**LESS IS MORE**

**Indications, Complications, and Management of Inferior Vena Cava Filters**

*The Experience in 952 Patients at an Academic Hospital With a Level I Trauma Center*

Shayna Sarosiek, MD; Mark Crowther, MD; J. Mark Sloan, MD

**Importance:** retrievable inferior vena cava (IVC) filters were designed to provide temporary protection from pulmonary embolism, sparing patients from long-term complications of permanent filters. However, many retrievable IVC filters are left in place indefinitely.

**Objectives:** To review the medical records of patients with IVC filters to determine patient demographics and date of and indication for IVC filter placement, as well as complications, follow-up data, date of IVC filter retrieval, and use of anticoagulant therapy.

**Design and Setting:** A retrospective review of IVC filter use between August 1, 2003, and February 28, 2011, was conducted at Boston Medical Center, a tertiary referral center with the largest trauma center in New England.

**Participants:** In total, 978 patients. Twenty six patients were excluded from the study because of incomplete medical records.

**Intervention:** Placement of retrievable IVC filter.

**Main Outcome Measures:** In total, 952 medical records were included in the analysis.

**Results:** Of 679 retrievable IVC filters that were placed, 58 (8.5%) were successfully removed. Unsuccessful retrieval attempts were made in 13 patients (18.3% of attempts). Seventy-four venous thrombotic events (7.8% of 952 patients included in the study) occurred after IVC filter placement, including 25 pulmonary emboli, all of which occurred with the IVC filter in place. Forty-eight percent of venous thrombotic events were in patients without venous thromboembolism at the time of IVC filter placement, and 89.4% occurred in patients not receiving anticoagulants. Many IVC filters placed after trauma were inserted when the highest bleeding risk had subsided, and anticoagulant therapy may have been appropriate. While many of these filters were placed because of a perceived contraindication to anticoagulants, 237 patients (24.9%) were discharged on a regimen of anticoagulant therapy.

**Conclusion and Relevance:** Our research suggests that the use of IVC filters for prophylaxis and treatment of venous thrombotic events, combined with a low retrieval rate and inconsistent use of anticoagulant therapy, results in suboptimal outcomes due to high rates of venous thromboembolism.

Pulmonary Embolism (PE) represents a serious cause of morbidity and mortality, particularly in hospitalized patients. It is estimated that PE leads to more than 200,000 deaths annually in the United States.1 For these patients and those at risk for PE, anticoagulant therapy remains the standard of care.2 If the patient has a contraindication to anticoagulants, an inferior vena cava (IVC) filter is often considered. The concept of surgical vena cava interruption was first introduced in 1865 by Trousseau.3 Surgical insertion of IVC filters was pioneered in the 1960s but was used infrequently until the development of the percutaneous IVC filter insertion technique in 1973 by Greenfield.4 The arrival of retrievable devices in the 1990s facilitated potential removal of IVC filters.5

See also pages 493 and 506

The Prévention du Risque d’Embolie Pulmonaire par Interruption Cave study6 was the first randomized controlled trial to assess filter placement. Patients with proximal deep vein thrombosis (DVT) were randomized to receive therapeutic anticoagulant therapy with unfractionated heparin,
transitional to warfarin, or similar therapy with insertion of an IVC filter. The study found a significant decrease in pulmonary emboli in the first 12 days after IVC filter placement. However, patients with filters had a significantly increased rate of recurrent DVT at 2 years.

Despite a lack of randomized controlled trials demonstrating long-term safety and efficacy, IVC filter insertion continues to increase each year. It was estimated that more than 259,000 filters would be placed in 2012, and most would be retrievable filters. Many professional groups have guidelines regarding filter insertion; these guidelines vary widely and often conflict. The American College of Radiology and Society of Interventional Radiology guidelines state that a filter can be placed as prophylaxis for any patient at high risk of developing a DVT or PE, while the American College of Chest Physicians guidelines recommend against an IVC filter unless the patient has an acute proximal lower extremity DVT and cannot tolerate anticoagulants. These conflicting guidelines reflect the absence of good-quality data to guide clinical practice.

Follow-up data reporting longitudinal outcomes of filter placement are necessary because unretrieved removable IVC filters may carry significant long-term risks. Recent data from a systematic review of 37 studies confirm the increased rate of complications when filters are left in place for longer than 30 days and indicate a retrieval rate of approximately 34%. Risks of unretrieved filters include recurrent DVT, vena cava thrombosis, organ perforation, and mechanical filter complications, such as migration and strut fracture. Multiple investigations have documented high rates of filter fracture, with some showing a fracture risk of up to 40% at 5.5 years. These risks seem to increase with the length of time that the filter is in place. Following the publication of a series of IVC filter–related complications, the US Food and Drug Administration issued a statement in 2010 reporting that retrievable IVC filters that are left in place are prone to filter fracture, filter migration, filter embolization, and IVC perforation, as well as increased risk of lower limb DVT. The Food and Drug Administration recommends that IVC filters should be removed as soon as the risk of PE has subsided.

Boston Medical Center is a large academic hospital with a level I trauma center, the busiest trauma institution in New England. Like most hospitals throughout the United States, Boston Medical Center has increased its use of IVC filters in the last decade. Given the scarcity of literature on the indications for placement, retrieval, or complications of these filters, we conducted a retrospective review to determine how IVC filters are used at our institution, as well as to review the complications related to their use.

**METHODS**

Institutional review board approval was obtained to perform a retrospective review of hospital medical records from all the patients who had an IVC filter placed between August 1, 2003, and February 28, 2011, at Boston Medical Center. A search was performed using Current Procedural Technology codes to determine which patients were billed for the placement of an IVC filter. Once identified, medical records were manually reviewed. Data extracted included patient demographics and indication for IVC filter placement, as well as filter types, filter retrieval, complications, use of anticoagulant therapy, and postdischarge follow-up data. Data were imported to a secure database that was kept separately from patient identifying information.

Filters were placed in 978 patients. Of these, 26 patients were excluded because of incomplete medical records. The remaining 952 medical records were included in this analysis. The median age of patients was 56 years (age range, 1-98 years). In total, 599 of 978 patients (61.2%) were male. Thirty-nine patients died during the index hospitalization, and 14 patients were discharged to hospice.

### FILTER PLACEMENT

Permanent filters (TRAPEASE [Cordis] or Bird’s Nest [Cook]) were placed in 273 of 952 patients (28.7%). Most of the permanent filters were placed before 2006. The first retrievable filters were used in September 2003. In total, 679 of 952 filters (71.3%) were retrievable (Option [Angiotech], Tulip [Günther-Cook], Optease [Cordis], Eclipse [Bard], or G2/G2X [Bard]). Inferior vena cava filters were placed by physicians from multiple departments; two-thirds (67.0%) were interventional radiologists. The medical or surgical services placing filters included radiology (n = 626), trauma surgery (n = 249), vascular surgery (n = 37), cardiology (n = 21), cardiothoracic surgery (n = 1), and unknown (n = 18).

### INDICATIONS FOR FILTER PLACEMENT

Stated indications for filter placement were as follows (in descending order): trauma (50.2%), malignancy (15.9%), bleeding during anticoagulant therapy (11.8%), cerebral hemorrhage (7.6%), active or previous gastrointestinal tract bleeding (6.3%), PE with large clot burden (6.3%), preparation for surgery in a patient with history of venous thromboembolism (VTE) (6.3%), inability to anticoagulate after surgery (3.4%), failure of anticoagulant therapy (3.3%), prophylaxis for high-risk surgery (1.8%), patient noncompliance (1.8%), hemorrhagic stroke (1.1%), fall risk (0.7%), or unclear indications (0.6%). Some patients had more than 1 stated indication for placement. In total, 504 of 952 patients (52.9%) had VTE at the time of filter placement, and the remaining 448 patients (47.1%) had filters placed in the absence of acute VTE. Figure 1 shows the indications for and retrieval rates of filters, partitioned according to the presence or absence of VTE at the time of filter insertion. Overall retrieval rates were lower when they were used for prophylaxis in the absence of VTE rather than in the presence of VTE (7.7% vs 9.5%).

Half of the filters (n = 478) were placed in patients after a fall, blunt trauma, or penetrating trauma. Of these, 375 filters inserted after trauma (78.5%) were placed without any evidence of VTE. A median of 3 days (range, 0-32 days) elapsed between the date of trauma and filter insertion, with 174 of 478 filters (36.4%) being inserted 5 or more days after trauma (Figure 2).
VENOUS THROMBOEMBOLISM

Before IVC filter placement, 31 of 978 patients (3.2%) sustained a VTE when receiving anticoagulant therapy and could be classified as anticoagulant failures. Of 952 patients who had a filter placed, 237 (24.9%) received therapeutic anticoagulant therapy before discharge from the hospital, indicating that their contraindication to anticoagulant therapy (if present at the time of filter insertion) was transient.

No protocol was in place for routine imaging after filter placement or retrieval. Approximately half of the patients included in this review had subsequent imaging performed at various times. The imaging showed that 74 patients had VTE that developed after filter placement. In those 74 patients, 85 VTEs were diagnosed. Forty-one of those 85 VTEs (48.2%) occurred in patients who had no VTE before filter placement. In these cases, the filter had been placed strictly for prophylaxis, and the subsequent VTE could be viewed as a consequence of filter insertion. Twenty-six VTEs found after filter placement occurred during the index hospitalization and included 9 pulmonary emboli. Sixteen of the remaining VTEs were pulmonary emboli that developed after discharge from the hospital, all of which occurred with the filter still in place. Eighty-nine percent of VTEs after IVC filter placement occurred in patients not receiving anticoagulants.

FOLLOW-UP DATA

Thirty nine of 952 patients included in this review died before leaving the hospital. Of the remaining 913 patients, 78 (8.5%) had no mention of IVC filter placement in the discharge summary. Two hundred seven patients had no documented follow-up data at Boston Medical Center, and 360 patients had no mention of the IVC filter during subsequent medical follow-up care at our institution.

An attempt was made to remove 71 of 679 retrievable filters (10.5%) placed. Among the 679 filters, 608 retrievals (89.5%) were not attempted, 58 retrievals (8.3%) were successful, and 13 retrieval attempts (1.9%) failed. Of the 58 successful retrievals, 15 (25.9%) had their filter removed during the index hospitalization, and 43 (74.1%) had their filter removed after hospital discharge. Retrieval attempts failed in 13 of 71 patients (18.3% of attempts) for the following reasons: filter embedded in the IVC (n=8), filter protruding through a blood vessel (n=3), abnormal filter position (n=2), or clot within the filter (n=1). One patient had more than 1 reason for retrieval failure, including a clot in the filter, and protrusion from the IVC. Of these unsuccessful attempts, 2 occurred during the index hospitalization, 1 shortly after discharge, and the remaining 10 failed after the filter had been in place for more than 85 days (Figure 3). The median retrieval time after filter placement was 122 days (range, 2-1931 days). No complications of filter retrieval were documented.

SELECTED COMPLICATIONS

Despite the lack of standardized follow-up imaging, at least 10 serious filter-related complications were captured in our
At least 10 serious complications were noted in this review, including 9 filters that had migrated from the initial location of placement and 2 filters that had fractured. Complications were considered serious if the patient required hospital admission or prolonged hospitalization for treatment. Several examples are given herein.

An 82-year-old woman had a filter placed because of the presence of multiple PEs and DVTs and perceived inability to anticoagulate after a recent surgical procedure. The filter was partially placed in the renal vein during the initial procedure. Despite multiple attempts, it could not be successfully repositioned or removed. Shortly after the filter placement, the patient’s hemoglobin level began to fall. She refused red blood cell transfusion for religious reasons and died days later.

A 33-year-old man was brought to the hospital after a motor vehicle crash. He had a prophylactic IVC filter (G2; Bard) placed 2 days later. The patient received no follow-up care at our institution for more than 5 years, until he returned with report of chest pain. He was found to have a fractured IVC filter, with one strut of the filter lodged in a pulmonary artery. The patient underwent a fluoroscopic procedure and had both the strut from the pulmonary artery and the remaining portion of the filter in the IVC removed.

A 56-year-old man developed a PE 4 days after a motor vehicle crash and had an IVC filter (Eclipse; Bard) placed. After filter placement, the patient’s hemoglobin level fell, and imaging showed IVC perforation by the filter and an associated retroperitoneal bleed. Filter removal was attempted 9 days after placement but was unsuccessful. The patient’s bleeding stabilized, and he was eventually discharged on a regimen of anticoagulant therapy, with the IVC filter in place.

A 41-year-old woman with a history of papillary thyroid cancer metastatic to the brain had a filter (G2; Bard) placed for PE prophylaxis in the setting of a lower extremity DVT. She returned to the hospital 44 days later with pain, and imaging showed filter prongs protruding into her lumbar vessels and overlying the aorta. She had the filter removed and replaced.

**COMMENT**

During our study, 952 IVC filters were placed, with approximately half of the filters placed for prophylaxis of PE without evidence of VTE at the time of filter placement. The use of filters for VTE prophylaxis is controversial; as noted in our study, they do not prevent the development of DVT and do not entirely prevent PE. Their use is associated with complications, and many patients can receive pharmacological prophylaxis instead of filters.

The 2012 American College of Chest Physicians guidelines recommend that an IVC filter should not be placed in a patient without current VTE based on a lack of high-quality evidence that temporary filters reduce clinically important outcomes compared with pharmacological prophylaxis. An important consideration when placing a filter is the risk of complications, not only during placement and retrieval but also long-term consequences if left in place. At least 10 serious complications were noted in this review. This is likely an underestimate of the total mechanical complications because minor mechanical issues were not systematically noted in this data set. Most of the filters in this review were designed for retrieval, yet only 8.5% were successfully removed. Therefore, approximately 91.5% of retrievable filters placed in patients at risk for VTE became permanent filters. The rate of filter retrieval varies significantly among institutions, with a recent systematic review noting on average a 34% retrieval rate.

Attention should be dedicated to improving overall retrieval rates. The goal is to increase retrievals in patients who no longer have an indication for the filter. Prompt retrieval decreases the long-term risks of filter retention, specifically increased incidence of DVT and filter fracture or migration. Although manufacturer literature shows safe retrieval of some filters up to 300 days after placement, recent data show that increasing complications occur when the filters are left in place for longer periods. While the feasibility of very delayed retrieval is well documented, the 18.3% rate of retrieval failure seen in our data was likely in part due to delayed retrieval attempts because 10 of 13 failed retrieval attempts occurred after the filter had been in place for 85 days or longer.

During the period of this medical record review, no standardized procedure was in place to track patients or facilitate retrieval, with 59.6% of patients having no follow-up data or no mention of the filter at the time of follow-up care. Efforts to improve filter retrieval rates have been a recent focus of our institution. A filter insertion procedure note that specifies the indication for filter placement and the anticipated duration of placement is now mandatory for all IVC filter insertions. Patients are given educational material after filter placement stating that most filters should be removed once the risk for blood clots has subsided or anticoagulant therapy is tolerated. Every IVC filter is promptly entered into a central interdepartmental registry and tracked until retrieval. For filters not deemed permanent at the time of insertion, a designated administrator schedules timely retrieval or a clinic visit specifically to assess for the appropriateness and timing of retrieval. Retrievals are performed by interventional radiology or vascular surgery and do not typically require interruption of anticoagulant therapy. Filter clinics and personnel dedicated to ensuring follow-up care for patients with filters have been shown to improve retrieval rates.

Many patients may qualify to have their filter removed before discharge from the hospital. In this review, 24.9% of patients who had VTE and had a filter placed received anticoagulants before leaving the hospital. Presumably, all these patients could have been considered for filter removal once anticoagulant therapy was tolerated. In addition, a significant proportion of filters placed for prophylaxis after trauma were inserted after the period of highest bleeding risk had subsided (>3 days after trauma), when anticoagulant therapy without an IVC filter may have been a more appropriate option. These issues may be influenced by inpatient hospital reimbursement. For example, by modifying the diagnosis related group, the Centers for Medicare and Medicaid Services reimbursement for a patient admitted for an acute DVT increases by almost 250% if an IVC filter is placed. Retrieval on the same admission would not increase reimbursement, while outpatient retrieval is reimbursed separately.
This analysis has limitations. The study was a retrospective medical record review; therefore, it is subject to various biases inherent in such data. We are aware of patients who had a filter placed during this period who were not included in our analysis, presumably because no billing code was generated for every filter placed. However, we believe that our review includes most relevant medical records. Some patients may have had their filters removed or experienced thrombotic events at outside hospitals, and these were not captured in our study. The high volume of filter use by the trauma service at our institution may skew the indications for placement and retrieval and may not necessarily apply to hospitals with a different patient population. The absence of systematic imaging or follow-up data for these patients is a serious limitation of this study.

In conclusion, our research suggests that the frequent use of IVC filters for VTE treatment and prophylaxis, combined with a low retrieval rate and inconsistent use of anticoagulant therapy, results in suboptimal outcomes, such as mechanical filter failure and high rates of VTE. More comprehensive longitudinal data would likely identify additional complications. To better analyze the risks associated with IVC filter placement, a prospective randomized trial or cohort study is needed for indications other than proximal DVT (eg, prophylaxis in patients with trauma without VTE).

Accepted for Publication: December 19, 2012.
Published Online: March 18, 2013. doi:10.1001/jamainternmed.2013.343

Correspondence: Shayna Sarosiek, MD, Section of Hematology and Oncology, Department of Medicine, Boston University, 72 E Concord St, Ste K503, Boston, MA 02118 (shayna.sarosiek@bmc.org).

Author Contributions: Drs Sarosiek and Sloan had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: All authors. Acquisition of data: Sarosiek and Sloan. Analysis and interpretation of data: All authors. Drafting of the manuscript: All authors. Critical revision of the manuscript for important intellectual content: All authors. Statistical analysis: Sarosiek. Obtained funding: Sloan. Administrative, technical, and material support: All authors. Study supervision: Crowther and Sloan.

Conflict of Interest Disclosures: Dr Crowther is the recipient of a Heart and Stroke Foundation of Ontario Career Investigator Award and holds the LEO Pharma Chair in Thromboembolism Research at McMaster University.

Funding/Sponsorship: Richard Davis, PhD, provided generous financial support for this research.

Additional Contributions: Jeffrey Kalish, MD, Hannah Marks, BS, Meg Waite, RN, and Patricia Nash, CCS, gave invaluable assistance during the preparation of the manuscript. We thank the IVC Filter Retrieval Task Force for their dedication to improve filter management at Boston Medical Center.

REFERENCES