JACC: CASE REPORTS VOL. 2, NO. 15, 2020

PROCEDURAL COMPLICATIONS: PART 1

INTERMEDIATE

CASE REPORT: CLINICAL CASE

Percutaneous Extraction of an Embolized IVC Filter Strut Embedded in the Right Ventricle

Dominik Beer, DO, Kishore Harjai, MD, Terry D. Bauch, MD, Pugazhendhi Vijayaraman, MD

ABSTRACT

The incidence of IVC filter fracture is high with risk for embolization and may require open surgery. We present a minimally invasive approach of complex transcatheter extraction of an embolized and embedded IVC filter strut from the right ventricle. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2020;2:2318–22) © 2020 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

PRESENTATION

A 29-year-old female presented to the emergency department with acute onset sharp and pleuritic chest pain which woke her out of sleep. Her chest pain was severe and made worse by leaning forward and deep inspiration. Physical examination was pertinent for clear lung fields, a heart rate of 110 beats/min, and blood pressure of 110/70 mm Hg with a pulsus paradoxus of 16 mm Hg. Echocardiography revealed a >10-mm circumferential pericardial effusion (**Figure 1A**) with echocardiographic evidence of tamponade.

MEDICAL HISTORY

The patient had a history of a large burden, deep venous thrombosis and pulmonary embolism 7 years prior for which she was treated with therapeutic anticoagulation and an Eclipse inferior vena cava (IVC) filter (Bard, Tempe, Arizona). Six years previously, 2 attempts to remove the filter were unsuccessful due to the tilt of the filter in relation to the IVC and neointimal coverage of the filter hook. No subsequent catheter procedures through the IVC filter were reported. Furthermore, due to suspicion of a hypercoagulable state, she had remained on therapeutic anticoagulation with warfarin.

LEARNING OBJECTIVES

- To understand the potential complication of embolization of fractured IVC filter strut.
- To understand the treatment options for removal of embolized IVC filter strut.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis included pericarditis, myopericarditis, myocardial infarction complicated by pericardial effusion, pulmonary embolism, and IVC filter-related complications such as fragment embolization and right ventricular (RV) perforation.

INVESTIGATIONS

Approximately 600 ml of brown-colored hemorrhagic fluid was removed during pericardiocentesis from the apical approach, using ultrasonographic,

From the Department of Cardiac Electrophysiology, Geisinger Heart Institute, Wilkes Barre, Pennsylvania, USA.
The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received May 5, 2020; revised manuscript received June 22, 2020, accepted July 29, 2020.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2020.07.054

fluoroscopic, and electrographic guidance. A metallic foreign object was noticed within the right ventricle during echocardiography and on subsequent imaging (Figure 1). Computed tomography (CT) scanning further characterized the foreign body in the right ventricle and identified it as an embolized IVC filter strut (Figure 1). The CT scan also revealed a dislocated strut still attached to the main body of the filter in the IVC. The images were reviewed with vascular surgery, interventional cardiology, electrophysiology, and cardiothoracic surgery staff, and a multidisciplinary decision was made to attempt percutaneous extraction first with cardiothoracic surgical backup.

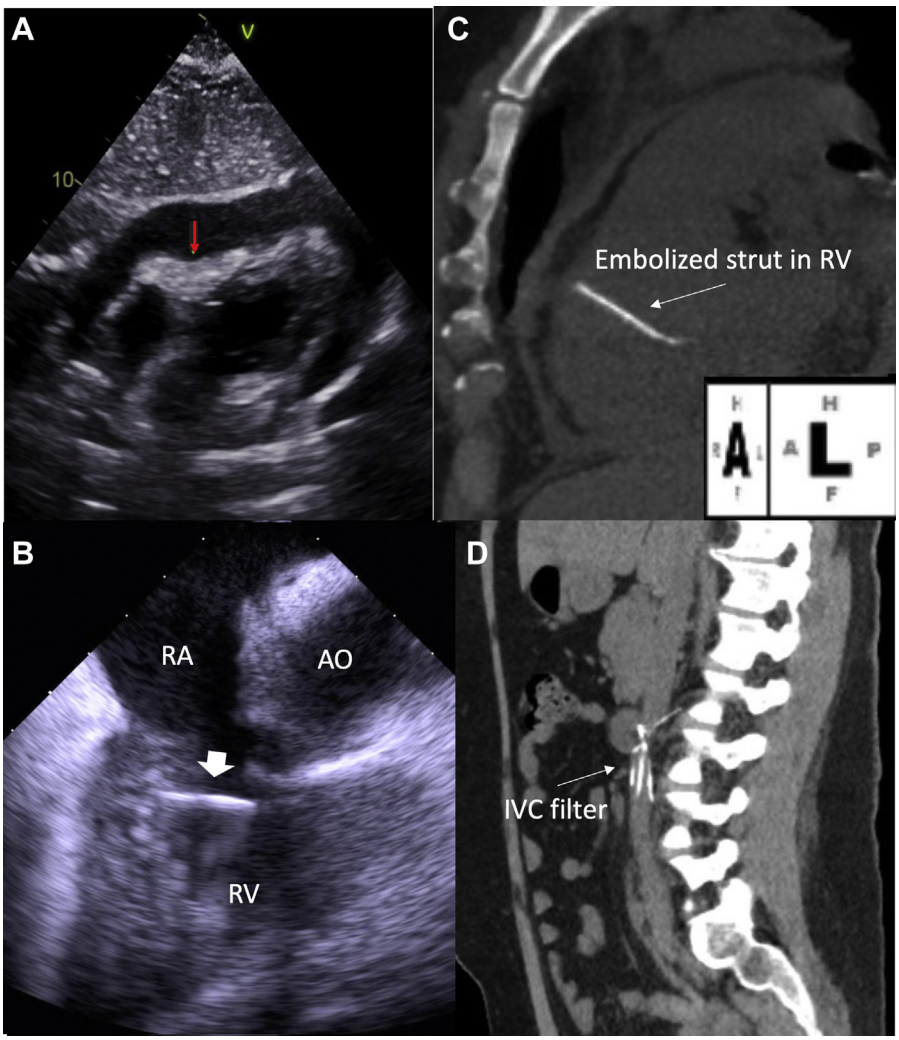
MANAGEMENT

Extraction attempts were initially performed using a right internal jugular vein approach. An Amplatz gooseneck snare (Medtronic, Minneapolis, Minnesota) was used first to attempt to snare the object (Figure 2A). When the object could not be snared

ABBREVIATIONS AND ACRONYMS

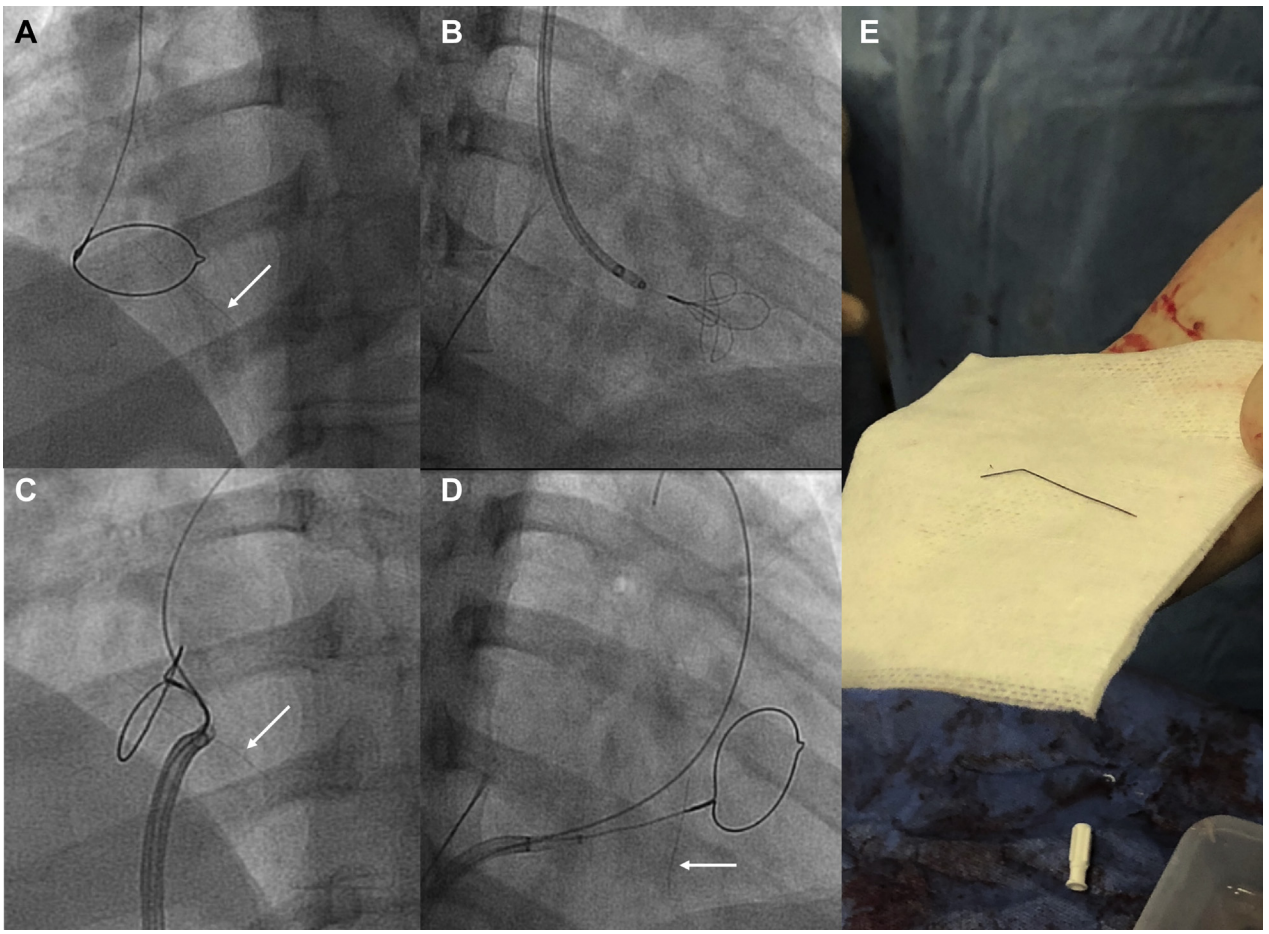
CT = computed tomography
IVC = inferior vena cava
RV = right ventricular

FIGURE 1 Embolized IVC Filter Strut



(A) Subcostal transthoracic echo image reveals a large circumferential pericardial effusion with complete right ventricular (RV) obliteration **(red arrow)**. **(B)** Intracardiac echo images reveal that the foreign body **(white arrow)** is imbedded in the RV free wall on one end and the interventricular septum on the other end (Video 1). **(C)** Dedicated computed tomographic imaging shows the IVC strut in its long axis. **(D)** IVC filter is shown in the sagittal plane with another strut directed superiorly and posteriorly outside the vessel lumen. AO = aorta; IVC = inferior vena cava; RA = right atrium.

FIGURE 2 Extraction of IVC Filter Strut from the Right Ventricle



(A) An Amplatz gooseneck snare is used to attempt to capture the foreign body **(white arrow)** around its free end in a straight LAO 30° projection. **(B)** An ENsnare (Merit Medical) is used to attempt to capture the foreign body around its free end in straight RAO 40°. **(C)** A lasso technique is used to extract the foreign body using an Amplatz gooseneck snare and wire in a straight LAO 30° and **(B)** straight RAO 40°. **(E)** The successfully extracted and intact filter strut is shown. IVC = inferior vena cava; LAO = left anterior oblique; RAO = right anterior oblique.

with this approach, an ENsnare (Merit Medical, South Jordan, Utah) was used (Figure 2B). This too proved unsuccessful, and intracardiac echocardiography was used at this point to better understand the foreign body's position within the RV. Intracardiac echocardiography revealed that the foreign body was in fact embedded in the RV free wall on one end and in the interventricular septum on the other end (Figure 1B, Video 1) with no free end to lasso. At that point, femoral venous access was obtained, and an initial attempt to use a needle's eye snare was unsuccessful due to the inability to advance the snare into the right ventricle and orient it toward the strut. Subsequently, a deflectable Agilis sheath (Abbott, Santa Clara, California) was placed in the right atrium after carefully negotiating the IVC filter. A glide wire was passed beyond and around the foreign body and then lassoed on the other side with a gooseneck snare (Figures 2C and 2D). Once the strut was encircled, the wire was tightened while advancing the Agilis in an attempt to envelop the strut prior to encountering the tricuspid valve. The entire ensemble was then retracted into the catheter, folding and retracting the foreign body along with it (Figure 2E). There were no procedural complications, and follow-up echocardiography showed no reaccumulation of pericardial fluid. The patient was discharged from the hospital pain free.

DISCUSSION

Use of IVC filters is an alternative or adjunctive guideline-supported treatment for venous thromboembolism but is associated with risk of fracture, perforation, and embolization (1-5). Because of these risks, it is essential that these filters be removed and that the pros and cons of this approach be discussed with the patient during their follow-up visit. Although percutaneous extraction of embolized filter struts have previously been described (6,7), the present case of an embolized strut embedded in the RV free wall and septal myocardium on both ends illustrates the role for attempted percutaneous extraction in even the most difficult cases. IVC filter fractures (incidence of up to 16%) and migrations to the heart or lungs (incidence of 1.0% to 4.5%) are well-described risks with long-term filter implantation and are proportional to filter dwell time (6). Inability to retrieve temporary IVC filters, with a retrieval failure rate as high as 5.5% in prospective studies, compounds the long-term complication rate (8). This problem has resulted in considerable complication reporting in the Manufacture and User Facility Device Experience (MAUDE) database (9). Several techniques, including the use of rigid endobronchial forceps, have been described to remove embedded, fractured, or tilted retrievable IVC filters from patients in whom standard retrieval techniques were unsuccessful (10, 11). Similarly, techniques including use of electroanatomical mapping and 3-dimensional ultrasonography have been used to successfully remove IVC struts embolized to the right ventricle (7). The needle's eye snare can also be used to capture a foreign body without a free end. Lack of deflectability and directionality with this approach makes it challenging to snare a small embedded strut. The ability to deflect and orient the snare and sheath toward the embedded strut using an Agilis sheath made the retrieval feasible in this case. Percutaneous extraction, as detailed here, is a potential option that avoids open-heart surgery.

FOLLOW-UP

The patient was referred to a center with expertise in complex tip-embedded IVC filter extraction, and she underwent successful percutaneous removal of the retained IVC filter using an endobronchial forceps technique (11). This patient had no further sequelae or hospitalizations.

CONCLUSIONS

This report describes unusual case of an embolized IVC filter strut in which both ends of the strut were embedded in the RV free wall, and interventricular septal myocardium leading to hemorrhagic pericardial effusion and tamponade. Percutaneous extraction was shown to be a viable management approach.

AUTHOR DISCLOSURES

Dr. Harjai has received honoraria from Edwards Lifesciences, Cordis, and Boston Scientific. Dr. Vijayaraman has served as a speaker and consultant and performed research for Medtronic; and has served as a consultant for Boston Scientific, Abbott, and Biotronik. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr. Pugazhendhi Vijayaraman, Cardiac Electrophysiology, Geisinger Commonwealth School of Medicine, Geisinger Heart Institute, MC 36-10, 1000 East Mountain Boulevard, Wilkes-Barre, Pennsylvania 18711, USA. E-mail: pvijayaraman@gmail.com.

REFERENCES

1. Secemsky EA, Carroll BJ, Yeh RW. Inferior vena cava filters and mortality: is it the underlying process, the patient, or the device? JAMA Netw Open 2018;1:e180453.

2. Turner TE, Saeed MJ, Novak E, Brown DL. Association of inferior vena cava filter placement for venous thromboembolic disease and a contraindication to anticoagulation with 30-day mortality. JAMA Netw Open 2018;1:e180452.

3. Jaff MR, McMurtry MS, Archer SL, et al. Management of massive and submassive pulmonary embolism, iliofemoral deep vein thrombosis, and chronic thromboembolic pulmonary hypertension: a scientific statement from the American Heart Association. Circulation 2011;123:1788–830.

4. Kaufman JA, Kinney TB, Streiff MB, et al. Special communications-guidelines for the use of retrievable and convertible vena cava filters: report from the society of interventional radiology multidisciplinary consensus conference. J Vasc Interv Radiol 2006;17:449–59.

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

6. Nicholson W, Nicholson WJ, Tolerico P, et al. Prevalence of fracture and fragment embolization of bard retrievable vena cava filters and clinical implications including cardiac perforation and tamponade. Arch Intern Med 2010;170: 1827–31.

7. Hannawa KK, Good ED, Haft JW, Williams DM. Percutaneous extraction of embolized intracardiac inferior vena cava filter struts using fused intracardiac ultrasound and electroanatomic mapping. J Vasc Interv Radiol 2015;26: 1368–74.

8. Angel LF, Tapson V, Galgon RE, Restrepo MI, Kaufman J. Systematic review of the use of retrievable inferior vena cava filters. J Vasc Interv Radiol 2011;22:1522–30.

9. Lee M, Valenti D, De Gregorio M, Minocha J, Rimon U, Pellerin O. The CIRSE retrievable IVC

filter registry: Retrieval success rates in practice. Cardiovasc Intervent Radiol 2015;38:1502–7.

10. Tavri S, Patel IJ, Kavali P, Irani Z, Ganguli S, Walker TG. Endobronchial forceps-assisted complex retrieval of inferior vena cava filters. J Vasc Surg Venous Lymphat Disord 2019;7:413–9.

11. Stavropoulos SW, Ge BH, Mondschein JI, Shlansky-Goldberg RD, Sudheendra D, Trerotola SO. Retrieval of tip-embedded inferior vena cava filters by using the endobronchial forceps technique: experience at a single institution. Radiology 2015;275:900–7.

KEY WORDS cardiac tamponade, extraction, intracardiac echo, IVC filter

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