YALE JOURNAL OF BIOLOGY AND MEDICINE 85 (2012), pp.255-259.

CASE REPORT

Recurrent Fracture of a Recovery Inferior Vena Cava Filter with Pulmonary Migration

Josephina Anna Vossen, MD PhD[a*]; Shrey Kumar Thawait, MD[a]; Jennifer Susan Golia, MD[a]; Murthy Chamarthy, MD[a]; Walter Cholewczynski, MD[b]; and Noel Velasco, MD[a]

[a]Department of Radiology and [b]Surgery, Bridgeport Hospital, Yale School of Medicine, Bridgeport, Connecticut

Inferior vena cava (IVC†) filters are indicated in patients with venous thromboembolic disease in whom standard anticoagulation therapy is contraindicated or ineffective. A 32-year-old female presented to our hospital with chest pain 5 years after IVC filter placement. Imaging revealed sequential fracturing and embolization of two of the IVC filter arms to the pulmonary arteries. IVC filter fracture and subsequent migration to the lung is a rare complication. Systematic long-term follow-up in patients with IVC filters and, if possible, filter removal should be considered to prevent possible complications.

INTRODUCTION

Deep vein thrombosis (DVT) and pulmonary embolism (PE) are frequent and potentially fatal conditions. The mortality rate of untreated PE is reported to be as high as 30 percent [1,2]. Venous thromboembolism (VTE) often starts as a thrombus within the large veins of the lower extremity or pelvis. A portion of this thrombus has the potential to break away and migrate to the pulmonary arteries, giving rise to a pulmonary embolism. Certain factors are believed to contribute to the formation of thrombus, including advanced age, obesity, trauma, surgery, major med-

*To whom all correspondence should be addressed: Josephina A. Vossen, Department of Radiology, Bridgeport Hospital, 267 Grant St., Bridgeport, CT 06610; Tele: 203-384-3834; Fax: 203-384-3833; Email: jvossen1@jhmi.edu.

†Abbreviations: IVC, inferior vena cava; DVT, deep vein thrombosis; PE, pulmonary embolism; VTE, venous thromboembolism; V/Q, ventilation/perfusion.

Keywords: inferior vena cava filter, pulmonary embolism, complications, fracture, migration

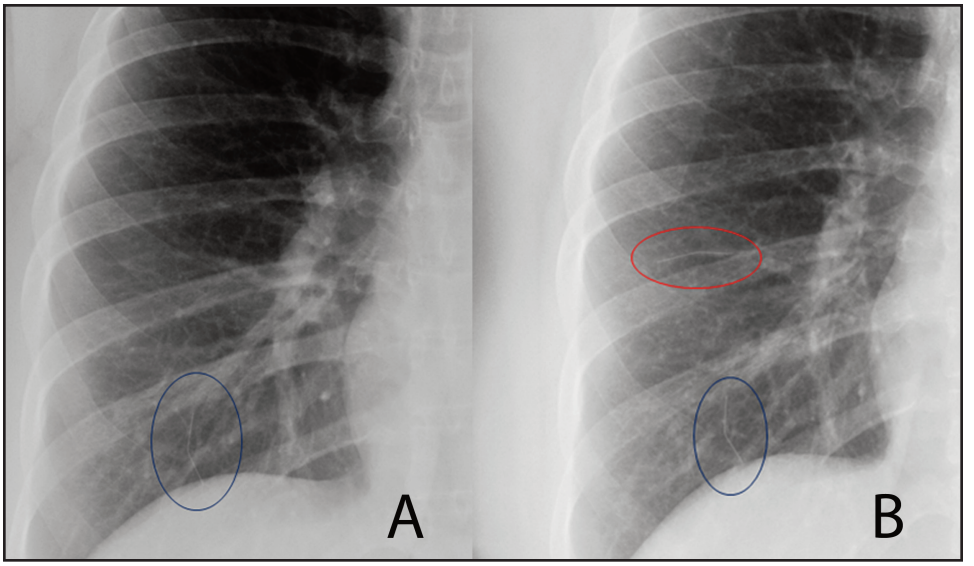

Figure 1. A. Frontal chest X-ray 2 years after filter placement showing a single linear opacity in the right lower lung field (blue). **B.** Frontal chest X-ray 5 years after filter placement showing an additional linear metallic foreign body within the right lung (red).

ical illness, and previous VTE; in addition, there may also be genetic risk factors for VTE [3].

Anticoagulant therapy is the mainstay of treatment for VTE [4]. The use of inferior vena cava (IVC) filters have gained acceptance for patients in whom standard anticoagulant therapy is contraindicated or ineffective [5,6]. IVC filters are designed to trap possible thromboemboli, while preserving normal blood flow in the IVC. The Mobin-Uddin umbrella filter (1967) was the first filter designed for this purpose, followed by the Kimray-Greenfield stainless steel IVC filter in 1973 [7]. Over the last decades, several IVC filters have been developed, featuring various materials, designs and delivery systems.

The Recovery filter (G1; Bard Peripheral Vascular, Tempe, AZ), commercially available from June 2003 to August 2005, is an IVC filter that can be retrieved after placement [8,9]. This filter is composed of six filter leg wires with anchoring hooks in a standard radial symmetric configuration and an additional six outward-directed centering arm wires at the top of the filter [10,11]. IVC filters are considered safe to deploy and effective in most patients. However, there have been several reports of short- and long-term complications. We report a case of repeated filter fracture and pulmonary migration.

CASE PRESENTATION

A 32-year-old female with a medical history of five caesarean sections and chronic pelvic pain presented to our hospital for diagnostic laparoscopy. Postoperatively, the patient developed chest pain and shortness of breath. A ventilation/perfusion (V/Q) scan demonstrated large segmental mismatched defects in both lungs, resulting in high probability for a pulmonary embolus. The patient was anticoagulated and discharged to home on oral warfarin therapy.

Two years later, the patient underwent exploratory laparotomy, total abdominal hysterectomy, salpingo-oophorectomy, and lysis of adhesions. Considering the history of pulmonary embolism and noncompliance with the oral anticoagulation therapy, the decision was made to place an IVC filter during the same admission. A Recovery filter was successfully deployed in an infrarenal position via a right femoral approach. A caval venogram after filter placement showed no extravasation of contrast and good filter alignment. Six months after fil-

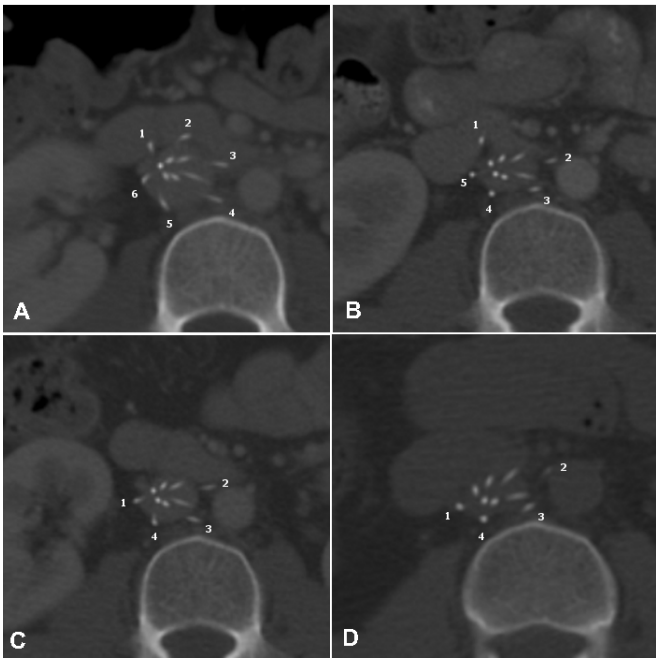

Figure 2. A. Axial CT image demonstrating the Recovery filter within the inferior vena cava, in close relationship to the spine and right kidney. The six upper arms of the Recovery filter (numbered 1 to 6) and the six legs (not numbered) are intact. **B.** Axial CT image obtained 3 years later demonstrating a missing filter arm. **C and D**. Axial CT images obtained 4 years and 5 years later, respectively, demonstrating two missing filter arms.

ter placement, the patient was prompted to return for consultation. However, at this time, the patient was not receptive and refused filter removal.

During the following 5 years, the patient presented to the hospital several times with chest pain and shortness of breath. The workup for PE remained negative. Five years after placement of the IVC filter, a plain chest radiograph showed two linear filter struts projecting over the right hemithorax (Figure 1). An abdominal CT study showed the absence of two of the short "alignment" arms of the Recovery filter. Retrospective review of prior abdominal CT scans showed sequential flexion of these arms, followed by their fracture and migration (Figures 2 and 3). Furthermore, the fractures' fragments within the pulmonary arteries could not be easily identified on the prior pulmonary CTA scans (Figure 4).

DISCUSSION

We describe a case of sequential flexion, fracture, and pulmonary migration of the wires of a retrievable IVC filter. Anticoagulation has been accepted as an effective treatment for venous thrombosis and PE. IVC filters have been used for the prevention of PE in patients with contraindications to anticoagulation and in patients with progressive venous thromboembolic disease despite anticoagulation [6].

IVC filters have been shown to be relatively safe. The most common complications after IVC filter placement are recurrent PE, thrombosis of the IVC, and local access site complications [6,12,13]. Migration of the filter is a relatively rare complication [14]. Filter fractures are extremely rare and have been reported in 1 to 2 percent of cases [15]. There is limited data published on the long-term outcomes with the Bard Recovery filter. This filter, described in our case, was commercially available until August 2005, when it was voluntarily withdrawn from the market and replaced by the Bard G2 filter [8,9]. The modified G2 filter was designed to decrease risk of perforation, migration, and fracture.

The risk of these long-term complications of indwelling filters increases with time; therefore, retrievable filters are considered beneficial to avoid possible late complications [16,17]. Despite the advantages of retrieval, only a small number of patients return for filter removal [18,19]. Grande et al. reported a less than 15 percent retrieval rate in all Recovery filters placed

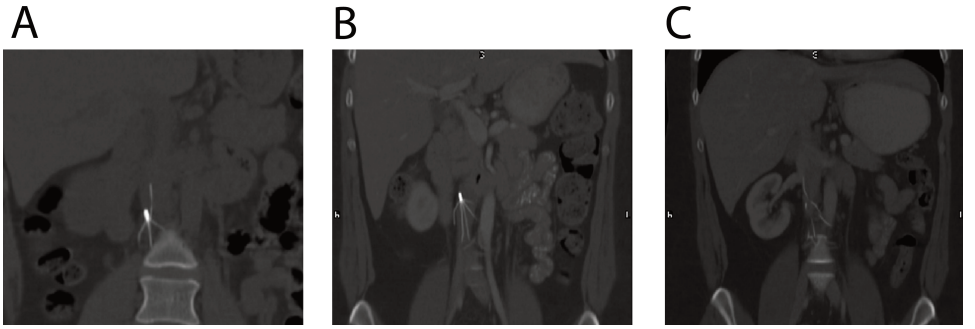

Figure 3. A. Coronal reformatted CT image demonstrating flexion of one of the upper arms of the Recovery filter 3 years after initial filter placement. **B.** Coronal reformatted CT image obtained 1 year later demonstrating the previously flexed filter arm now to be missing. **C.** Coronal reformatted CT image obtained 6 months later showed another filter arm flexed upward.

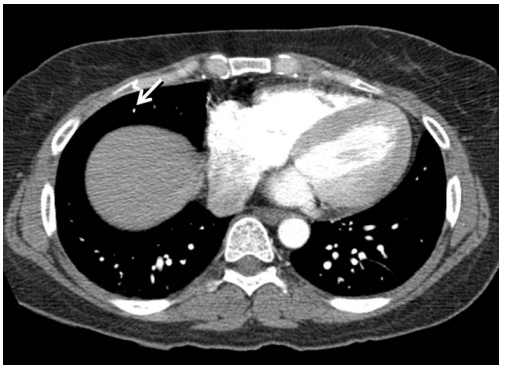

Figure 4. Axial CT image of the chest demonstrating the fractured and migrated IVC filter strut as a bright radiolucent structure within a right pulmonary artery branch (arrow). The surrounding enhancing pulmonary branches appear bright as well, due to administration of contrast, and are difficult to distinguish from the IVC filter strut.

with the intention of future retrieval [20]. An overestimation of the number of patients who need only temporary IVC filtration combined with high rates of loss to follow-up probably contribute to this low retrieval rate. The filter in our case was placed with the intent of removal, however, due to poor patient compliance, was never retrieved.

Nicholson et al. reported a 25 percent (seven of 28) prevalence of device fragmentation and embolization in patients with the Bard Recovery filter. All the fractured fragments embolized to an end organ [21]. Another study showed filter leg fractures with migration into the right ventricle, the pulmonary artery, and the retroperitoneum in 21 percent of the patients (three of 14) [18]. A MAUDE database search performed by Desjardins et al. demonstrated 329 reported cases of significant malfunction of the Recovery filter within a 6-year period, including 69 cases of filter migration, 149 cases of filter fragmentation, and 88 cases of filter fragment migration [22]. The migrated fragments were reported to be lodged within the heart and lungs. The unique feature in our case is the fact that two of the filter arms underwent consecutive fracture and pulmonary migration. This highlights the increased risk for a subsequent filter fragment migration after the first event.

The mechanism of fracture may be related to tilting of the filter, continuous strain on the engaged strut resulting in repetitive flexion, and eventual fracture caused by metal fatigue. In our case, both leg fractures were preceded by leg flexion. To detect malposition, leg flexion or fracture, a plain radiograph of the abdomen is the initial screening test that will allow detection of gross changes in filter position, location, and orientation. Additionally, abdominal CT scanning can be useful in detecting filter angulation, caval perforation, and leg flexion and fracture. The fractured and migrated IVC filter struts within pulmonary arteries are difficult to distinguish from surrounding enhancing vessels on pulmonary CTA. Therefore, careful review of the plain chest X-ray film should be performed.

CONCLUSIONS

Based on our experiences, we advocate for systematic long-term follow-up in patients with IVC filters, particularly retrievable IVC filters. Plain radiography and unenhanced CT imaging can be used to screen for arm flexion, fracture, or migration. The occurrence of filter strut flexion might precede filter strut fracture. Additionally, there might be an increased risk for repeat filter strut flexion, fracture, and migration. In patients with any of these findings, removal of a retrievable filter should be considered to prevent possible further complications. Furthermore, removal of these types of filters should be considered earlier if they are no longer needed.

REFERENCES

1. Dalen JE, Alpert JS. Natural history of pulmonary embolism. Prog Cardiovasc Dis. 1975;17(4):259-70.
2. Miniati M, Monti S, Bottai M, Scoscia E, Bauleo C, Tonelli L, et al. Survival and restoration of pulmonary perfusion in a long-term follow-up of patients after acute pulmonary embolism. Medicine (Baltimore). 2006;85(5):253-62.
3. Cushman M. Epidemiology and risk factors for venous thrombosis. Semin Hematol. 2007;44(2):62-9.
4. Mackman N. Triggers, targets and treatments for thrombosis. Nature. 2008;451(7181):914-8.
5. Kearon C, Kahn SR, Agnelli G, Goldhaber S, Raskob GE, Comerota AJ. Antithrombotic therapy for venous thromboembolic disease: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest. 2008;133(6 Suppl):454S-545S.
6. Greenfield LJ. The PREPIC Study Group. Eight-year follow-up of patients with permanent vena cava filters in the prevention of pulmonary embolism: the PREPIC (Prevention du Risque d'Embolie Pulmonaire par Interruption Cave) Randomized Study. Perspect Vasc Surg Endovasc Ther. 2006;18(2):187-8.
7. Greenfield LJ, McCurdy JR, Brown PP, Elkins RC. A new intracaval filter permitting continued flow and resolution of emboli. Surgery. 1973;73(4):599-606.
8. 510(k) - K050558; G2 Filter with Femoral Delivery [Internet]. Available from: http://www.accessdata.fda.gov/cdrh_docs/pdf5/K050558.pdf.
9. 510(k) - K031328; Recovery Filter System [Internet]. Available from: http://www.accessdata.fda.gov/cdrh_docs/pdf3/K031328.pdf.
10. Brountzos EN, Kaufman JA, Venbrux AC, Brown PR, Harry J, Kinst TF, et al. A new optional vena cava filter: retrieval at 12 weeks in an animal model. J Vasc Interv Radiol. 2003;14(6):763-72.
11. Kalva SP, Athanasoulis CA, Fan C-M, Curvelo M, Geller SC, Greenfield AJ, et al. "Recovery" vena cava filter: experience in 96 patients. Cardiovasc Intervent Radiol. 2006;29(4):559-64.
12. Decousus H, Leizorovicz A, Parent F, Page Y, Tardy B, Girard P, et al. A clinical trial of vena caval filters in the prevention of pulmonary embolism in patients with proximal deep-vein thrombosis. Prévention du Risque d'Embolie Pulmonaire par Interruption Cave Study Group. N Engl J Med. 1998;338(7):409-15.
13. Joels CS, Sing RF, Heniford BT. Complications of inferior vena cava filters. Am Surg. 2003;69(8):654-9.
14. Owens CA, Bui JT, Knuttinen M-G, Gaba RC, Carrillo TC, Hoefling N, et al. Intracardiac migration of inferior vena cava filters: review of published data. Chest. 2009;136(3):877-87.
15. Ferris EJ, McCowan TC, Carver DK, McFarland DR. Percutaneous inferior vena caval filters: follow-up of seven designs in 320 patients. Radiology. 1993;188(3):851-6.
16. Lorch H, Welger D, Wagner V, Hillner B, Strecker EP, Herrmann H, et al. Current practice of temporary vena cava filter insertion: a multicenter registry. J Vasc Interv Radiol. 2000;11(1):83-8.
17. Binkert CA, Sasadeusz K, Stavropoulos SW. Retrievability of the recovery vena cava filter after dwell times longer than 180 days. J Vasc Interv Radiol. 2006;17(2 Pt 1):299-302.
18. Hull JE, Robertson SW. Bard Recovery filter: evaluation and management of vena cava limb perforation, fracture, and migration. J Vasc Interv Radiol. 2009;20(1):52-60.
19. Karmy-Jones R, Jurkovich GJ, Velmahos GC, Burdick T, Spaniolas K, Todd SR, et al. Practice patterns and outcomes of retrievable vena cava filters in trauma patients: an AAST multicenter study. J Trauma. 2007;62(1):17-24; discussion 24-25.
20. Grande WJ, Trerotola SO, Reilly PM, Clark TWI, Soulen MC, Patel A, et al. Experience with the recovery filter as a retrievable inferior vena cava filter. J Vasc Interv Radiol. 2005;16(9):1189-93.
21. Nicholson W, Nicholson WJ, Tolerico P, Taylor B, Solomon S, Schryver T, 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(20):1827-31.
22. Desjardins B, Kamath SH, Williams D. Fragmentation, embolization, and left ventricular perforation of a recovery filter. J Vasc Interv Radiol. 2010;21(8):1293-6.