structure in the right ventricular apex and perforating the free wall, resulting in a moderate pericardial effusion with tamponade physiology. There was collapse of the right atrium during diastole. In addition the IVC appeared dilated with no changes in diameter with minimal inspiratory collapse. Computer tomography (CT) of the chest showed a moderate hyperdense pericardial effusion with a needlelike density projecting over the anterior heart and pericardial space, with suggestion of possible fracture and migration of an IVC filter strut to the right ventricle with resulting perforation of the free wall resulting in a hemorrhagic pericardial effusion (see Fig. 1). The Chest CT also showed radio-opaque material within the right lower lobe pulmonary artery, consistent with either calcification or foreign metallic object, also suggesting the possibility of IVC filter strut fracture and migration. Imaging of the abdomen revealed that the IVC filter was malpositioned with extracaval extension (see Fig. 2).

The decision was made to attempt percutaneous retrieval of the filter strut that had perforated the right

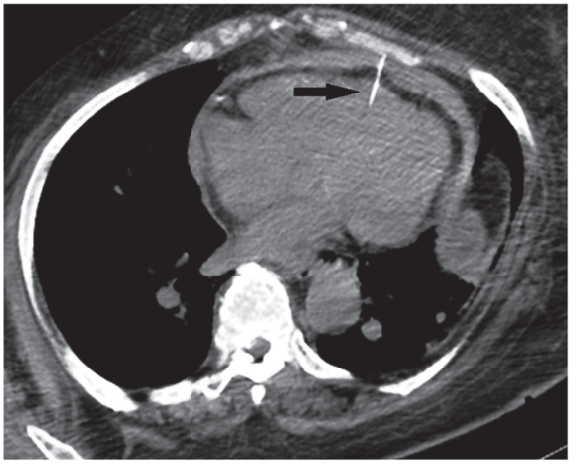

Fig. 1. CT image showing pericardial effusion with needlelike density projecting over anterior heart suggestive of right ventricular perforation.

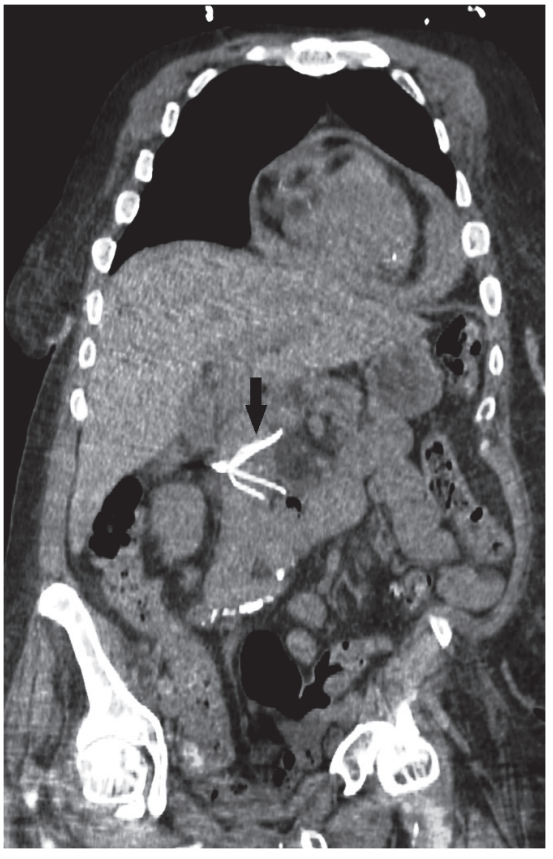

Fig. 2. CT image of abdomen showing malpositioned IVC filter with extracaval extension.

ventricle prior to possible cardiothoracic surgery. The patient was brought to the angiography suite and fluoroscopy was performed, which showed the IVC filter malpositioned horizontally with extracaval extension of the apex and multiple struts. Fluoroscopy also demonstrated a small metallic device within a branch of the right lower lobe pulmonary artery consistent with an IVC filter strut that had fractured and embolized to the right lower lobe (foreign body pulmonary embolism). Another small linear metallic device was identified in the lower left thorax consistent with the filter strut identified on CT scan that had perforated through the right ventricular wall. An attempt was made to extract the filter fragment from the right ventricle using the wire snare, but this was unsuccessful. A second attempt using a 10 mm En-snare was successful at capturing the filter strut. Hemostasis was achieved with manual compression. Following removal, the patient's chest pain and dyspnea significantly improved. On the following day, the patient was brought down to the CT suite for IR-guided drainage of the hemorrhagic pericardial effusion. However, the effusion was noted to be decreased in size and the procedure was aborted given the patient's clinical improvement in symptoms and resolved hypotension. The patient was discharged home three days after admission.

Discussion

Cardiac tamponade occurs as a complication of increase in pericardial effusion. Once the effusion exceeds the pericardial reserve volume, intrapericardial pressure increases, causing a reduction in transmyocardial gradient and therefore decrease in chamber filling particularly on the right side.[7] Our patient presented with cardiac tamponade physiology, which was obvious on physical examination with supporting evidence from radiological testing. Cardiac tamponade usually presents with Beck's triad (hypotension, muffled hurt sounds and jugular venous distension[8] and raised jugular venous pressure with prominent x-decent (which tells you rapid filling during systole) and absent Y decent (absent filling during diastole). A unique physical finding is the presence of pulsus paradoxes defined as a drop in systolic blood pressure greater than 10 mmHg upon deep inspiration that occurs due to respiratory interdependence of ventricular filling. Clinicians must appreciate that there are many causes of pulsus paradoxes.[1,9] Presence of pulsus paradoxes greater than 10 mmHg in the setting of pericardial effusion has greater than 80% sensitivity for the diagnosis of cardiac tamponade.[10] Symptoms and physical findings of cardiac tamponade have been outlined in Table 1.

With the availability of bedside ultrasound, most emergency physicians are trained to perform focused assessment with sonography in trauma (FAST). However, a quick screening echocardiogram in dyspnea of unknown origin, as in our case, can aid in the diagnosis as well. Common causes of cardiac tamponade include trauma, malignancy, idiopathic pericarditis, myocardial infarction, end stage renal disease, congestive heart failure, collagen vascular disorders, and bacterial infections like tuberculosis.[10] Iatrogenic causes are procedure and anticoagulation related.

In recent decades IVC filter placement has steadily increased due to the use of retrievable filters, ease of percutaneous placement, and the expansion of clinical indications to include poor compliance or prophylaxis in the setting of trauma, surgery, or advanced malignancy.[11,12] It has become well known that IVC filter struts, though rare, may fracture in up to 25% of cases.[13] In a study by Vijay et al. overall fracture rate was 12% and increased with longer dwell times. The distal embolization rate of fractured filter components was 13%.[14] Some of complications of IVC filters include penetration through the IVC wall causing perforation and erosion into neighboring structures, such as the duodenum, aorta, and common iliac artery. There have been reported cases of retroperitoneal hemorrhage, aorto-caval fistulas, aortic pseudoaneurysm, and small bowel obstruction.[3-5,15,16] It has also been reported that IVC filters or fractured filter struts may migrate to the heart and pulmonary arteries.[3-5,17-27] Although mortality is rare, there have been reported cases of death secondary to IVC filter or fractured

Table 1. Symptoms and physical findings of cardiac tamponade

Symptoms	Physical findings
Chest Pain	Becks triad (hypotension, muffled heart sounds, jugular venous distension)
Dyspnea	Pulsus paradoxus (> 10 mmHg drop in systolic blood pressure on inspiration)
Syncope or Presyncope	Pericardial friction rub
	Hepatomegaly
	Sinus tachycardia
	Tachypnea

filter struts migrating to the heart and pulmonary arteries causing massive pulmonary embolism, cardiac tamponade, and cardiac arrhythmias.[19,23]

A review of the literature reveals several case reports of IVC filter migration into the right atrium and right ventricle that required either interventional radiology for percutaneous retrieval or cardiothoracic surgery for surgical retrieval.[17-20,23-25] Of these IVC filters and fractured filter struts that have migrated, there have been eight reported cases of consequent cardiac tamponade.[22-29] One patient passed away after signing out against medical advice hindering further intervention from removing the filter and correcting the tamponade.[23] Of the eight patients with pericardial tamponade reported in the literature, three of the cases were secondary to IVC filter migration and occurred within days of placement.[23-25] The remaining three patients suffered pericardial tamponade due to migration of a fractured filter strut to the right ventricle with penetration of the ventricular wall.[22,26-29] These cases occurred months to years after IVC filter placement, although the case report by Chandra et al does not specify the time period between IVC filter placement and cardiac tamponade.[27] We present the fourth such case of cardiac tamponade caused by a fractured IVC filter strut that migrated to the right ventricle and perforated the free wall. This is also the first case report with successful percutaneous retrieval of a fractured filter strut that had perforated through the pericardium causing tamponade. The percutaneous approach is important to stress here, as it was a conservative approach that was successful. Often more common causes of cardiac tamponade such as trauma and post myocardial wall rupture require emergent complicated surgical intervention, which may lead to patient demise.

Risk factors for strut fracture or migration are thought to be related to duration of filter placement. Lynch et al. retrospectively reviewed the removal of Bard G2 IVC filters in 174 patients whose implantation periods were longer or shorter than 180 days. Of 174 G2 filters, 170 were removed the 6 of which that had fractured (3.4%), all had been in place longer than 180 days.[30] In addition Durack et al. demonstrated that increased perforation depth was related to longer dwell time.[31] Despite the complications on IVC filters they should be used in the right clinical setting if complication does occur retrieval of filter should be conducted immediately. As demonstrated by Dinglasan et el. removal of fractured IVC filters is feasible and relatively safe and rarely are they not accessible.[32]

Conclusion

Our case represents a rather unique etiology of cardiac tamponade. IVC filter placement is indicated for thromboembolic disease for those who are unable to tolerate anticoagulation. Although considered a safe procedure with rare mortality, there have been several documented cases of significant morbidity and even fatal outcomes. We hope to raise awareness through this case report of the rare but potential complications of IVC filter placement, particularly for those practicing in the emergency room. Our case in also interesting as we have report a novel non-surgical approach to filter strut retrieval by a successful percutaneous approach, with the goal of limiting the patient's morbidity and length-of-stay.

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