Penn Medicine

CLINICAL BRIEFING™

Division of Interventional Radiology

Complex Retrieval of Embedded or Fractured Inferior Vena Cava Filters

Interventional radiologists at Penn Medicine are performing retrieval of tip-embedded and/or fractured inferior vena cava (IVC) filters using endobronchial forceps, a technique developed by Penn Interventional Radiology. The efficacy and safety of the technique has been confirmed in several clinical studies published in the medical literature,[1] and it has become the standard world-wide for complex filter retrieval.[2]

The largest venous trunk in the body, the IVC is a conduit for thromboemboli originating in the legs. Among hypercoagulable individuals, particularly those with contraindications for anticoagulant therapy, blood clots are the primary cause of catastrophic pulmonary embolism. Percutaneous placement of permanent or retrievable IVC filters is an effective way to trap these clots before they reach the lungs.

Although the FDA recommends that IVC filters be removed when no longer needed, it is estimated that fewer than half of retrievable devices are taken out each year. This number includes the 5 to 10 percent of retrieval attempts that fail because the filter tip is embedded in a vessel wall. Tip-embedded filters must be removed because they present a substantial risk for vessel occlusion and further penetration through the IVC into bowel, bone, arteries and other structures.

Fragmentation of the filter struts is also a possibility, necessitating removal of fractured and/or embolized filter elements to prevent further complications such as pericardial tamponade and arrhythmia, among others.[3]

Standard retrieval of IVC filters involves capturing the devices with snares or cones. Neither technique is effective, however, when the filter tip is embedded in the vessel wall, a circumstance that prompted clinicians at Penn Interventional Radiology to develop a technique employing endobronchial forceps.

IVC Filter Retrieval at Penn

For nearly two decades, interventional radiologists at Penn Medicine have been developing methods to improve the results of IVC filter retrieval and to optimize retrieval of tip-embedded and/or fractured caval filters. Every tip-embedded filter retrieval is considered a high-risk procedure. Incomplete, failed or overly aggressive removal of the filter can result in vessel damage with consequent bleeding risk and/or further distortion/fracture of the filter.

The approach to these complex retrievals involves the use of endobronchial forceps placed into the IVC from the right internal jugular vein through a sheath, dissecting away engulfing tissue, grasping the filter tip and removing the device. This and other techniques can be used, as well, to remove fragments from the IVC, heart, and lungs.[3]

The technique incorporates several imaging modalities, including rotational venography, spot radiography and CT venography.

In a retrospective study at Penn, the endobronchial forceps approach was used successfully to retrieve 109 of 114 (96%) tip-embedded IVC filters.[1] Three minor complications and one major complication occurred (the latter involved a patient in whom the struts as well as the tip were embedded), but these resulted in no permanent sequelae.

Based on over 600 complex removals, the success rate is now more than 99%. Penn IR physicians have not failed to remove a filter in over 10 years. The safety profile remains the same: 1% major complications, nearly all small caval perforations requiring observation only.

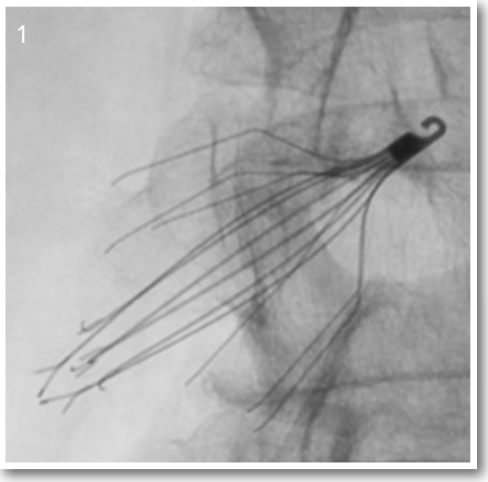

Figure 1: A tip-embedded IVC filter appearing on CT colonoscopy. This filter is spanning the renal veins; typically IVC filters are placed below or above the renal arteries.

CASE STUDY 1

Mrs. J, a 64-year-old woman had an IVC filter placed in a community hospital when she developed unprovoked bilateral lower extremity DVTs and massive pulmonary emboli several days after surgery for an inguinal hernia.

Mrs. J was started on heparin, but when she developed bleeding, her anticoagulation was stopped and a temporary IVC filter placed.

She was later started on apixaban, which she tolerated well. Both her pulmonologist and her hematologist recommended lifelong anticoagulation, and when she saw the surgeon who had inserted the filter, he recommended it stay in place lifelong, as well.

Several months later, Mrs. J obtained a second opinion regarding the possibility of filter removal. During this visit, a review of a recent CT scan revealed that the filter was malpositioned such that it spanned the IVC with one end in each renal vein (Fig 1). Mrs J was referred to Penn Interventional Radiology for further assessment.

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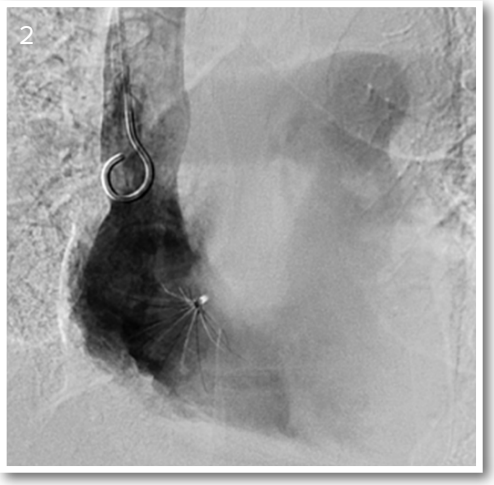

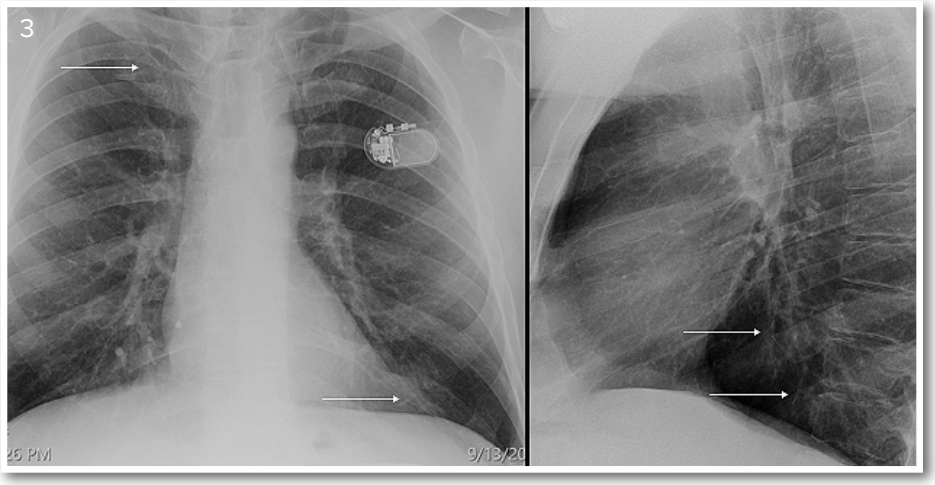

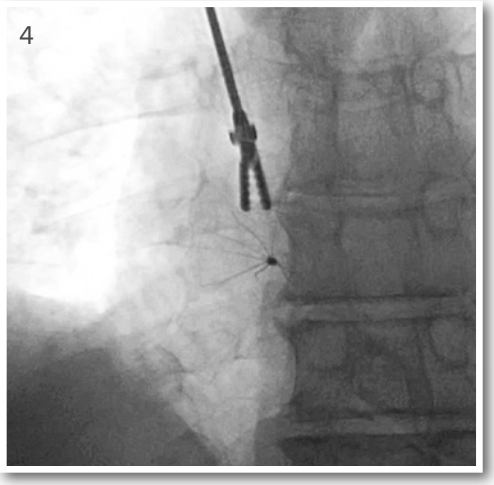

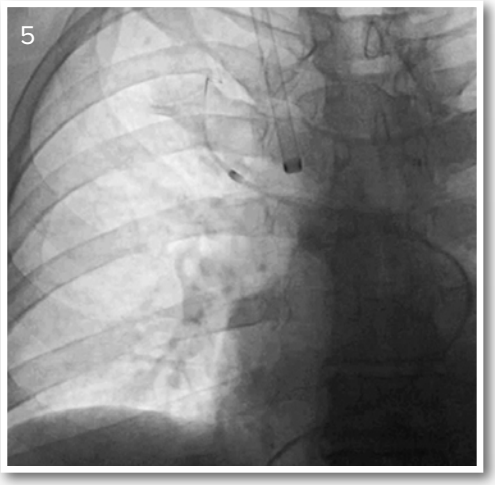

Figure 2: An IVC filter lodged in the right atrium of the heart. The loop shown is a diagnostic pigtail catheter (not used for retrieval).

Figure 3: Fragments from the IVC filter struts within the pulmonary veins.

Figure 4: Endobronchial forceps preparing to grasp and remove the atrial IVC filter.

Figure 5: A 5 mm snare inserted through a hockey stick catheter retrieving fragments of the IVC filter in the pulmonary veins.

CASE STUDY 1 *Continued from page 1.*

At Penn IR, Mrs. J reported that while she had no chest pain, she had pain in her upper abdomen, particularly on the left side, left hip discomfort and sciatica, frequent numbness and tingling in her right foot with prolonged standing or walking, and occasional left calf discomfort when walking.

A venogram at Penn IR confirmed the malposition of the filter (Figure 2), which was subsequently removed with endobronchial forceps in a procedure that lasted less than half an hour (total fluoroscopy time 9 minutes). At her one-month follow-up, Mrs. J reported that her symptoms had resolved.

CASE STUDY 2

Mr. G, a 60-year-old man with a history of IVC filter placement following a DVT in his mid-50s, was admitted to the Hospital of the University Pennsylvania (HUP) for a neurostimulator revision. At HUP, pre-operative chest X-rays revealed that the filter had migrated into the right atrium of Mr. G's heart (Figure 2); filter fragments were also found in the pulmonary arteries (Figure 3).

The working diagnosis was that the filter had been dislodged by a guide wire during a central line placement procedure, or had migrated spontaneously to the heart. Mr. G demonstrated no arrhythmia or pericardial effusion during his workup.

He was referred to Penn IR, where endobronchial forceps were used to remove the IVC filter under fluoroscopic guidance (Figure 4). A snare was then used to retrieve the pulmonary artery fragments (Figure 5).

Reference

[1] Stavropoulos SW, Ge BH, Mondschien Ji, Shlansky-Goldberg Rd, Sudheendra D, Trerotola SO. Retrieval of tip-embedded inferior vena cava filters by using the endobronchial forceps technique. Radiology 2015;12:141420.

[2] Lian W, Tian F, Li S, Gu X, Jia Z. Forceps-assisted Removal of Difficult-to-Retrieve Filters: Preliminary Results. Ann Vasc Surg 2019;61:371-376.

[3] Trerotola SO, Stavropoulos SW. Management of Fractured Inferior Vena Cava Filters: Outcomes by Fragment Location. Radiology 2017;284:887-896.

FACULTY TEAM

The specialists with the Division of Interventional Radiology Division at Penn Medicine offer the diagnosis and treatment of a variety of diseases, disorders and conditions using minimally invasive techniques. In addition to dedicated IR suites, the Division has an active outpatient clinic, admitting and consulting services.

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