

IVC Filter

An **inferior vena cava filter**, also **IVC filter** a type of vascular filter, is a medical device that is implanted into the inferior vena cava to prevent pulmonary emboli (PEs).



Inferior vena cava filter - Gunther Tulip.

IVC filters are used in case of contraindication to anticoagulation, failure of anticoagulation or complication to anticoagulation in patients who have a venous thromboembolism disease or in a prophylactic use for patients with high risk of pulmonary embolism.

Placement

IVC filters are placed endovascularly, meaning that they are inserted via the blood vessels. Historically, IVC filters were placed surgically, but as designs changed they could be placed via the groin through a thin tube or catheter. With modern filters which can be compressed into much thinner catheters, however, access to the venous system can be obtained either via the femoral vein (the large vein in the groin), the internal jugular vein (the large vein in the neck.) or via the arm veins with one design. Choice of route depends mainly on the amount and location of blood clot within the venous system. To place the filter, a catheter is guided into the IVC using fluoroscopic guidance, then the filter is pushed through the catheter and deployed into the desired location, usually just below the junction of the IVC and the lowest renal vein.

Review of prior cross-sectional imaging or a venogram of the IVC is performed before deploying the filter to assess for potential anatomic variations, thrombi within the IVC, or areas of stenoses, as well as to estimate the diameter of the IVC. The size of the IVC may affect which filter is deployed, as some (such as the Birds Nest) are approved to accommodate larger cavas. There are situations where the filter is placed above the renal veins (e.g. pregnant patients or women of childbearing age, renal or gonadal vein thromboses, etc.). Also, if there is duplication of the IVC, the filter is placed above the confluence of the two IVCs or a filter can be placed within each IVC.

What is inferior vena cava filter placement? Inferior vena cava filter placement is surgery to place a filter into your inferior vena cava. The inferior vena cava, or IVC, is a large blood vessel found in your abdomen (stomach). It begins at your abdomen, and continues up to your heart, inside your chest. The IVC brings blood from the lower parts of your body back to your heart. During the procedure, a catheter (thin plastic tube) is inserted into the blood vessels in your neck or groin. A Doppler ultrasound or fluoroscope (x-ray) is used to guide the catheter into your IVC. The IVC filter is inserted through the catheter and into the IVC where it attaches to the walls of the vein. The catheter is pulled out after the procedure and the filter is left in.

What is an inferior vena cava filter? An IVC filter is a specially shaped mesh made of very thin wires. It is placed in the center of the IVC to trap blood clots going to your heart. This helps prevent the blood clots from blocking blood vessels in your lungs and causing serious problems. The following are the types of IVC filters:

- **Permanent filters:** These filters are left firmly in the IVC and are not taken out. Examples include the Greenfield filter, Bird's Nest filter, and TrapEase filter.
- **Temporary or retrievable filters:** These filters can be removed from the IVC after a period of time. They may also be left permanently in the IVC depending on the person's

condition. Examples include the OptEase filter, Gunther Tulip filter, and Recovery filter. They have small hooks or knobs on one end so that they could be removed by caregivers. A special catheter with a hook is used to remove temporary IVC filters. Your caregiver will tell you when the IVC filter may be removed.

What is pulmonary embolism? Pulmonary embolism is a condition where blood vessels in your lungs get blocked by a floating blood clot. When this happens, the area it supplies with blood may die and rot. You may have trouble breathing, chest pain, fainting, bluish skin color, and you may even die. The blood clot that causes this condition usually comes from the blood vessels in your legs or hips. Blood clots are made of fat and fibers. Clots that stick on blood vessel walls make the vessels narrow. They may completely clog the blood vessel, or they may break off from the walls and float in your blood.

Why might I need an inferior vena cava filter placed? You may need surgery to place an IVC filter when you have blood clotting problems. You may also need it if you are at risk of having blood clots, such as during pregnancy or surgery. You may also need it after trauma, such as a head injury or fractured pelvis. A filter may also prevent patients who have a history of deep venous thrombosis, from getting clots in their lungs. When medicine to thin the blood cannot be used, an IVC filter may be placed.

What are the risks of having an inferior vena cava filter? There are risks with IVC placement surgery, including infection and bleeding. Blood clots may form and float elsewhere from the area where the catheter is inserted. Your IVC and the tissue around it may get damaged. Your IVC filter may break, loosen, change position, or get blocked. If there are problems with your filter, you may need to have more surgery. Even after IVC filter placement, blood clots may still appear and clog blood vessels. Ask your caregiver if you have any questions or concerns about your condition, treatment, or care.

Indications for use

Most filters are placed for the following reasons. **Failure of anticoagulation**; eg development of deep vein thrombosis (DVT) or pulmonary emboli (PE) despite adequate anticoagulation.

Contraindications to anticoagulation; eg a patient at risk of PE who has another condition that puts them at risk of bleeding, such as a recent bleed into the brain, or a patient about to undergo major surgery **Large clots** in the vena cava or iliac veins **Patients at high risk** of having a PE

- contraindication to anticoagulation
- failure of anticoagulation
- complication of anticoagulation: hemorrhage or thrombocytopenia
- large free-floating IVC/iliac vein thrombus

Other indications:

- cor pulmonale and DVT/PE
- patients with high risk of complications to anticoagulation
 - metastatic disease
 - syncope in elderly
- prophylactic placement in high-risk trauma patients
 - spinal cord injury
 - severe head injury
 - complex pelvic fractures
 - multiple long bone fractures
- prophylactic placement before hip/knee replacement in patients with prior DVT

Prophylactic filters remain controversial

Retrieval

Most IVC filters are permanent, but some filters are now available that are "retrievable." Retrievable filters are fitted with some sort of

device (that varies from model to model) that allows them to be pulled back into a catheter (technically a "sheath") and removed from the body, often through the Jugular vein. Previously, filters that had been in the IVC for less than three weeks were considered suitable to attempt retrieval, as filters that have been in place longer might have been overgrown by cells from the IVC wall and there was an increased risk of IVC injury if the filter is dislodged. Newer designs, and developments in techniques mean that some filters can now be left in for prolonged periods and retrievals after a year are now being reported. This would include the ALN, Option, Tulip and Celect filters.

IVC filter brands

- B Braun Tempofilter IVC filter (retrievable)
- B Braun VenaTech LGM IVC filter (no longer sold)
- B Braun VenaTech LP IVC filter
- Bard G2 IVC filter (retrievable, unlimited indwell time)
- Bard Recovery IVC filter (retrievable) (no longer sold)
- Boston Greenfield IVC filter
- Cook Birds Nest IVC filter
- Cook Celect IVC filter (not approved for retrieval in the US)
- Cook Gunther Tulip IVC filter (retrievable)
- Cordis OptEase IVC filter (retrievable, 12 day indwell time)
- Cordis TrapEase IVC filter
- Mobin-Uddin Umbrella IVC filter (no longer sold)
- Pyramed ALN IVC filter (retrievable)
- Rex Medical Option IVC filter (retrievable) (in clinical trials)
- Simon Nitinol IVC filter

Complications

A 41-year-old man was admitted to the intensive treatment unit (ITU) with a second episode of severe acute pancreatitis secondary to

alcoholism. His post-operative period was complicated by intraabdominal bleeding for which he required distal pancreatectomy, cholecystectomy, splenectomy and Roux-en-y-pancreaticojejunostomy.

Day 1 post-operatively, the patient developed central venous catheter (CVC) infection and *Candida glabrata* was grown from blood cultures taken through the CVC, peripheral line and later from the CVC tip. He commenced treatment with Liposomal Amphotericin B (AmBisome). The CVC in his external jugular vein was removed and resited in his left femoral vein because central venous access was crucial as he was critically ill, needing inotropic support. He continued to have candidaemia and 7 days later his left leg was noted to be swollen. Doppler scan of his femoral veins revealed bilateral deep vein thrombosis. He was started on heparin and the femoral line was removed. The next day, he had a Gunther Tulip retrievable inferior vena cava (IVC) filter (William Cook Europe, Bjaeverskov, Denmark) placed in his inferior vena cava via the transjugular route as prophylaxis against pulmonary embolism (PE).

Despite Amphotericin therapy for 10 days, he continued to have a high temperature, with elevated white blood cell (WBC) and C-reactive protein (CRP), and *C. glabrata* was resited from his blood cultures persistently. The IVC filter was considered for removal but this was outweighed by the high risk of PE. Amphotericin was changed to Caspofungin because of its superior efficacy of penetrating into biofilms [1, 2]. He remained candidaemic with a high temperature and raised inflammatory markers after 48 h of Caspofungin at which stage the IVC filter was removed (15 days after its insertion) following consultation with vascular surgeons who judged that the thrombus was now sufficiently organized for removal of the IVC filter.

Direct cultures of the IVC filter on Sabaraud dextrose agar plates were negative. The filter was placed in Robertson's cooked meat broth (RCMB) for enrichment from which *C. glabrata* was isolated.

He remained afebrile after removal of the IVC filter, his WBC and CRP remained normal, and his blood cultures were sterile. He was discharged out of ITU to the wards to complete a 6-week course of Caspofungin for septic central vein thrombosis.

Data from the American National Nosocomial Infection Surveillance (NNIS) programme suggest that fungi account for 9% of all nosocomial infections. *Candida* species accounted for almost 80% of these infections. *Candida albicans* has been found to be the most common cause of *Candida* blood-stream infection. Recent data also suggest an increase in the rates of *C. glabrata* blood stream infections.

The risk factors for the development of candidaemia include: prolonged ITU stay, use of CVC and other prosthetic devices, total parenteral nutrition, prior use of antibiotics and immunosuppression.

Candidaemia and thrombosis are well known complications following central venous catheterization. However, septic candida thrombophlebitis of the central veins is less frequent and probably an underreported complication of central venous catheterization [3].

Septic thrombophlebitis of the deep veins is a life-threatening complication following central venous catheterization. The risk of CVC related DVT is approximately 10% and the risk of catheter related sepsis increases by 2.6 times when thrombosis occurs [4].

Causative organisms for septic thrombophlebitis include *Staphylococcus aureus*, *Staphylococcus epidermidis*, Gram negative organisms such as *Klebsiella*, *Pseudomonas* and *Enterobacter* species and *Candida*.

A literature search of cases of candida thrombophlebitis and candida inferior vena caval filter infections over the last 25 years revealed 18 reported cases of candida thrombophlebitis and no cases of candida IVC filter infection [3, 5].

Among the cases of candida thrombophlebitis reported *C. albicans* was the most common causative agent and the other species reported

has been *C. glabrata*. Thrombosis occurred more frequently in the superior vena cava/subclavian/right atrium and less commonly in the inferior vena cava, which could probably be explained by the fact that the upper extremity veins are more frequently catheterized than lower extremity veins. The most common presentation was fever with or without oedema. The risk factors associated with the development of candida thrombophlebitis were presence of CVC, antibiotic treatment, admission to ITU and abdominal surgery. All cases were treated with Amphotericin B with or without surgery (excision of the affected veins). Mortality attributable to candida thrombophlebitis was 22%.

To the best of our knowledge this is the first case report of candida IVC filter infection. Although it is known historically that foreign material placed in tissues tend to form biofilms, our case report emphasizes this and the fact that it is important to remove such material when clinically indicated (recurrent bacteraemia/candidaemia, worsening clinical condition, risk-benefit assessment). The filter that was placed in the IVC of our patient was a retrievable Gunther Tulip IVC filter, which could be removed promptly via the transjugular route when the risk of development of PE was reduced. The ideal time for removal of these filters is within 10–14 days following insertion. After this time there is an increased risk of IVC tear during removal because of incorporation of the filter into the caval wall, although recent reports describe safe and successful removal of the filter after 14 days [6].

Direct culture of the IVC filter on Sabouroud dextrose agar plates yielded no growth; whereas subculture from RCMB grew *C. glabrata*. This needs to be considered while processing prosthetic devices in laboratories.

Caspofungin, the newer antifungal agent, has not been reported to have been used for the treatment of central venous *Candida* thrombophlebitis. Successful treatment of our patient with

Caspofungin suggests that this drug can be effective in candidal intravascular infections.

In a pilot study, 22 patients undergoing major spine reconstruction received prophylactic IVC filters. These patients were prospectively followed to evaluate complications related to the filter, the rate of deep venous thrombosis (DVT) formation, and the rate of pulmonary embolism (PE). These data were compared with those obtained in a retrospective review for PE in a matched cohort treated at the same institution. At a second institution the treatment guidelines were implemented in 17 patients undergoing complex spine surgery with the same follow-up criteria.

In the pilot study, no patient experienced PE (0%), whereas two had DVT (9%). Bilateral DVT developed postoperatively in one patient (associated morbidity rate 4.5%), who required thrombolytic therapy. One patient died of unrelated surgical complications. The PE rate in the matched cohort at the same institution was 12%. At the second institution, no patient had PE, and no complications were noted.

In this patient population, prophylactic IVC filter placement appears to decrease the PE rate substantially, from 12 to 0%. The placement of IVC filters appears to be a safe and efficacious intervention for prevention of PE in high-risk patients.

Pulmonary embolism is a significant cause of morbidity and mortality after spine surgery. Multiple prophylactic measures have been suggested and include venous compression boots, subcutaneously administered heparin, and early ambulation to prevent DVT. In complex spine surgery, the current practice for postoperative DVT prophylaxis depends primarily on the surgeon and institution. Mechanical prophylaxis alone is often not sufficient, where as anticoagulation therapy carries a significant risk of bleeding complications.^[10,50] The treatment of PE often involves mandated systemic anticoagulation therapy. Specifically in spine surgery, anticoagulation with heparin may be associated with complications in

up to 67% of patients.^[10] As an alternative to this treatment, IVC filters have been demonstrated to prevent PE in selected patients who are prone to thromboembolic disorders. Furthermore, the indications have expanded as easier insertion techniques have resulted in lower complication rates.^[31,44,64] In this paper we describe a select group of patients at two institutions who underwent major spine reconstruction and were considered at high risk for development of a thromboembolic event. The preoperative IVC filter concept was prospectively evaluated at the initial institution, with encouraging results. The treatment guidelines were subsequently implemented at a second institution for further evaluation

Transcatheter closure of patent foramen ovale (PFO) has recently gained acceptance as a form of therapy for patients with cryptogenic stroke.^{1–3} The standard approach involves passage of a large delivery sheath from the femoral vein into the inferior vena cava and right atrium. The delivery sheath is then positioned across the PFO, and the septal occlusion device is deployed under both fluoroscopic and transesophageal echo (TEE) guidance. The approach as previously described is often straightforward; however, previous placement of an inferior vena cava (IVC) filter can preclude the performance of right heart catheterization through the femoral venous system, for fear of dislodging the IVC filter.^{4,5} We describe a novel approach to prevent or minimize the risk of displacement/dislodgement of a previously implanted IVC filter in a patient with cryptogenic stroke who underwent transcatheter closure of a PFO.

Case Report. A 36-year-old woman previously diagnosed with multiple cerebellar infarcts and possible pulmonary embolism and who had prior placement of an IVC filter (Greenfield Filter) was referred for transcatheter closure of patent foramen ovale. The patient had previously undergone work-up to rule out the presence of a hypercoagulable state. Transesophageal echocardiography demonstrated the presence of paradoxical (right to left) flow across the PFO. After discussing the risks and benefits of cardiac

catheterization and transcatheter closure of PFO, consent was obtained and the decision was made to proceed with cardiac catheterization. A 7 French (Fr) sheath was positioned in the right femoral vein and a 4 Fr sheath was positioned in the left femoral artery (to monitor arterial blood pressure). After obtaining both venous and arterial access, the patient received a 3,000 unit bolus of heparin. Angiography was then performed through a 7 Fr NIH Cardiometer catheter (Medtronic AVE, Santa Rosa, California) positioned in the inferior vena cava directly below the Greenfield filter (Meditech, Watertown, Massachusetts) (Figure 1).

Angiography was performed in the IVC to make sure that there was no clot or thrombus present in either the IVC or the Greenfield filter. The Cardiometer catheter was then exchanged for a 7 Fr Goodale Lubin (GL) end-hole catheter (Medtronic AVE), which was positioned directly below the IVC filter. A 0.035'' Amplatz super-stiff guidewire with a 1 cm, soft straight tip (Boston Scientific/Scimed, Inc., Maple Grove, Minnesota) was then advanced through the GL catheter and across the IVC filter into the right atrium. Both the GL catheter and 7 Fr sheath were then removed and exchanged over the super-stiff wire for a 10 Fr Mullins transseptal sheath (Cook Incorporated, Bloomington, Indiana). Under both PA and lateral fluoroscopy, the transseptal sheath (TSS) was carefully advanced over the super-stiff wire through the IVC filter. The TSS was then positioned in the IVC/right atrial junction. The dilator and super-stiff wire were then slowly withdrawn and the sheath was bled back to clear it of any bubbles.

A slow flush was then attached to the back-bleed device at the end of the TSS. A 7 Fr Multipurpose (MP) catheter (Cordis Corporation, Miami Lakes, Florida) was then advanced through the transseptal sheath positioned in the IVC/right atrial junction. Right heart catheterization was performed, after which agitated saline was injected through the MP catheter in the right atrium to demonstrate paradoxical right to left flow [demonstrated by transesophageal echocardiography (TEE)]. The MP catheter was advanced across the patent foramen ovale into the left atrium. Left atrial pressure and

saturation measurements were then obtained. The PA camera was positioned in left anterior oblique/cranial angulation, and left atrial angiography was performed (Figure 2).

The MP catheter was then positioned in the left upper pulmonary vein. A 0.035'' Amplatz super-stiff wire was advanced through the MP catheter into the left upper pulmonary vein. The MP catheter was then exchanged over the super-stiff wire for a 20 mm NuMED sizing balloon (NuMED, Hopkinton, New York). Balloon sizing of the PFO was performed. The PFO was measured both fluoroscopically and by TEE. The sizing balloon was removed over the super-stiff wire and the TSS was then bled back to clear it of any bubbles. After making sure that the sheath was adequately flushed, the TSS was advanced over the super-stiff wire into the left atrium. After confirming proper position of the TSS in the left atrium, the super-stiff wire was removed. A 28 mm CardioSeal septal occlusion device (NMT Medical, Boston, Massachusetts) was then safely deployed across the atrial septum (Figure 3). The TSS was positioned in the IVC/RA junction. The delivery catheter was then removed from the TSS, bled back and cleared of bubbles. The 7 Fr MP catheter was advanced through the TSS and positioned in the right atrium. Repeat bubble study through the MP catheter was then performed, confirming complete occlusion of the foramen ovale (absence of paradoxical flow by TEE evaluation). The MP catheter was removed and exchanged for the super-stiff wire, which was positioned in the IVC/RA junction. The TSS was then carefully withdrawn over the super-stiff wire under fluoroscopic guidance. The super-stiff wire was carefully withdrawn out of the body under fluoroscopic guidance.

In the past, the presence of an IVC filter was considered a contraindication to the performance of right heart catheterization from the femoral venous system. Patients who had prior placement of an IVC filter could, however, undergo right heart catheterization through the internal jugular veins, subclavian veins or via the transhepatic approach. Recent reports have shown that right heart catheterization through a previously implanted IVC filter is

technically feasible and can be safely performed without complications.⁶ We describe a technique that allows for the performance of both right heart catheterization and device closure of a PFO through a previously implanted IVC filter. The technique described is able to minimize displacement of the previously implanted IVC filter by limiting the number of catheter and sheath exchanges through the previously implanted IVC filter. Utilizing this technique, the IVC filter is only traversed once with the TSS. Once the TSS is positioned in the IVC/RA junction, right heart catheterization, angiography, balloon sizing of the PFO and device deployment can be safely performed with the appropriate catheters through the TSS.

There are several important technical points. The performance of angiography in the IVC prior to passage of a guidewire or catheter is important to make sure that there are no clots or thrombi that could be dislodged during guidewire or sheath advancement through the IVC filter. The use of a straight guidewire to traverse the Greenfield filter is also important. There have been previous reports of J-tipped guidewires becoming trapped within the arms of the Greenfield filter.^{4,5} The choice of wire is important because it must also be stiff enough so that the natural curve of the TSS does not distort the arms of the Greenfield filter as it is advanced into the IVC/RA junction. This is true for both the initial phase of the catheterization when the IVC filter is first traversed and at the end of the case when it is time to remove the TSS. Both PA and lateral fluoroscopy are essential so that the operator can follow the course of both the guidewire and TSS as they are advanced (initially) and withdrawn (at the end of the case) through the IVC filter. Because of the length of the TSS, it is absolutely essential to clear the sheath of any bubbles that might be trapped within the sheath. This must be performed after each catheter exchange to prevent trapping of air bubbles or clot formation within the sheath. We have also found it beneficial to attach a slow, continuous heparinized flush to the back-bleed device at the end of the sheath prior to the introduction of any catheter or device into the sheath. This is important because catheter and sheath mismatch can lead to clot formation within the TSS.

The device used to close the PFO in this patient was a CardioSeal septal occlusion device. As of this writing, this is the only Food and Drug Administration (FDA)-approved device for PFO closure in the US. In the past, this device could only be delivered through an 11 or 12 Fr sheath. Since the redesign of its loading mechanism, the device can now be delivered through a 10 Fr sheath. While this is an improvement compared to the earlier design, it still requires a relatively large sheath when compared to some of the newer septal occlusion devices (Amplatzer, Helex, etc.), which can be delivered through smaller sheaths. Because these newer devices can be delivered through smaller sheaths, traversing previously implanted IVC filters could be potentially safer. Another alternative would have been to obtain transhepatic access. The transhepatic approach has previously been described to close atrial septal defects and perform other interventional procedures;⁷ however, this approach is not without risk, and intraperitoneal hemorrhage has been described.⁸ In the future, once the other septal occlusion devices that use smaller delivery sheaths receive FDA approval for PFO closure, the transhepatic approach may become a safer option. In the interim, if one utilizes the aforementioned technique, the performance of cardiac catheterization, angiography, balloon sizing and device closure of PFO can be performed with minimal risk of dislodgement of the IVC filter.

In summary, we describe a novel technique to prevent displacement of a previously implanted IVC filter in a patient with cryptogenic stroke who underwent transcatheter closure of a patent foramen ovale. We believe that this technique can minimize the number of catheters/sheaths that need to traverse the IVC filter, thereby decreasing the risk of displacement/dislodgement of the IVC filter.

Contraindications to [anticoagulants](#) (substances that prevent blood clotting)-patients who have serious active bleeding, recent spinal cord injury, hemorrhage, stroke, and recent surgery or trauma

- Complications of anticoagulation-patients who have serious active bleeding from [heparin](#) or [warfarin](#) or [heparin-induced thrombocytopenia](#) (decrease in blood platelets) or who have a sensitivity to heparin or warfarin, manifesting in skin rash or skin necrosis (destruction of tissue)
- Failure of anticoagulation-patients who have recurrent thrombosis (clotting in a blood vessel) or extension of a thromboembolism while adequately anticoagulated
- Pulmonary embolism-patients who have suffered a massive pulmonary embolism and are undergoing pulmonary embolectomy (removal of a clot from the lung); a filter is placed immediately following embolectomy to prevent recurrence of pulmonary embolism
- Prevention of pulmonary embolism and thromboembolism-patients scheduled for major elective orthopedic surgery and have a high risk for thrombosis; also, persons who have sustained major trauma, including bone fractures, injuries to the veins, and head and spinal cord injury, plus those with heart or lung conditions

Other possible indications for vena cava interruption are advanced age, malignancy, and pregnancy in patients at risk for developing clotting problems.

What is Vena Cava Interruption?

The inferior vena cava is the large vein that returns deoxygenated blood to the heart (Figure 1). Vena cava interruption is the placement of a filter in the inferior vena cava to trap clots and prevent [pulmonary embolism](#) (clot in lung). This "interrupts" or interferes with the free flow of blood through the vein. Methods have been developed that allow vena caval interruption devices to be placed directly into the vena cava through the femoral (in the thigh) or jugular (in the neck) vein. An example of such a device is a

Greenfield umbrella filter, which is placed inside the vessel to trap clots. Filters have improved greatly and are widely used as both treatment for and prophylaxis (prevention) of thromboembolic disease (blockage by a clot carried in the bloodstream from another site). The Greenfield filter has successfully maintained long-term vein patency (condition of being open) in over 95% of patients.

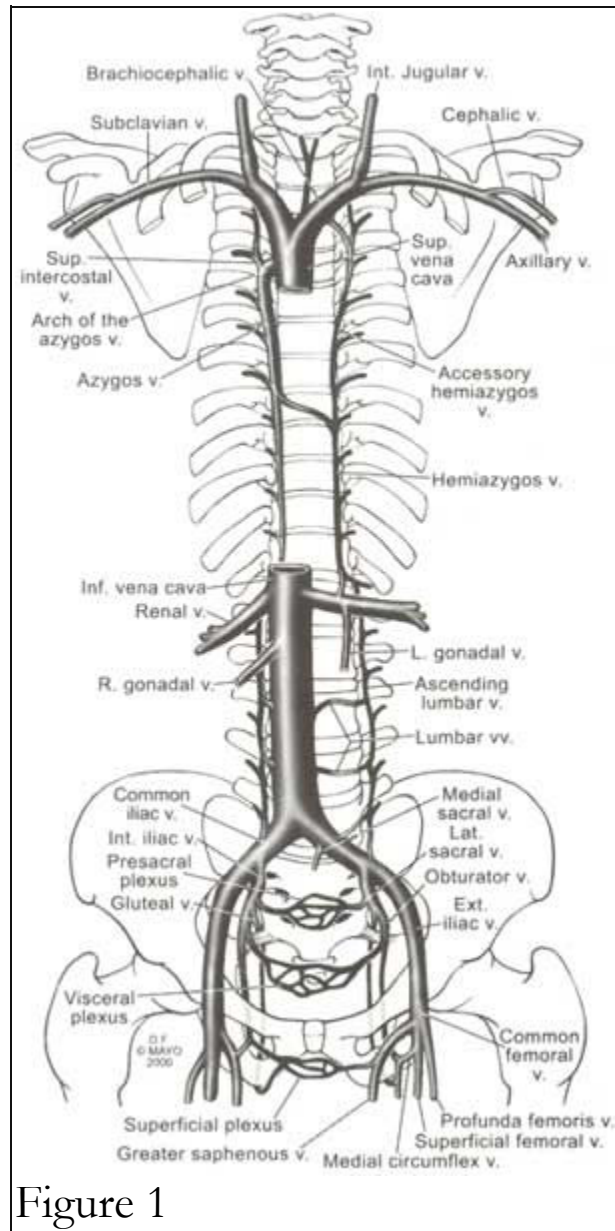


Figure 1. Major veins of the pelvis, abdomen, and chest. Note that the inferior vena cava is the large vessel in the center of the figure.

Before placement of a vena caval filter, a venacavogram (x-ray of the vena cava) is taken to determine the best site for placement. Techniques for placing a filter differ according to the type of filter chosen by the physician. Besides the Greenfield filter, the Bird's Nest filter, the Vena Tech filter, and the Simon Nitinol filter are possibilities.

In critically ill patients, those who are pregnant, those who have a contraindication to contrast material, or those whose weight exceeds the weight limits of standard x-ray equipment,

vena caval filters can be safely placed at the bedside using fluoroscopy and ultrasound or ultrasound alone for guidance. Fluoroscopy is a diagnostic method by which x-ray images are projected onto a fluoroscopic screen.

Patient Follow-up

Patients with vena cava filters should have an annual follow-up examination so the physician can evaluate the mechanical stability of the filter and determine whether blood is flowing freely through the filter. The examination includes x-rays and usually ultrasound examination of the filter and the vena cava. Evaluation of the legs is done to monitor for signs of recurrent thrombosis or chronic venous disease. The physician observes for edema (accumulation of fluid), hyperpigmentation (darkening of the skin), tissue loss, skin ulceration, and other signs of [post-thrombotic syndrome](#). The patient needs to give the physician information about his or her need for and use of [support hose](#), use of anticoagulants and any adverse effects, recent hospitalizations, and operations. Information about filter placement needs to be known by the patient's local practitioner so that arrangements for appropriate studies can be made.

A patient with symptoms and/or signs of pulmonary embolism should undergo a diagnostic test to determine the patency of the filter and to look for the presence of trapped or propagating emboli (clots)-a rare occurrence. Such tests may include venocavagram, computed tomography (CT), or magnetic resonance imaging (MRI).

The patient should immediately call the physician if he or she has new edema in both legs. Or, report to an emergency department. In this case, an [ultrasound duplex scan](#) is done to look for thrombus in the filter or the vena cava.

Since the introduction of inferior vena cava (IVC) filters more than 30 years ago, there has been a steady improvement in the design, ease, and safety of the delivery systems. Today, all of the commonly used filters can be placed via a peripheral vein by using standard percutaneous Seldinger technique. However, this typically requires fluoroscopy, intravenous contrast agents, radiation exposure, and transport of the patient to the interventional or operating suite. In the multiply injured trauma or critically-ill intensive care unit patient, often requiring inotropic and ventilator support, transport to these facilities can be hazardous. In addition, these patients frequently have a combination of neurospinal and long bone injuries, which require skeletal immobilization, thus further complicating transportation. Advancing technology with portable duplex ultrasound and improved deep abdominal duplex imaging has allowed for routine diagnostic evaluation of the IVC, renal veins, and surrounding visceral structures. This degree of accuracy has allowed numerous centers to gain experience with ultrasonic imaging of the IVC and insertion site after a filter has been placed. A logical progression has evolved to the point in which, today, duplex ultrasound can be used to guide the insertion of IVC filters.

The following describes, in detail, a technique for the percutaneous placement of an IVC filter at the bedside using only duplex ultrasound guidance. The article also briefly compares and contrasts this technique with an alternate technique using intravascular ultrasound. Vena caval interruption can be safely performed under ultrasound guidance in a monitored, intensive care unit environment. In selected intensive care unit or multiply injured trauma patients, this will reduce the risk, complexity and cost of transport for these critically ill patients. Duplex-guided IVC

filter placement also reduces procedural costs compared to an operating room or interventional suite, and eliminates intravenous contrast material exposure.

Proven and Unproven Effects of IVC Filters

- Reduces, but does not eliminate, the risk of symptomatic PE in patients with proximal DVT in the short-term⁷
- Does not prevent small PE
- Not proven to reduce PE in the long-term. Large venous collaterals develop around an occluded IVC. Patients have had PE (and fatal PE) after IVC filters (< 5%).
- Insertion site thrombosis (up to 40% with femoral approach)
- No pressure gradient across the filter (unless > 60% of IVC occluded by clot)
- Little or no thrombogenic potential
- High rate of long-term patency (> 95%)
- No evidence of a decrease in fatal PE
- No all-cause mortality reduction
- Increase in symptomatic DVT in patients with filters

Therefore, limited evidence suggests that IVC filters temporarily prevent PE in patients destined to have PE. However, unlike anticoagulant therapy, IVC filters have no effect on the prevention of DVT, nor do they prevent extension of existing DVT, recurrence of DVT, and postphlebotic syndrome.⁶

Indications for an IVC Filter

The indication to use an IVC filter should be carefully evaluated in each individual case, based on a clear understanding of the objectives of filter insertion and consideration of alternatives. IVC filters are often inserted for unproven and inappropriate reasons.

A. Generally Accepted Indication

The only generally accepted indication for IVC filter insertion is the presence of a recent proximal DVT plus an absolute contraindication to therapeutic anticoagulation.

Contraindications to therapeutic anticoagulation might include:

- Current or recent active major bleeding that cannot be treated acutely
- Frank intracranial bleeding in the past 5 days
- Need for a major surgical procedure in the next 2 weeks
- Severe, prolonged thrombocytopenia

B. Controversial Uses

For the uses below, there is no evidence that an IVC filter is necessary. Therefore, we do not recommend placement of an IVC filter for these indications. With greater experience in IVC filter placement and the introduction of retrievable filters, there is the temptation to expand the indications for filter use without evaluation of the benefit of this expensive, invasive practice.

Controversial Uses	Comments
PE (without current proximal DVT) with absolute contraindication for full-dose anticoagulation	If there is no proximal DVT, such patients do not require therapeutic anticoagulation now – they can be given prophylactic doses of anticoagulants that should prevent recurrent proximal DVT and, therefore, recurrent PE until therapeutic anticoagulation can be initiated

	<p>once the high bleeding risk resolves. If the clinical situation warrants, the possibility of a pelvic vein thrombus should be considered. Large pelvic vein thrombi may be detectable using a high resolution contrast-enhanced CT scan.</p>
<p>DVT/PE in patients with a high risk for bleeding (but not currently bleeding)</p>	<p>Most patients at high risk of bleeding, do not develop major or life-threatening bleeding when they are anticoagulated.</p>
<p>PE within a few days of the start of full anticoagulation for DVT</p>	<p>A small proportion of patients with DVT will develop PE in the first few days of treatment, related to mechanical break-off of some of the thrombus. This does not represent anticoagulation failure. Continued therapeutic anticoagulation is required in these patients and an IVC filter is not necessary.</p>
<p>Progression of DVT despite full anticoagulation</p>	<p>This does represent anticoagulant 'failure' and should be managed by increasing the intensity of the anticoagulation or switching to another anticoagulant. An IVC filter will not control the</p>

	uncontrolled thrombosis, and is, therefore, not necessary.
Recurrent thromboembolic disease despite full anticoagulation	This situation is very uncommon. If recurrent thromboembolism despite full anticoagulation is proven, this does represent anticoagulation failure, and should be managed by increasing the intensity of the anticoagulation or switching to another anticoagulant. An IVC filter will not control the uncontrolled thrombosis, and is therefore, not necessary.
Massive PE with residual DVT (recurrent PE could be fatal)	Recurrent PE is uncommon once anticoagulation is started.
Extensive proximal DVT or DVT with a free-floating proximal end	There is no increase in PE with conventional anticoagulation if DVT is free-floating. ⁸
Large proximal DVT in a patient undergoing thrombolysis	Very few of such patients experience symptomatic PE.
Proximal DVT or PE in a patient with poor cardio-respiratory reserve	There is no agreement on a definition of poor cardio-respiratory reserve.

DVT in the setting of heparin-induced thrombocytopenia	These patients require anticoagulation with a heparin-safe anticoagulant.
DVT or PE in patients with cancer	These patients need to receive an anticoagulant that suppresses the thrombotic process or else they will continue to clot, with or without an IVC filter.
During or after pulmonary embolectomy	There is no evidence supporting this indication.
Before pulmonary thromboendarterectomy in chronic thromboembolic pulmonary hypertension	There is no evidence for this indication.
Primary prophylaxis in selected high risk patients e.g. major trauma, spinal cord injury, arthroplasty, neurosurgery	There is no evidence of the benefit of IVC filters for this indication. We are unable to predict which patients might benefit, and the use of an IVC filter may delay effective prophylaxis. Very costly. Evidence-based thromboprophylaxis is indicated.

Contraindications to IVC Filter Insertion

1. Uncorrectable, severe coagulopathy

2. Extensive IVC thrombosis such that placement of a filter above the thrombus is not possible

3. Bacteremia

IVC Filter Insertion Procedure

Angiographic imaging of the IVC should be obtained prior to filter placement to characterise IVC anatomy and to exclude the presence of IVC thrombus. Filter insertion can be performed via a femoral vein or a jugular vein approach.

Placement of the filter is performed under fluoroscopic guidance. If possible, filters should be placed in the IVC below the level of the renal veins (unless there is infrarenal IVC thrombus or the recipient is a woman of child-bearing potential or is pregnant). For retrievable filters, a cavogram should also be performed prior to removal to rule-out the presence of thrombus trapped in the filter itself.

In experienced hands, the technical success rate for percutaneous IVC filter placement should be 97% or better.

Types of IVC Filters:⁵

A. Permanent Filters

Device	Size of introducer*	Insertion site (jugular/femoral)	Comments
Bird's Nest	14 Fr	Either (separate kits)	Can be used in IVC up to 40 mm; requires 5-8 cm of IVC to insert; not MRI compatible
Greenfield (stainless steel)	14 Fr	Either (separate kits)	Less insertion control (all-or-none release); not MRI compatible

Simon Nitinol	9 Fr	Either (separate kits)	Thermal-mechanical memory; max IVC diameter 28 mm; MRI compatible
TrapEase	8 Fr	Either (1 kit for both)	Little data; maximum IVC up to 30 mm; MRI compatible
VenaTech	14.6 Fr	Either (one kit)	MRI-compatible

* Outer diameter

B. Optional Filters (temporary retrievable or permanent)

Device	Size of introducer*	Insertion site(jugular/femoral)	Comments
Gunther Tulip	12 Fr	Either (separate kits)	Maximum IVC up to 30 mm; MRI compatible
OptEase	8 Fr	Either	Little data; maximum IVC up to 30 mm; MRI compatible
Recovery Filter	9 Fr	Femoral	Retrievable up to several weeks or months after implantation using a 12 Fr

			retrieval catheter; MRI compatible
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* Outer diameter

Complications Associated with IVC Filter Use^{4,9}

In experienced hands, the process of IVC filter insertion is associated with a low rate of complications. Furthermore, with proper selection of filter indications and appropriate management of patients who have IVC filters, the risk of long-term complications is also low.

A. Short-Term Complications

- Contrast reaction
- Arrhythmia
- Air embolism (especially with jugular insertion)
- Pneumothorax/hemothorax
- Extravascular penetration of guidewire
- Premature opening - iliac vein
- SVC, heart, proximal IVC
 - Incomplete opening
 - Tilting/angulation
 - Misplacement – iliac vein, renal vein, etc
- proximal to renal veins when this was not planned
- often requires placement of a second filter
 - Guide wire entrapment
 - Filter migration (3-69%)
 - Embolization of the filter (2-5%) – to heart, pulmonary artery
- Filter fracture
- Insertion site bleeding/hematoma – this will interfere with subsequent anticoagulation
- Infection at insertion site

- Contrast-induced renal dysfunction
- A-V fistula
- *Failure or delay in anticoagulation, which may lead to progressive DVT, phlegmasia cerulea dolens, or venous gangrene
- *Insertion site thrombosis (2-35%) appears to be greater with femoral route
- Recurrent PE (0.5%-6%)
- Fatal PE – rare (<1%)
- Death – very rare (3/2,557)

B. Long-Term Complications

- *Increased risk of subsequent DVT^{7,10}
- *Physician assumption of long-term protection → failure to prophylax
- Migration: proximal or distal
- Penetration of the vein wall/perforation – retroperitoneal, aorta, ureter, bowel
- common, generally no adverse consequences
- Filter fracture
- IVC occlusion (2-28%) with resultant chronic leg edema, hyperpigmentation and ulceration
- Venacaval syndrome
- Risks associated with subsequent Rt heart/PA catheterization from femoral vein including temporary pacemakers
- Lumbar pain from nerve impingement
- Pyophlebitis (very rare)

Anticoagulation in Patients with IVC Filters

As a general rule, the use of an IVC filter does not change the need for or duration of anticoagulation. Since most (or all) patients who have IVC filters inserted have a proximal DVT,

therapeutic anticoagulation should be instituted as soon as it is considered safe to do so (usually within a few days after insertion). While IVC filters may reduce the risk of PE in patients with DVT, they do not prevent extension of DVT, including extension through the filter. The duration of anticoagulation is the duration of anticoagulation for patients with DVT without a filter.

Permanent versus Retrievable Filters¹¹

Although the contraindication to anticoagulation (and therefore the indication for an IVC filter) is generally temporary, there are few long-term complications associated with the presence of a filter and there are some disadvantages of retrievable filters, including the need for two central venous procedures, less experience with their use, and perhaps these filters are less effective or associated with more complications than permanent filters.

Selection of a Filter

The choice of which filter is inserted is largely dictated by local experience and availability. For patients with large diameter IVCs, the bird's nest filter is recommended. The most commonly used retrievable filters are the Gunther tulip and the Recovery nitinol filters.