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CASE REPORT

BEGINNER

CLINICAL CASE

A Pericardial Pin

Embolization of an Inferior Vena Cava Filter Strut Presenting as Acute Pericarditis

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ABSTRACT

A 39-year-old man presented with chest pain initially attributed to viral pericarditis. He was found to have an embolized inferior vena cava filter strut that perforated the right ventricle. Inferior vena cava filter fracture and embolization should be considered in patients with chest pain and pericardial effusion. (**Level of Difficulty: Beginner.**)
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Inferior vena cava (IVC) filters are used for patients with recurrent venous thromboembolism with contraindications to anticoagulation (1). Their use increased significantly in the 2 decades since they were first introduced, with a more than 20-fold increase from 1979 to 1999 (2). The incidence of serious complications with IVC filters is low, but device migration, IVC filter fracture, and strut embolization can occur (3). We present a case of right ventricle (RV) perforation caused by embolization of a fractured IVC filter presenting as acute pericarditis.

LEARNING OBJECTIVES

- To summarize the indications for IVC filter placement and understand the role of multimodality imaging in IVC filter complications.
- To understand the contribution of IVC filters to the differential diagnosis for chest pain.

HISTORY OF PRESENTATION

A 39-year-old man presented to Hennepin Healthcare with 3 days of pleuritic chest pain. He reported excellent functional capacity without previous angina or shortness of breath. He had a runny nose for several days without cough, fever, chills, or leg swelling. His symptoms worsened the morning of presentation, which prompted him to call emergency medical services, who gave him aspirin 324 mg and nitroglycerin, with minimal improvement.

MEDICAL HISTORY

The patient had a history of protein C and S deficiency, stroke status of post-ventriculoperitoneal shunt, and Cook Celect IVC filter (Cook Medical, Bloomington, Indiana) placement following multiple

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deep vein thromboses (DVTs) and submassive pulmonary emboli (PEs) occurring on anticoagulation.

DIFFERENTIAL DIAGNOSIS

The most likely differential diagnosis on arrival included pericarditis, recurrent PE, and acute coronary syndrome.

INVESTIGATIONS

On arrival, the patient's blood pressure was 98/63 mm Hg, heart rate was 80 beats/min, and respiratory rate was 22 breaths/min. He was afebrile, and oxygen saturation was 98% on room air. The examination findings were unremarkable, aside from a pericardial friction rub. The electrocardiogram showed diffuse ST-segment elevation and PR-segment depression (**Figure 1**). Troponin I measurements remained between 0.05 and 0.06 μg/l without a clear rise or fall. The remainder of his laboratory study results were unremarkable. Bedside ultrasonography showed a small pericardial effusion. He was started on colchicine and ibuprofen and admitted for suspected myopericarditis.

Transthoracic echocardiogram (TTE) showed a moderate pericardial effusion with pre-tamponade physiology. The patient's symptoms resolved with medication management, and he remained hemodynamically stable. Therefore, he was managed expectantly. A repeat TTE on hospital day 3 showed an increase in the effusion with diastolic RV collapse and a plethoric IVC, prompting a pericardiocentesis. During the procedure, 630 ml of hemorrhagic fluid was aspirated from the pericardial space. On fluoroscopic images, a linear metallic density (25 mm × 0.5 mm) was superimposed on the RV (**Figure 2**, Video 1). Repeat fluoroscopic imaging using oblique projections showed movement of the metallic density in concert with cardiac cycles, suspicious for a foreign body within the RV free wall. Computed tomography (CT) with intravenous contrast showed that one of the IVC filter struts was absent compared to 3 years prior, likely due to fracture, and confirmed the RV metallic density (**Figure 3A**) and multiple struts extending beyond the IVC (**Figures 3B and 3C**).

MANAGEMENT

The patient underwent urgent mediastinal exploration. The filter fragment was removed (**Figure 4**), and the perforation of the RV was repaired.

DISCUSSION

The morbidity and mortality of IVC filter placement depends on the type of filter, comorbidities, and procedural complexity. Two retrospective studies showed a mortality and major complication rate of 0.12% and 0.3% (4,5). Less common complications include IVC wall erosion, device migration, and strut embolization from IVC filter fracture.

The rate of fracture and embolization depends on the filter subtype and length of follow-up. A single-center retrospective analysis of 741 Celect filters (follow-up: 5.8 months) showed no fracture or filter migration (6), whereas a recent study looking at long-term IVC filter complications showed limb embolization rates of 10.2% and 12.3% for Cook Celect and Bard filters, respectively (3). Filter fracture can result in device embolization to the lungs and heart. There are several case reports of RV perforation from strut embolization, sometimes presenting as cardiac tamponade (7). To the best of our knowledge, this is the first case of fractured IVC strut-mediated RV perforation presenting as acute pericarditis.

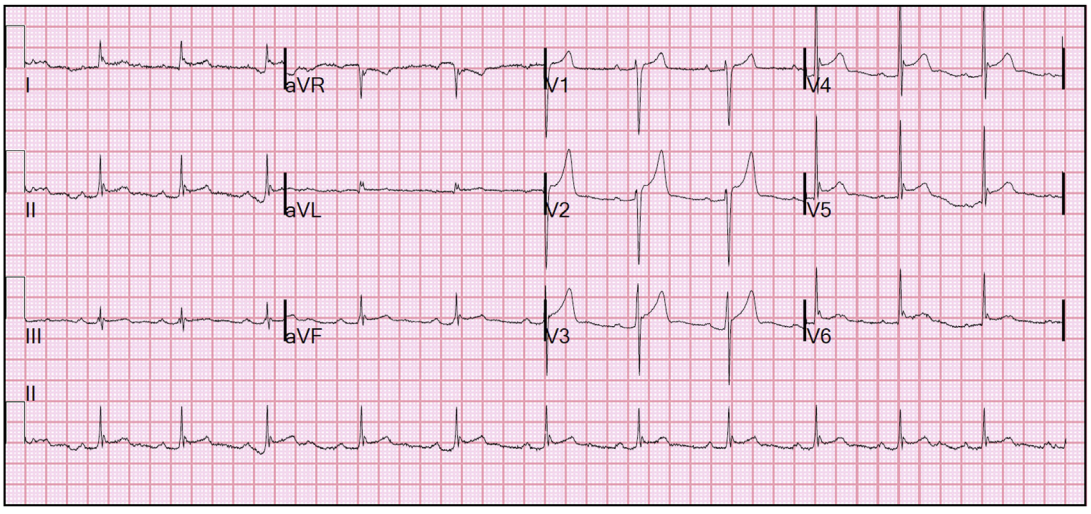
One proposed mechanism for strut fracture is repetitive flexion and strut fatigue, evidenced by multiple cases of fracture associated with vigorous exercise. One report shows a higher incidence of fracture with older filters (6). In our patient, the presence of multiple arms perforating the IVC was likely a major contributing factor to the eventual fracture and embolization.

Potential barriers to a timely diagnosis include: 1) inherent limitations of spatial resolution on TTE, which was not able to identify the fractured IVC filter strut; and 2) a lack of knowledge of rare but serious sequelae of IVC filter placement. Given these risks, we encourage judicious adherence to the American College of Chest Physicians (ACCP) guidelines for IVC filter placement. The rate of guideline nonadherence is high, with one study showing a 40% rate of IVC filter placement without an approved indication (8). The 2012 ACCP guidelines recommended IVC filters for acute DVT of the leg with contraindications to anticoagulation. The 2016 guidelines were less prescriptive and recommend against IVC filters only in patients with DVT or PE treated with anticoagulants (1,9). Although our patient had a contraindication to anticoagulation at the time of IVC filter placement, earlier removal was indicated.

ABBREVIATIONS AND ACRONYMS

CT = computed tomography
DVT = deep venous thrombosis
IVC = inferior vena cava
PE = pulmonary embolism
RV = right ventricle
TTE = transthoracic echocardiogram

FIGURE 1 Electrocardiogram in the Emergency Department Showing Diffuse ST-Segment Elevation and PR-Segment Depression



Longer IVC filter dwell times are associated with higher rates of complications, including caval wall perforation, filter tilting, migration, and embolization (10). Therefore, percutaneous retrieval is recommended once contraindications to anticoagulation have resolved (1,4). Strut erosion into the IVC wall can make percutaneous removal difficult. In patients for whom percutaneous removal fails, open IVC filter removal can be done in those with symptoms attributable to the IVC filter (10).

FIGURE 2 Fluoroscopic Image Showing an Embolized Inferior Vena Cava Filter Strut Superimposed on the Right Ventricle

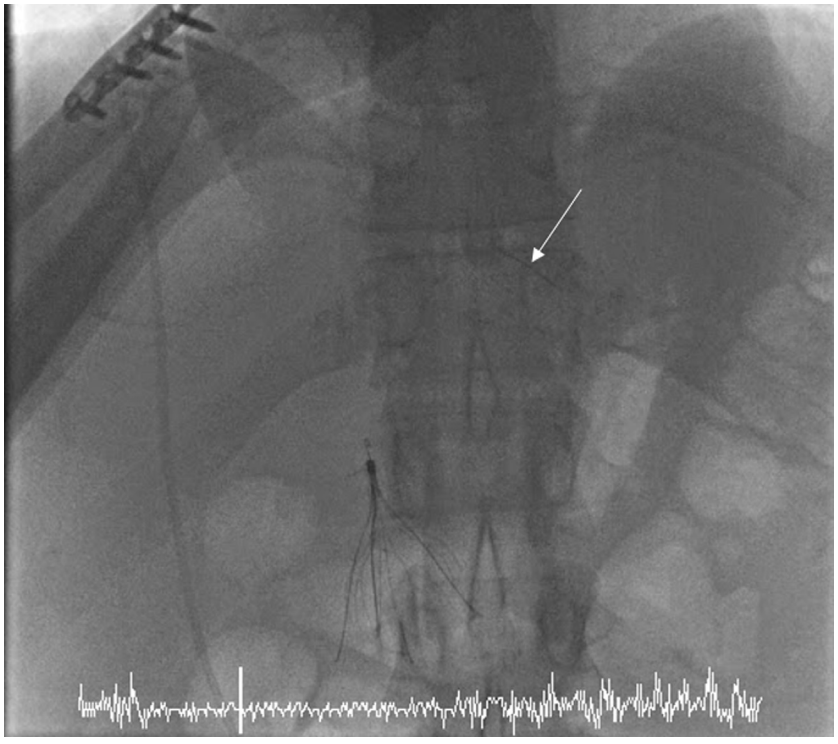
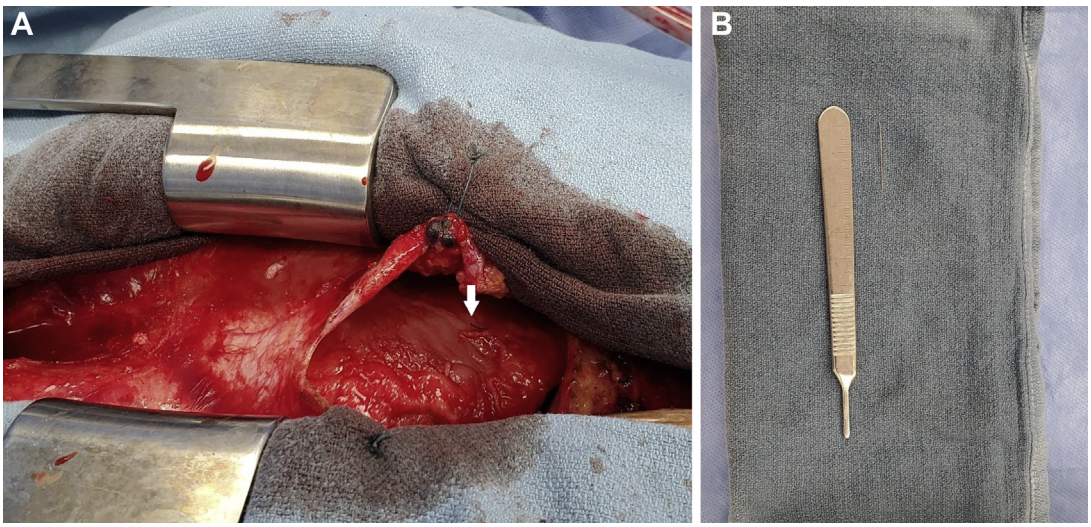


FIGURE 3 **Computed Tomography Scan Showing Right Ventricular Perforation by an Embolized Inferior Vena Cava Filter Strut**

(A) Sagittal computed tomography showing a 2.5-cm inferior vena cava strut perforating the free wall of the right ventricle. **(B)** Transverse computed tomography showing the inferior vena cava filter with a primary strut abutting the aortic wall **(white arrow)** and multiple primary struts extending posteriorly with the distal portion of one strut embedded in the vertebral body of L2 **(black arrow)**. **(C)** Coronal view of the inferior vena cava filter in place with a strut abutting the wall of the aorta.

In this case, our patient's constellation of clinical findings and his response to ibuprofen and colchicine was suggestive of viral pericarditis. Still, the consideration of IVC fracture and embolization is in the differential diagnosis for any patient with pericardial effusion and an IVC filter. In cases of suspected IVC filter migration or embolization, noncontrast CT is reasonable when there is clinical

FIGURE 4 Intraoperative View of the Inferior Vena Cava Filter Strut Perforating the Epicardium



(A) The embolized inferior vena cava filter strut **(white arrow)** penetrating the epicardium. **(B)** The retrieved inferior vena cava filter strut.

uncertainly or suspicion for IVC filter-related pathology.

FOLLOW-UP

The patient's post-operative course was unremarkable; the IVC filter was safely removed percutaneously after discharge.

CONCLUSIONS

IVC filter migration and strut embolization, although rare, should be considered before filter placement. ACCP guidelines can be followed to ensure the appropriate use of IVC filters. Strut fracture and cardiac embolization should be considered in patients with IVC filters who present with chest pain, pericarditis, or pericardial effusion. CT of the chest and abdomen is recommended to evaluate for IVC filter strut fracture and embolization.

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Dr. Carlson is a consultant for Sage Health Management Solutions. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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REFERENCES

1. Kearon C, Akl EA, Comerota AJ, et al. Antithrombotic therapy for VTE disease: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest 2012;141 Suppl 2:e419S–96S.

2. Stein PD, Kayali F, Olson RE. Twenty-one-year trends in the use of inferior vena cava filters. Arch Intern Med 2004;164:1541–5.

3. Ayad MT, Gillespie DL. Long-term complications of inferior vena cava filters. J Vasc Surg Venous Lymphat Disord 2019;7:139–44.

4. Becker DM, Philbrick JT, Selby JB. Inferior vena cava filters: indications, safety, effectiveness. Arch Intern Med 1992;152:1985–94.

5. Athanasoulis CA, Kaufman JA, Halpern EF, et al. Inferior vena caval filters: review of a 26-year single-center clinical experience. Radiology 2000;216:54–66.

6. Wang W, Zhou D, Obuchowski N, et al. Fracture and migration of celect inferior vena cava filters: a retrospective review of 741 consecutive implantations. J Vasc Interv Radiol 2013;24:1719–22.

7. Sako Z, Avula SR, Gaies E, et al. Migration of a fractured inferior vena cava filter strut to the right ventricle of the heart. BMJ Case Rep 2018;2018: bcr2017222054.

8. Patel G, Panikkath R, Fenire M, et al. Indications and appropriateness of inferior vena cava filter placement. Am J Med Sci 2015;349:212–6.

9. Kearon C, Akl EA, Ornelas J, et al. Antithrombotic therapy for VTE disease: CHEST guideline and expert panel report. Chest 2016;149: 315–52.

10. Charlton-Ouw KM, Afaq S, Leake SS, et al. Indications and outcomes of open inferior vena cava filter removal. Ann Vasc Surg 2018;46:205.e5–11.

KEY WORDS cardiac tamponade, IVC filter, pericardial effusion, procedural complications, right ventricular perforation

APPENDIX For a supplemental video, please see the online version of this paper.