Lesson 3, Volume 14
Use of Vena Cava Filters in the Management of Venous Thromboembolic Disease

By Robert J. Schilz, DO, PhD, FCCP, and Joel Wirth, MD, FCCP

Objectives

1. Understand the efficacy and safety of vena cava filters in the management of venous thromboembolism.
3. Outline current consensus statements regarding the use of vena cava filters for the management of venous thromboembolism.
4. Discern evolving indications regarding the use of vena cava filters for venous thromboembolism prophylaxis in trauma or surgical patients; primary treatment in patients with advanced cancer and COPD; primary treatment of venous thromboembolism in the elderly.
5. Identify potential complications of vena caval filters.
6. Review the role of anticoagulants in the patient with a vena cava filter, the use of these filters in pregnancy, and placement of suprarenal and superior vena cava filters.
7. Determine the potential costs of the use of vena cava filters.

Key Words

Bird's Nest filter; Greenfield filter; Simon-Nitinol filter; vena cava filter; Vena Tech filter; venous thromboembolism

Abbreviations

DVT = deep venous thrombosis; IVC = inferior vena cava; PE = pulmonary embolism; VCF = vena cava filter; VTE = venous thromboembolism

Introduction and Overview

The incidence of pulmonary embolism (PE) in the United States has been estimated at approximately 600,000 cases annually.¹ Untreated PE carries a 30% incidence of mortality, which is decreased to 8% with anticoagulation.² Although systemic anticoagulation remains the cornerstone of both treatment and prophylaxis for venous thromboembolism (VTE), permanent implantable endovascular filtering devices...
Although the concept of caval interruption to prevent embolization or propagation of proximal deep venous thrombosis (DVT) has been proposed since at least 1851, the first implantable endovascular devices for the treatment of VTE were the Mobbin-Uddin Umbrella and the Kimray-Greenfield filter. Like their modern counterparts, these devices were designed to filter and trap thrombi that could result in a lung embolus. Their design allowed filtering to occur without occlusion of the venous return. A number of devices have since been introduced and original designs have undergone significant technical refinements. Most devices are made of fatigue-resistant stainless steel or titanium alloys and are compatible with magnetic resonance MRI techniques. In contrast to the surgical cutdown required to place early caval filters, nearly all filters now are deployed via a percutaneous catheter-guided method under fluoroscopic guidance.

Vena cava filters (VCFs) are typically positioned within the infrarenal inferior vena cava (IVC) to trap thrombi arising from the lower extremities, avoiding potential occlusion of the renal veins. Limited reports also document the successful use of caval filters in the superior vena cava, as well as in the suprarenal IVC.

Both fatal and nonfatal complications have been reported for VCFs. Fatal or serious nonfatal complications are rare. Improved safety profiles and favorable experience with these devices have led a number of authors to advocate broader indications for the placement of caval filters, although many proposed indications remain controversial.

The number of VCFs placed annually has dramatically increased since the availability of the transcatheter delivery system, leading some authors to speculate that many filters may be placed without appropriate indications. Our experience in a major teaching hospital, consistent with many other reports, suggests that most VCF use is for what would be generally agreed upon as standard indications.

### Types of VCFs Available for Use

There are six permanent caval filters, representing four major design types, available for use in the United States.

![Figure 1. Available IVC filters: (A) stainless steel Greenfield; (B) modified hook titanium Greenfield; (C) alternating hook stainless steel Greenfield; (D) Bird's Nest; (E) Simon-Nitinol; (F) Vena Tech.](image)

**Greenfield Filter**

The Greenfield filter (Medi-Tech/Boston Scientific Corp; Watertown, MA) was introduced in 1973. Three designs have been approved by the Food and Drug Administration for patient use in the United States. The original stainless steel cone-shaped design allowed 70 and 80% of the volume of the device to be filled with clot without a significant reduction in blood flow and was designed for a maximal
caval diameter of ≤2.8 cm. The original stainless steel Greenfield filter was introduced through a relatively large 26F sheath and, due to its composition, led to significant artifact on MRI. It has been shown to be resistant to dislodgment at MRI field strengths of 1.5 T. This initial design was refined to a titanium “modified hook” Greenfield filter, which was contained within a smaller 14F sheath, facilitating percutaneous placement and causes no artifacts on MRI. The original stainless steel design was also recently modified to allow insertion over a guidewire through a smaller 12F sheath. It also has alternating hook arrangements. These two later designs may be safely accommodated within a larger caliber IVC.

**Gianturco-Roehm (Bird's Nest) Filter**

Commonly known as the Bird's Nest filter (Cook Corp; Bloomington, IN), this filter consists of two V-shaped struts supporting a random tangle of stainless steel wire. It was introduced in 1984. Stable placements of this filter in vessels up to 4 cm have been reported. The Bird's Nest filter is placed through a small sheath (14F), allowing for percutaneous placement through the femoral, internal jugular, or antecubital routes. One drawback of the Bird's Nest filter is a significant image artifact with abdominal MRI. Safety in a 1.5-T MRI field has been demonstrated with no significant device migration.

**Simon-Nitinol Filter**

The Simon-Nitinol filter (Nitinol Medical Technologies; Woburn, MA) is introduced through the smallest sheath (9F) of all the designs available in the United States, allowing for introduction via an antecubital or the external jugular vein. This filter has a unique composition (nickel-titanium alloy) that assumes a preformed shape when warmed, but is pliable when cooled. This alloy is compatible with MRI and creates only minor local artifacts. This property necessitates the infusion of iced saline through the introducer sheath during its deployment in the IVC, where it subsequently warms and expands.

**Lehmann-Girofflier-Metais/Vena Tech**

This filter, referred to as the Vena Tech filter (B. Braun; Vena Tech; Evanston, IL) in the United States, is a derivation of a conical filtering device with anchoring longitudinal side rails. These serve to center the device in the vessel, thereby decreasing malalignment. The original design, introduced in 1986, was modified because of incomplete opening, caudal migration, and decreased clot trapping ability. The currently used Vena Tech cone and side rail lengths are approximately equal and are contained within a 12.9F sheath. The filter is made from an eight-metal alloy with a low ferromagnetic moment, which does not cause significant artifact on MRI.

Several other caval filter types that are in use in Europe, including permanent filters such as the Antheor and Gunther Tulip, and temporary filters such as the Cardinal, Filcard, and Gunther devices. These are not available for use in the United States and will not be discussed here.

**Efficacy of VCFs**

The goal of treatment of VTE is to prevent mortality from initial or recurrent PE. Both of these endpoints are reported in large studies reviewing the efficacy of the IVC filter in the management of VTE.
Mortality attributable to recurrent PE after IVC filter placement in 24 case studies ranged from 0 to 4%.\textsuperscript{10} Pooled data on studies representing 1,094 consecutively enrolled patients receiving Greenfield filters reported the PE incidence to be 2.4% and a mortality incidence of 0.7%. Similar studies report a 1.9% incidence of symptomatic PE, with no PE-related deaths with the use of the Bird's Nest, Simon-Nitinol, and Vena Tech filters.\textsuperscript{10} Subsequent studies have quoted similar rates of symptomatic PE recurrence of 3.4%.\textsuperscript{10,21-23} These studies in general lack systematic screening for recurrent PE and long-term follow-up of the patients; thus, the reported device failure rate is likely underestimated.

IVC filter placement appears to confer substantial protection from both recurrent PE and death due to recurrent PE. Its rate of recurrence compares favorably to that found when PE is treated with anticoagulation alone. A recent comparison of IVC filters and anticoagulation shows similar incidences of mortality and complications when each is used as the primary management strategy of VTE, although the incidence of PE was lower in patients receiving VCFs.\textsuperscript{24}

The efficacy of caval filters may be affected by positioning. The filter may be malpositioned within the lumen of the IVC (\textit{ie}, tilted), thus reducing the effective filtering capacity of the device. All devices, with the exception of the Bird's Nest filter, are subject to tilting. An \textit{in vitro} study\textsuperscript{25} has suggested that clot trapping can be decreased in the Greenfield or Vena Tech filter if the degree of tilt is >15 degrees. The incidence of significant tilting of these two filter types has been reported as 1.7%\textsuperscript{26} and 1 to 2% respectively.\textsuperscript{21} On the other hand, Simon-Nitinol filters show no decrease in clot trapping efficiency when tilted up to 20 degrees.\textsuperscript{25} Although the reported cases are few, evidence is accumulating that recurrent PE after VCF placement may be associated with tilted devices.\textsuperscript{27}

The Bird's Nest filter, by virtue of its design, is subject to wire prolapse proximal to the anchoring struts. The incidence of wire prolapse is reported as 11% (9 of 78), but this malposition does not significantly decrease filtering ability.\textsuperscript{28}

**Consensus Statements Regarding the Use of IVC Filters**

The indications for placement of IVC filters are currently expanding and being re-evaluated. Most authors agree that patients with documented venous thromboembolic disease and either contraindications to anticoagulation therapy or failure of conventional therapy are candidates for IVC filter placement. Between 67 and 80%\textsuperscript{10} of filters are placed for these indications. Additional indications are summarized in the American College of Chest Physicians consensus statement regarding indications for the placement of IVC filters (Table 1). Since publication of this consensus statement, a single report\textsuperscript{29} showed no statistical difference in the incidence of embolization from free-floating caval thrombus between patients treated with VCFs and those treated with systemic anticoagulation, raising some controversy with respect to this indication.

<table>
<thead>
<tr>
<th>Indications</th>
</tr>
</thead>
</table>

**Table 1 Standard Indications for IVC Filter Placement According to the American College of Chest Physicians Consensus Statement\textsuperscript{87}**

\textsuperscript{87}
Contraindications to anticoagulant therapy in patients at high risk for morbidity and mortality due to proximal vein thrombosis or PE
Complications of anticoagulant therapy for VTE
Recurrence of VTE despite adequate anticoagulation
Chronic recurrent embolism with pulmonary hypertension
Surgical pulmonary embolectomy or endarterectomy
Large, free floating vena caval thrombus

Proposed Newer or Expanding Indications for VCFs

Increasing numbers of VCFs are being placed in patients who do not specifically fit the consensus recommendations. The use of caval filters is expanding within two general categories: 1) prophylaxis, particularly among surgical patients without DVT but at high risk for the development of DVT or PE, and 2) primary therapy in medical patients that may be at increased risk for anticoagulation complications or treatment failure.

Prophylaxis in High-Risk Surgical Trauma Patients

DVT incidence among high-risk trauma patients can be as high as 58 to 100%. Prophylaxis in these populations is not possible in up to 14% of patients, and failure of prophylaxis to prevent fatal PE can be as high as 15%. These limitations have led a number of authors to advocate prophylactic placement of IVC filters in high-risk trauma patients. Factors such as severity of injury, spinal cord or head trauma, pelvic or lower extremity fracture, and increased numbers of traditional risk factors for VTE have been used as criteria by at least four groups reporting prophylactic IVC filter placement in trauma patients (Table 2). Each of these groups reported no fatal PE and substantial decreases in the total incidence of PE among patients receiving prophylactic IVC filters compared to historical controls. No studies have directly compared the effectiveness of IVC filters with either compression devices or subcutaneous heparin. The groups involved in these reports placed prophylactic filters in a small percentage (1 to 2%) of the total trauma population admitted to their institutions during the study period. In the meantime, patients with high injury severity scores (>9), head or spinal cord trauma, pelvic or lower extremity fracture or iliac injury, prolonged immobility, or ventilator support may be candidates for prophylactic IVC placement, particularly if they cannot receive other methods of prophylaxis.

Table 2 Incidence of Fatal PE in High-Risk Trauma Patients Receiving Prophylactic IVC Filters

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>High-Risk Criteria</th>
<th>Fatal PE/Total High-Risk Historical Controls Without IVC Filter</th>
<th>PE or Fatal PE/Total Patients With IVC Filter</th>
</tr>
</thead>
</table>

Primary Treatment of VTE in Patients With Advanced Malignancy

The use of anticoagulation as primary therapy of VTE in the cancer patient has been questioned because of increased rates of hemorrhagic complications and anticoagulation failures. Rates of major hemorrhage leading to cessation of therapy or death in cancer patients have been reported as high as 25%, with the recurrent PE rate as high as 19% while patients were on adequate anticoagulation. One study using caval filters as the sole treatment for VTE in cancer patients reported no recurrent PE and serious hemorrhage. Although substantial data support the safety of IVC filters in this population, few studies directly compare the efficacy and complication rates of use to that of anticoagulation in homogenous populations of patients.

A frequently raised concern in the setting of malignancy is whether IVC filter placement results in a significant increase in either survival or quality of life. Lossef et al followed 34 patients with advanced neoplasms receiving IVC filters for documented VTE and found no deaths from clinically apparent PE. Overall mean survival in this study was 5.5 months, and 14% of the patients were able to undergo invasive therapeutic or palliative procedures because of the filter. The authors concluded that advanced malignancy in itself should not be a deterrent to insertion of IVC filters since most patients survived well beyond the initial hospitalization. Sarasin and Eckman used the Markov decision and
cost-effectiveness analysis\textsuperscript{107} to address the question of theoretical benefit of IVC filter placement in advanced malignancy. Their model predicted that IVC filters and anticoagulation would be approximately equivalent in producing quality adjusted life month measures, but that IVC filter insertion was less expensive overall given the additional expenses incurred by bleeding complications due to anticoagulation. In spite of evolving safety and efficacy data, the most recent consensus recommendation is that anticoagulation remains the treatment of choice in cancer patients who otherwise have no contraindications to its use.\textsuperscript{43}

**Prophylaxis in Orthopedic Surgery Patients**

Patients undergoing hip and knee arthroplasties have a reported incidence of VTE as high as 84\% in untreated patients.\textsuperscript{44} Perioperative use of adjusted-dose heparin or coumadin has been shown to be effective in reducing this risk with an acceptable incidence of complications.\textsuperscript{44} Emerson and co-workers\textsuperscript{45} reported the results of prophylactic placement of IVC filters (n=37) vs anticoagulation (n=47) for patients undergoing hip and knee arthroplasty. They reported no postoperative wound hemorrhage, no clinically evident PE and no difference in lower extremity swelling between groups. Several reports document safety and efficacy in this population, but studies directly comparing IVC filter placement with anticoagulation, particularly low molecular weight heparin,\textsuperscript{46} have not been performed.

**Primary Treatment of VTE in Patients With COPD**

Patients with severe COPD and poor cardiopulmonary reserve have also been considered to be a class of patients who should receive for IVC filter placement in the setting of VTE.\textsuperscript{47} Little clinical evidence exists to support or refute this approach.

**Primary Treatment of VTE in Elderly Patients**

The risk of major bleeding complications during the administration of systemic anticoagulation is known to increase with age.\textsuperscript{48} Several authors have suggested that IVC filters (without anticoagulation) should be the primary therapy of VTE in patients older than 65. Fink et al\textsuperscript{41} followed 42 patients (average age, 65.5 years; mean duration of follow-up, 14 months) who received IVC filters as the sole treatment for VTE.\textsuperscript{49} They reported no recurrent PE, a 33\% incidence of leg swelling, and a 5\% incidence of venous ulceration. A 6-month follow-up of a similar group of patients by these same authors showed no difference in venous patency (assessed by impedance plethysmography or duplex scanning) between patients receiving IVC placement plus anticoagulation vs IVC filter placement alone as primary therapy for VTE. Similarly, no difference in clinical symptoms was seen between these groups.\textsuperscript{50} At present, further evidence directly comparing the safety and efficacy of anticoagulation to VCF is needed to support this approach.

**Complications of the Use of VCFs**

Reviews\textsuperscript{10,51,52} of complications associated with IVC filters indicate that filter placement is associated with a favorable safety profile. Both fatal and nonfatal complications have been reported; however, fatal complications are rare and most nonfatal complications are of minimal clinical significance.
Fatal Complications

Death directly attributable to IVC filter placement is unusual. Only four deaths were reported among 3,256 patients (0.12%) in 29 studies reviewed by Becker and colleagues. Isolated case reports of fatal complications include incidents related to procedural complications, malposition, strut perforation or migration, device infection, caval occlusion, and other miscellaneous complications (Table 3).

<table>
<thead>
<tr>
<th>Table 3 Fatal Complications Related to IVC Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>During Placement</strong></td>
</tr>
<tr>
<td>Right ventricular perforation due to introducer sheath/dilator</td>
</tr>
<tr>
<td>Puncture of carotid artery leading to stroke</td>
</tr>
<tr>
<td>Cardiac arrest</td>
</tr>
<tr>
<td>Inadvertent placement in heart leading to arrest</td>
</tr>
<tr>
<td><strong>Subsequent to Placement</strong></td>
</tr>
<tr>
<td>Migration to pulmonary artery</td>
</tr>
<tr>
<td>Caval occlusion with hemodynamic compromise</td>
</tr>
<tr>
<td>Sepsis due to device infection</td>
</tr>
<tr>
<td>Migration</td>
</tr>
</tbody>
</table>

Nonfatal Complications

Potentially serious nonfatal complications associated with IVC filters are also rare and include thrombosis and caval occlusion, strut perforation of adjacent structures, malpositioning, entrapment of other endovascular devices by the filter, and filter migration.

Insertion site thrombus formation appears to be relatively common but is of unclear clinical significance. The reported incidence of insertion site DVT varies from 2 to 27.8% depending on the device and the method of surveillance, among other factors. The clinical relevance of this relatively high incidence is not well characterized but may not be clinically significant given the overall rates of death and recurrent PE cited.

Thrombosis can also occur at the filter itself, leading to obstruction and lower extremity venous stasis or a nidus of clot, which may grow antegrade and form further PE. Obstruction leading to venous occlusion and subsequent arterial compromise (phlegmasia cerulea dolens) has been reported after IVC filter placement. This complication was not been reported in some large series of patients receiving IVC filters and is likely infrequent. Studies that have directly imaged IVC filters in an attempt to determine long-term patency report incidences of IVC obstruction from 0 to 30%; however, the presence of IVC obstruction does not necessarily result in increased rates of venous stasis. Asymptomatic caval occlusion can occur; rates may vary by device type. A 12-year follow-up of Greenfield filter use revealed a 96% patency rate of the stainless steel Greenfield filter. Early reports of the use of the Simon-Nitinol filter documented an IVC occlusion rate of 16% (7 of 44), which appears to be
confirmed by report indicating a 20% (20 of 102) incidence of occlusion. Initial experience with the Bird's Nest filter found IVC occlusion rates of 19% (7 of 37); however, one study demonstrated 100% IVC patency by duplex ultrasonography in 37 patients receiving Bird's Nest filters and followed between 2 and 40 months. Actuarial patency of the IVC, determined in 137 patient receiving a Vena Tech filter, was 92%, 80%, and 70% at 2, 4, and 6 years. The length of follow-up, method of screening for thrombus, and patient populations vary widely among many of these studies, making direct comparison of rates of IVC occlusion and thrombosis difficult. Nonetheless, these results have led some investigators to recommend that the Vena Tech filter not be used in patients when long-term patency is important and to warn that the Simon-Nitinol filter design or alloy may promote in situ thrombosis.

Lower extremity swelling and stasis ulceration due to venous insufficiency are known complications of DVT. At least three series comparing thromboembolic complications such as recurrent DVT, PE, vena caval obstruction, or venous insufficiency have failed to show a difference in the rates of occurrence of these complications in patients with VTE treated with IVC filters alone, compared to patients treated with both IVC filter and anticoagulation.

Penetration of the retaining hooks of the filter through the lumen of the IVC is necessary for the proper anchoring of the device. Further penetration of these struts is commonly seen on radiographs, reported in 9.1% to 24.5% of 234 patients in three studies but this complication is rarely of clinical significance with no adverse clinical events corresponding to these findings. Examples of isolated serious complications due to strut perforation of adjacent structures are shown in Table 4, along with other serious nonfatal complications related to IVC filters.

---

**Table 4 Rare Nonfatal Complications of IVC Filters Related to Migration or Strut Perforation**

<table>
<thead>
<tr>
<th>Possible Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pericardial tamponade&lt;sup&gt;66&lt;/sup&gt;</td>
</tr>
<tr>
<td>Aortic perforation&lt;sup&gt;93&lt;/sup&gt;</td>
</tr>
<tr>
<td>Duodenal perforation&lt;sup&gt;94&lt;/sup&gt;</td>
</tr>
<tr>
<td>Small bowel obstruction&lt;sup&gt;95,96&lt;/sup&gt;</td>
</tr>
<tr>
<td>Pancreatic pseudocyst formation&lt;sup&gt;97&lt;/sup&gt;</td>
</tr>
<tr>
<td>Hydronephrosis&lt;sup&gt;98&lt;/sup&gt;</td>
</tr>
<tr>
<td>Retroperitoneal hemorrhage&lt;sup&gt;99&lt;/sup&gt;</td>
</tr>
<tr>
<td>Causalgia&lt;sup&gt;100&lt;/sup&gt;</td>
</tr>
<tr>
<td>Air embolism during IVC filter insertion&lt;sup&gt;58&lt;/sup&gt;</td>
</tr>
<tr>
<td>Guidewire entrapment&lt;sup&gt;101&lt;/sup&gt;</td>
</tr>
<tr>
<td>Malposition in heart causing myocardial infarction&lt;sup&gt;102&lt;/sup&gt;</td>
</tr>
<tr>
<td>Vertebral body penetration with back pain&lt;sup&gt;103&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Fatal consequences of device migration, as discussed, are rare. Some migration (0.5 to 7.0 cm) of the approved filters is common but rarely of clinical significance. Surgical or percutaneous retrieval of the misplaced or migrated filters is occasionally necessary, but at least three reports comprising five
patients whose devices have migrated to the heart suggest that some of these misplaced devices may not require removal.\textsuperscript{22,68,69}

Care must be taken when accessing the IVC in a patient with an IVC filter. Filter dislodgment and significant migration have been described in the context of guidewire manipulation during the insertion of a central venous catheter.\textsuperscript{70,71} Recent \textit{in vitro} data suggest that use of a straight rather than a J-tipped introducer wire may minimize the incidence of entrapment and subsequent device disruption and potential displacement.\textsuperscript{72} Fluoroscopic guidance of IV catheter or wire insertion in patients who have an indwelling filter has been recommended by manufacturers.

**Special Situations Regarding the Use of VCFs**

**Use of Anticoagulation in Patients With an IVC Filter in Place**

Consensus statements typically recommend continuing anticoagulation in patients with a caval filter, if there are no contraindications, to decrease the incidence of venous insufficiency, caval thrombosis, or embolization from the filter. It is not clear that the literature supports this. Several uncontrolled studies have compared the incidence of venous insufficiency and recurrent PE in patients with VCFs with and without anticoagulation\textsuperscript{21,49,58,73} without detecting a significant difference in complications between these two treatments. A single randomized prospective trial came to the same conclusions with regard to early recurrence of PE and secondary end points of late symptomatic PE, DVT, venous insufficiency, filter complication, bleeding, or death.\textsuperscript{24} Patients with extending thrombosis in the presence of a filter may be candidates for anticoagulation, but no studies have clearly outlined which patients should receive anticoagulation plus filter placement as opposed to caval filters alone.

**Superior Vena Cava and Suprarenal Placements of Filters**

Suprarenal placement of VCF comprises 6 to 9\% of all placements. The majority of the data describes successful suprarenal placement of Greenfield filters.\textsuperscript{8,74} The successful placement of Vena Tech and Bird's Nest filters have been reported.\textsuperscript{9} Although renal vein thrombosis below the IVC filter is a theoretical concern, no renal dysfunction has been reported in these series containing a total of 89 patients. These limited data also suggest similar efficacy and safety of suprarenal IVC filter placement.

Superior vena cava placement of filters has also been reported for the management of upper extremity thrombosis, typically in patients with contraindications to or unsuccessful anticoagulation.\textsuperscript{7,75} Although the experience is limited, the largest series, consisting of 41 patients, confirms previous reports of successful placement without migrations, fracture or dislodgment, even with central venous catheters placed through the filter.\textsuperscript{75} No clinical episodes of PE or superior vena cava syndrome were seen in these patients, with a median follow-up period of 12 weeks.

**Temporary and Retrievable Caval Filters**

In addition to permanently implanted devices, temporary VCFs that may be removed after 2 to 6 weeks have been used experimentally. These removable devices presumably would not be subject to long-term complications. The first national trial of one such filter type in the United States (Tempo Filter; Braun Celsa, Chasseneuil, France) was recently halted due to rare device fracture. At this time, no temporary
filters are approved for widespread use in the United States, although both retrievable filters and temporary filters are available in Europe and Canada. Favorable safety profiles have been reported for these temporary devices. Further investigation is necessary before the role of the temporary filter can be assessed.

**Use of IVC Filters During Pregnancy**

Pregnancy is widely recognized as a hypercoagulable state and a risk factor for VTE. Anticoagulant treatment of VTE during pregnancy is complicated by the potential for uterine and fetal hemorrhage and the contraindication to coumadin use. Heparin and low molecular weight heparin have been successfully used during pregnancy in the management of VTE and form the standard against which IVC filter placement must be compared. A number of authors have reported successful management of VTE in pregnancy with IVC filters alone without significant complication or recurrence of PE; however, no prospective studies have directly compared VCFs with anticoagulation in the pregnant patient with VTE. Of particular concern in this patient group is the long-term effects of a caval filter, possibly in place for four or five decades, and the potential effect on the course of future pregnancies. Although theoretically possible, to our knowledge, device deformation or caval perforation due to the weight of a gravid uterus has not been described.

**Cost of IVC Filter Placement**

An ongoing concern regarding IVC filters is clearly the cost effectiveness of their use. A number of authors have expressed concern that this modality of treatment may not be cost effective in reducing either total mortality or significant morbidity in a number of the groups examined. The cost of IVC placement has been estimated at approximately $5,000 per device, including supplies and medical personnel time. This compares with an estimated $4,500 for hospitalization and subsequent oral systemic anticoagulation with laboratory follow-up in the treatment of documented VTE for 3 months. Efficacy of these two regimens has been shown to be comparable in some patient subsets and is clearly cost effective. However, application of this technology broadly in 1% of all trauma patients, for example would lead to an annual cost of approximately $900 million. A reduction of PE-related mortality of 66% (comparable to that seen by Khansarinia and colleagues) would be expected to save 1,200 lives at a cost of $900,000 for each life saved. Recent calculations using similar assumptions have estimated the cost per PE prevented in such high-risk trauma patients at $93,700.

**Summary**

The role of IVC filter placement in the management of VTE has continued to expand. Long-term follow-up information is accumulating, but the efficacy and complication rate of IVC filters in place for four or five decades is unknown. IVC filters are considered the standard of care in failures of anticoagulation, in patients with an absolute contraindication to anticoagulation, and for patients with chronic thromboembolic pulmonary hypertension. The role of IVC filter insertion as a primary intervention (without anticoagulation) for certain patient populations and as a prophylactic intervention for select high-risk patients is under investigation. Because of the substantial number of involved patients and the potentially increased cost of these proposed indications, further clinical trials are needed to support their widespread use.
References

1. Dalen JE, Alpert JS. Natural history or pulmonary embolism. Prog Cardiovasc Dis 1975; 17: 259-270
34. Silver D, Sabiston DCJ. The role of vena caval interruption in the management of pulmonary embolism. Surgery 1975; 77:1-10
cancer patients. Cancer 1987; 1087:983-985
47. Pomper SR, Lutchman G. The role of intracaval filters in patients with COPD and DVT. Angiology 1991; 42:85-89
56. Aruny JE, Kandarpa K. Phlegmasia cerulea dolens, a complication after placement of a Bird's Nest
vena cava filter: a simple device to facilitate percutaneous insertion of the Kimray-Greenfield filter. AJR Am J Roentgenol 1990; 154:1105-1106


64. Berland LL, Maddison FE, Bernhard VM. Radiologic follow-up of vena cava filter devices. AJR Am J Roentgenol 1980; 134:1047-1052


