Inferior Vena Cava Filters
Why, Who, and for How Long?

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KEYWORDS
- Vena cava • Filter • Venous thromboembolism

KEY POINTS
- Vena cava filters are indicated for the prevention of pulmonary emboli (PE) in patients who are unable to receive anticoagulation.
- Retrievable vena cava filters should be removed once the indication for PE prevention is no longer present.
- Patients with inferior vena cava (IVC) filters in place require close follow-up to ensure timely removal.

INTRODUCTION
The mainstay of treatment of patients with venous thromboembolic (VTE) disease is anticoagulation. Patients on anticoagulation have low rates of recurrent VTE, and patients with deep venous thrombosis (DVT) have low rates of subsequently developing pulmonary embolism (PE).1,2 Before current practice of anticoagulation, primary PE prophylaxis often consisted of surgical ligation or interruption of the inferior vena cava (IVC) as means of disrupting the route for PE to develop. These surgical procedures paved the way for IVC filters, which are used today. IVC filters are implantable devices designed to intercept thrombus that has broken free from the lower extremities or pelvis and prevent its migration to the lungs. The purpose of this article is to review IVC filters and their impact on VTE treatment.

TYPES OF INFERIOR VENA CAVA FILTERS
IVC filters are divided into 2 main categories: permanent and retrievable. Permanent IVC filters are designed to remain within the patient for the duration of their lifetime and have no engineering considerations to facilitate removal. Retrievable (also known as optional or removable) IVC filters are specifically designed to allow for retrieval once the high-risk period for VTE has passed; however, these filters are also US Food and Drug Administration (FDA) approved to remain permanently. A novel category of IVC filters, the temporary IVC filter, are filters that are tethered to a cord or other device, such as a central venous catheter. These filters can be left in place for a very short amount of time while the patient is in the hospital and must be removed. Preliminary data suggest these temporary IVC filters may safely prevent PE in patients with transient indications for IVC filtration, such as trauma.3,4

There is no consensus on any one filter design or type being superior to another. To date, no comparative studies of permanent versus retrievable filters have been conducted nor have there been any head-to-head studies of different filters within either category. Nonetheless, current

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practice patterns have led to a significant increase in the use of retrievable IVC filters, which are now placed much more commonly than permanent filters. Physicians should consider the length of time IVC filtration is necessary because there are some data to suggest that permanent IVC filters have fewer long-term complications than retrievable filters, and they are more cost-effective. However, if the indication for filtration is likely to be temporary (ie, the patient may be able to resume anticoagulation in the future), then a retrievable filter would be favored.

INDICATIONS/CONTRAINDICATIONS FOR INFERIOR VENA CAVA FILTER PLACEMENT

In the late 1990s, the PREPIC study was conducted to determine the safety and efficacy of IVC filters in the setting of proximal DVT. The landmark study found initial benefit of IVC filters in preventing PE, but this was offset by an increase in recurrent DVT in patients with an IVC filter. This study remains one of the few randomized controlled trials (RCT) that has been performed evaluating IVC filters, and the results play a major role in how IVC filters are currently used. In today’s practice, the most widely accepted indication for placement of an IVC filter is the prevention of PE in a patient with VTE and a contraindication to anticoagulation: this is the only unanimously agreed upon indication. Findings from a more recent RCT (“PREPIC II”), which included patients with a diagnosis of PE and DVT, confirmed that there was no reduction in the risk of recurrent, symptomatic PE at 3 months in anticoagulated patients who received an IVC filter versus patients on anticoagulation alone. Other accepted indications for placement of an IVC filter include a complication of anticoagulation, worsening of VTE despite adequate anticoagulation, VTE with poor cardiopulmonary reserve, high-risk or massive PE, and free-floating caval or iliac DVT. The most updated societal guidelines regarding the indications for placement of an IVC filter are highlighted in Table 1.

There are no absolute contraindications to IVC filter placement. The most updated recommendations from the American College of Chest Physicians (ACCP) state, “In patients with acute DVT or PE who are treated with anticoagulants, we recommend against the use of an inferior vena cava filter.”

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| CHEST/ACCP Guidelines<sup>1,2</sup> | - In patients with acute VTE and contraindication to anticoagulation (AC), recommend the use of an IVC filter  
- In patients with high-risk/massive PE, consider IVC filter in addition to anticoagulation  
- In patients with recurrent VTE despite adequate AC, IVC filter is an option of last resort |
| SIR Guidelines<sup>31</sup> | - IVC filters are indicated in patients with PE or IVC, iliac, femoral, or popliteal DVT and one or more of the following:  
  - Contraindication to AC  
  - Complication of AC  
  - Failure of AC  
  - Inability to achieve/maintain adequate AC  
  - Thrombus progression despite adequate AC  
  - High-risk/massive PE with residual DVT  
  - Free-floating caval or iliac DVT  
  - Severe cardiopulmonary disease and DVT  
  - Prophylactic IVC filters (no documented DVT/PE) are indicated in the following settings:  
    - Severe trauma, closed head injury, spinal cord injury, multiple long-bone or pelvic fractures  
    - Patients at high risk for VTE (immobilized, ICU patient, and so forth) |
| AHA Guidelines<sup>39</sup> | - Adult patients with any confirmed acute PE (or proximal DVT) with contraindications to anticoagulation or with active bleeding complication should receive an IVC filter  
- For patients with recurrent acute PE despite therapeutic anticoagulation, it is reasonable to place an IVC filter  
- Placement of an IVC filter may be considered for patients with acute PE and very poor cardiopulmonary reserve, including those with high-risk/massive PE |
cava (IVC) filter.” Although this is not a true contraindication, it bears mention because a recent RCT failed to show any benefit from placing an IVC filter in patients who are receiving anticoagulation. There have been reports of patients with a nickel allergy having a reaction to the IVC filter, but these are rare and routine screening is not necessary. Anatomic issues may preclude IVC filter placement (ie, caval thrombosis, anatomic variants, invasion or compression by tumor), but these are also rare. Bacteremia should prompt the physician to weigh the risks of infection versus the benefit of filter placement; although infection of an IVC filter is exceedingly unusual, several cases have been reported.

INFERIOR VENA CAVA FILTER PLACEMENT

Before IVC filter placement, patients should have all relevant laboratory work up-to-date, including a complete blood count, basic metabolic panel, and prothrombin time/international normalized ratio if indicated. Typically, iodinated contrast is used for the filter placement procedure, and therefore, renal function should be within acceptable limits; patients need to be evaluated for a contrast allergy. For patients unable to receive iodinated contrast, intravascular ultrasound, carbon dioxide, and gadolinium-based contrasts are alternatives.

IVC filters are typically placed in an angiography suite using fluoroscopic guidance. Either the jugular or the femoral vein is accessed; the ideal filter position is determined using fluoroscopic guidance, and the filter is typically deployed in the infrarenal IVC. Ideally, the filter is placed so that the apex is centered within the cava, just below the level of the most inferior renal vein. Physicians placing IVC filters need to be aware of anatomic variants that could limit the filter’s effectiveness or make placement challenging. For example, if the caval diameter is greater than 30 to 40 mm, so called, megacava, many filters are not approved for use at that caval size, and the patient may require placement of 2 filters, one in each of the bilateral iliac veins. Duplicated IVC, circumaortic and retroaortic renal veins, and caval interruption likewise require attention and technical modifications during filter placement.

COMPLICATIONS OF INFERIOR VENA CAVA FILTERS

When performed in an angiography suite, procedural complications during IVC filter placement are infrequent and typically of little clinical significance. One study detailing a single-center experience with IVC filters reported a 0.3% major complication rate. Rarely, there can be a problem with filter deployment (ie, filter placement at an unintentional location within the IVC or in an unintentional vessel), which may prompt immediate retrieval and replacement.

On the other hand, the long-term complications of indwelling IVC filters are far more common and have led to increased scrutiny of IVC filters in recent years. In 2010, the FDA issued a safety communication urging physicians placing retrievable IVC filters to consider removal once the indication for their placement has resolved. The safety communication was in response to more than 900 reports of adverse events involving IVC filters. Complications such as filter fracture, embolization, migration, caval wall penetration, and thrombosis are the most worrisome.

Filter fracture occurs when one of the struts or filter components becomes discontinuous with the main filter element. A fracture increases the risk of embolization of the fractured fragment or migration of the filter itself. Fracture is the most common major complication of retrievable IVC filters. Although the overall incidence of filter fracture is hard to discern, recent reports cite fracture rates of 10% to 15%, with the risk of fracture increasing with increasing dwell times. Typically, fractured filter fragments are of little clinical significance; however, filter fracture can be symptomatic if embolization occurs or if the component perforates adjacent retroperitoneal structures or other organs along the downstream blood flow from the filter (ie, kidneys, liver, heart, or lungs).

Filter migration occurs when the entire filter moves from its original deployment location and, although rare, extreme migration to an intracardiac location has been reported.

Caval wall penetration involves the struts of the filter protruding beyond the limits of the caval wall while remaining attached to the filter. Multiple reports exist describing complications involving penetration of adjacent structures.

Caval thrombosis can occur as a result of the filter trapping a large thrombus and failing to recanalize or because of recurrent thrombus forming inside the filter and propagating to the point of caval stenosis or occlusion. Caval thrombosis is also rare, with a recent systematic review reporting a frequency of caval thrombosis or stenosis for patients receiving a retrievable IVC filter of 2.8%. In vitro models suggest that normal caval flow dynamics are impaired by the presence of an IVC filter, especially in the setting of trapped thrombus or a tilted filter. This increased turbulence may help explain the increased rate of recurrent DVT. There is currently no consensus on the recommendations for anticoagulation following IVC filter placement.
placement. There is some evidence to suggest that patients with an IVC filter who remain on anti-coagulation have lower rates of recurrent VTE and are less likely to form thrombus within the filter.22,23

**INFERIOR VENA CAVA FILTER RETRIEVAL**

As previously mentioned, most of the IVC filters placed today are designed to be retrieved. Current retrievable filter designs (Fig. 1) commonly include a hook at the cranial or caudal filter apex, which is used to retrieve the filter once it is no longer needed. The procedure to retrieve the filter typically entails obtaining jugular venous access, as most filters are designed to be removed from a jugular vein approach. After performing a venogram, the physician then engages the hook with a snare device, and the filter is collapsed into a vascular sheath and removed. Technical success of IVC filter retrieval is generally very high (>95%) and depends on several factors (dwell time of filter, degree of filter tilt, and so forth).24-28 If the filter is tilted or embedded in the wall of the IVC, more advance techniques may be required to remove the filter. In addition, there is no absolute cutoff time after which IVC filter retrieval should not be attempted. In cases of prolonged IVC filter dwell time, extreme tilt, caval penetration, caval ingrowth or filter migration, filter removal may require referral to centers specifically experienced in complex filter removals.

Although against their indications for use, permanent IVC filters can be safely removed from patients if the indication to do so is sufficiently strong.

**ADDITIONAL TOPICS**

*Prophylactic IVC filters:* Certain patients, such as critically ill patients in an intensive care unit or polytrauma patients, are at a higher risk for VTE. If a DVT were to develop, these patients often have a contraindication to anticoagulation because of their injuries or the potential need for multiple surgical procedures. Although level I data are lacking, The Society of Interventional Radiology and the Eastern Association for the Surgery of Trauma advocate the placement of an IVC filter, even if no DVT is present, in these high-risk patients.31-33

*Superior vena cava (SVC) filters:* The incidence of PE resulting from an upper extremity DVT is small, approximately 2%.34 Although it is possible that thrombus located in an upper extremity vein could break free and embolize to the pulmonary arterial system, the available data suggest this is less likely to be clinically significant compared...
with thrombus embolizing from the lower extremity.\textsuperscript{35} Although the ACCP guidelines do recommend anticoagulation for upper extremity DVT, SVC filters are not routinely used in these patients. Placement of IVC filters in the SVC is considered an off-label use, and data on safety and efficacy are limited. Moreover, retrieval of SVC filters may prove higher risk than those in the IVC secondary to the risk of cardiac injury.\textsuperscript{36}

\textbf{Novel filter designs:} Since the advent of the retrievable IVC filter, the general design concept of the IVC filter has not significantly changed. However, research and development of novel filter designs are ongoing. Future directions include devices that are composed of biocompatible materials that allow all or part of the filter to dissolve.\textsuperscript{37,38} If this technology provides a viable filter model, it could potentially alleviate the issue of patients being lost to follow-up with an IVC filter in place.

\section*{SUMMARY}

IVC filters, when used appropriately, have been proven safe and effective. Societal guidelines vary in the indications for IVC filter placement; however, most agree that IVC filters are indicated to prevent PE in patients with active lower-extremity DVT who cannot receive anticoagulation. It is imperative that patients with retrievable IVC filters are followed closely and that their IVC filters are removed once no longer indicated.

\section*{REFERENCES}


