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 2016 Jun;33(2):6570. doi: 10.1055/s-0036-1581088Vena caval interruption, currently accomplished by percutaneous image-guided insertion of an inferior vena cava (IVC) filter, is an important therapeutic option in the management of selected patients with venous thromboembolism. The availability of optional (or retrievable) filters, in particular, has altered the practice patterns for IVC filters, with a shift to these devices and expansion of indications for filter placement. As new devices have become available and clinicians have become more familiar and comfortable with IVC filters, the indications for filter placement have continued to evolve and expand. This article reviews current guidelines and expanding indications for IVC filter placement.Keywords: inferior vena cava filters, indications, guidelines, interventional radiologyObjectives: Upon completion of this article, the reader will be able to describe current guidelines and expanding indications for inferior vena cava filter placement.Accreditation: This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of Tufts University School of Medicine (TUSM) and Thieme Medical Publishers, New York. TUSM is accredited by the ACCME to provide continuing medical education for physicians.Credit: Tufts University School of Medicine designates this journal-based CME activity for a maximum of 1 AMA PRA Category 1 Credit. Physicians should claim only the credit commensurate with the extent of their participation in the activity.Venous thromboembolism (VTE)deep vein thrombosis (DVT) and pulmonary embolism (PE)affects 1 to 2 individuals per 1,000 annually, and it is a leading cause of preventable hospital death in the United States.123 Although DVT is diagnosed approximately twice as often as PE, the 1-month mortality rate of PE is twice that of DVT.4Anticoagulation is the preferred treatment for VTE.56 Vena caval interruption, currently accomplished by percutaneous image-guided insertion of an inferior vena cava (IVC) filter, is another important therapeutic option in the management of selected patients with VTE. Specifically, when anticoagulation is contraindicated, results in complications, or fails to protect patients adequately from thromboembolism, patients can be treated with insertion of an IVC filter.7There are two general types of IVC filters currently available in the United States: permanent and optional (or retrievable). Permanent filters have been used since the 1970s and are placed in patients with a long-term need for mechanical prophylaxis against PE and absolute contraindications to anticoagulation.8 Optional filters (i.e., filters that have the option of being retrieved) have been available since the late 1990s and are designed to be retrieved or left in place after the temporary risk of PE or contraindication to anticoagulation has resolved.9 If retrieved, these devices offer the theoretical benefit of fewer long-term complications associated with permanent IVC filters, such as increased risk of subsequent DVT, filter migration/embolization, and IVC stenosis or occlusion.1011The availability of optional filters, in particular, has altered the practice patterns for IVC filters, with an increase in filter placement rates and shift to these devices and expansion of indications for filter placement.9 For example, optional filters are now placed for prophylactic indications in patients who are at increased risk for the development of VTE and unable to tolerate prophylactic anticoagulation, such as in the setting of trauma.1213 As a result, the number of filter placements in the United States has increased steadily each year, with prophylactic indications now accounting for more than half of all filter placements.14As new devices have become available and clinicians have become more familiar and comfortable with IVC filters, the indications for filter placement have continued to evolve and expand.14 This article reviews current guidelines and expanding indications for IVC filter placement.According to the Society of Interventional Radiology (SIR), IVC filters are typically placed in three clinical scenarios: (1) in patients with VTE and classic indications; (2) in patients with VTE and extended indications; and (3) in patients without VTE for primary prophylaxis against PE15 (Table 1).Patients with documented VTE and classic indicationsPatients with documented VTE and expanded indicationsPatients without VTEContraindication to anticoagulationIliocaval or large free-floating proximal DVTTrauma patient with high risk of VTEComplication of anticoagulation necessitating cessationInability to achieve/maintain adequate anticoagulationSurgical procedure in a patient at high risk for VTEFailure of anticoagulationMassive PE with residual DVT in a patient at risk for further PEMedical condition with high risk of VTEPropagation/progression of DVT during therapeutic anticoagulationChronic venous thromboembolism treated with thromboendarterectomyThrombolysis of iliocaval DVTVTE with limited cardiopulmonary reserveRecurrent PE with IVC filter in place (filter failure)Poor compliance with anticoagulationHigh risk of complication of anticoagulation (e.g., high fall risk)The classic indications for IVC filter placement include documented VTE and:Absolute contraindication to anticoagulationComplication of anticoagulation resulting in cessation of therapyFailure of anticoagulation15Contraindications to anticoagulation include conditions with a high risk of uncontrolled bleeding, such as major bleeding diathesis (e.g., coagulation defects, severe thrombocytopenia [platelet count 28 to 32 mm indiameter is called a megacava. In addition, the IVC isvery elastic, and its diameter can vary depending onthe volume status of the patient and whether thepatient is performing a Valsalva maneuver at the timeof the venogram. However, most IVCs are elliptical inshape. Therefore, the anterior-posterior diameter of theIVC tends to be less than the medial-lateral diameter,which provides some component of safety while determiningthe IVC diameter based on a venogram. Whena megacava is encountered, there are a few availabletreatment options. The Gianturco-Roehm Bird's Nestfilter (Cook Medical, Bloomington, IN), which is a permanentfilter, can be placed in an IVC up to 40 mm indiameter. The Bird's Nest filter consists of four stainlesssteel wires (25 cm X 0.18 mm) attached to two V-shapedstruts and is best suited for an IVC that is at least 7 cm in length below the renal veins. Alternatively, bilateralcommon iliac venous filters may be placed, especiallywhen the use of an optional filter is desired.LOCATION OF FILTER PLACEMENTMost filters are placed in an infrarenal location,because 90% of clinically significant PE originates fromthe lower extremity or pelvic veins. Therefore, the optimalposition of an IVC filter is immediately below (fornonconical filters) or just at the level of the lowest renalvein (for conical filters) for the reasons previouslydescribed. The inflow of blood from the renal veins willtend to minimize clot formation craniad to an appropriatelyplaced infrarenal IVC filter. However, placementof filters in the suprarenal IVC, bilateral iliac veins, superiorvena cava (SVC), or in both components of a duplicatedIVC (Figure 4) has been performed based on thepatient's anatomy and the likely source of PE.Suprarenal placement of an IVC filter is performed ifthere is a duplicated IVC, if there is a large volume ofthrombus within the infrarenal IVC or extrinsic compressionof the IVC preventing the safe positioning ofan infrarenal filter, or if there is extensive renal orgonadal venous thrombosis. There are some physicianst hat will place a filter in a suprarenal location in womenwho are likely to become pregnant. Filters placed in asuprarenal location are potentially subjected to chronictrauma from the overlying liver and may be more proneto fracture or penetrating the IVC over time. In addition,conical-shaped filters can severely tilt if their legs prolapsed into a hepatic vein. We experienced onepatient who developed significant pain with deep inspirationafter placement of a suprarenal filter and, uponinspection, we suspected that one of its legs was protrudinginto a hepatic vein and irritating the liver capsulesduring respiration. Upon removal of the filter, thepain immediately resolved.Bilateral iliac vein filters are typically used in patientswith a megacava (> 2832 mm) or a duplicated IVC, orin patients with a retroaortic left renal vein componentthat drains into the IVC close to the iliac venous confluence.Upper extremity and large volume internal jugularvenous thromboses are being encountered with increasingfrequency as the use of central lines increases. Dueto the relatively smaller size of upper extremity veins,the risk for clinically significant PE is lower as comparedto the risk associated with lower extremity and pelvicvenous and IVC thrombosis. However, it may be a verychallenging clinical situation when a patient with significantacute subclavian, axillary, and brachial venousthrombus presents with PE (and no other obviousource for the PE) and cannot be anticoagulated. Inthese types of cases, the benefits of placing an SVC filtermust be weighed against the potential risks. The SVC ismuch shorter in length than the IVC, and the legs of aconical filter could prolapse into the azygous vein, causingthe filter to tilt significantly. In addition, many ofthese patients undergo multiple central venous lineplacements, and the various wires and catheters couldbecome engaged with the SVC filter and displace the filter.Constant cardiac motion and mediastinal pulsationcould also cause the hooks or legs of the filter to penetratethe SVC, leading to a hemopericardium and tamponade.4 Therefore, placement of an SVC filter shouldbe only undertaken after careful consideration of eachindividual case, factoring in the anatomical challengesand the lack of good outcomes data with SVC filters.5 Ifa decision is made to place an SVC filter, the ideal locationis one in which the filter legs are craniad to the azygousvein (which is usually outside of the pericardialreflection) and just caudal to the confluence of the brachiocephalicveins.Choosing the Venous Access Site for Filter PlacementThe right internal jugular or right common femoralveins are the most common access sites for filterdeployment.6 With the availability of more flexible andlower-profile filter devices, the left internal jugular, bothexternal jugular, left femoral, and upper extremity veins,as well as a transcaval approach, have all been used asaccess sites for IVC filter placement for a variety of reasons(eg, extensive trauma, diffuse thrombosis, etc.).The transcaval approach is the least often usedapproach due to its complexity, but the left commonfemoral vein approach is the least desired of the otheraccess site options for placement of a non-self-centeringconical-shaped filter. The acute angle of the left iliacvein with the IVC directs the filter delivery sheathagainst the right lateral aspect of the IVC wall, causingthe filter to be deployed in a tilted, and therefore lessfunctional, orientation (Figure 3).Anatomic ConsiderationsThe reported prevalence of a duplicated IVC is about0.2% to 0.3%.7 With a duplicated IVC, the left IVC mostoften drains into the left renal vein (Figure 4). There areseveral reports of clinicallysignificant PE after placementof an IVC filter inpatients with an undiagnosedduplication of theIVC.8 While obtaining anIVC gram with a catheterplaced in the distal rightsidedIVC, it is important tohave contrast reflux wellinto the left common iliacvein; otherwise, a duplicatedIVC may be missed. Onoccasion, a separate accessinto the left commonfemoral vein is needed,because the iliac veins maynot join together but ratherempty into their respectiveIVC moieties. Venographicevidence that might alertone to the possibility of aduplicated IVC is a diminutiveright-sided IVC or a large amount of unopacified blood flowing from theleft-sided IVC into the left renal vein and subsequentlyinto the right-sided IVC. When these findings areobserved and there are no previous cross-sectional studiesthat have excluded the presence of a duplicated IVC,a left common iliac venogram should also be obtained.When the presence of a duplicated IVC is diagnosed, thefilter can be placed in a suprarenal location or withineach IVC component.7 Our preference is to place a singlefilter within the suprarenal IVC. Suprarenal IVC filters arereported to be safe and effective in the prevention of PE,despite some concern about the increased risk for filterfractures.9FILTER AND IVC THROMBOSESThe reported frequency of IVC thromboses varieswidely (0%28%), depending on the consistency, duration,and method of follow-up evaluation.10Approximately 50% of IVC thromboses may be presentwithout patients reporting symptoms. Therefore,detailed imaging of the IVC should be performed beforeany filter retrieval attempt. Having stated this, our experiencewith retrieval of Gnther Tulip or Celect filters(Cook Medical) at a mean of 43 days (1343 days)showed a very low incidence of clot burden in these filtersduring venography at the time of their retrieval.6However, our experience may be biased toward patientsthat are less likely to have thrombophilia and therefore less likely to have clot in the filter at the time of itsretrieval. Chronic IVC occlusion/thrombosis in the presenceof a filter in situ is not uncommon and is probablydue to the specific patient populations receiving IVC filtersas well as the chronicity of the device. Systemic anticoagulationis the first-line treatment in symptomaticpatients with IVC thrombosis and a filter. In symptomaticpatients, when anticoagulation fails, if the patienthas bulky acute/subacute thrombus, thrombolyticagents may be used. If there is a chronically occluded,partially recanalized, string-like IVC present, balloonangioplasty and stent placement could be considered torestore patency through the filter (Figure 5).FILTER MISPLACEMENTIVC filter misplacements outside of the confines of theIVC have been reported, including placement of a filterwithin the aorta11 and within the spinal canal.12 Mildlyor severely maldeployed filters (mild-to-severe tilting ofthe filter or placement of the filter too caudal below therenal veins or significantly covering the renal veins) arenot uncommon. If a misplaced IVC filter is a permanentIVC filter, retrieval of the filter is much more challengingor sometimes impossible, whereas if an optional filter isused and maldeployed, it may be retrieved and repositionedrelatively easily (Figure 3).FILTER TILTWhat degree of tilting of a conical-shaped IVC filtershould be considered significant is debatable. However,once tilting of a conical-shaped filter occurs, there are invitro data that show that the filtration efficiency of thefilter may be reduced. In a few published series, there is asuggestion that conical-shaped filters with > 15 of tiltingfrom the longitudinal axis of the IVC may reduce itsfiltration capability. Tilting of conical IVC filters has beenassociated with recurrent pulmonary emboli.13,14Therefore, if tilting occurs during deployment, filterrepositioning may be considered. Using optional filtershas significant advantage over permanent filters. Filterretrieval and repositioning is possible even when the filteris severely (> 45) tilted.15FILTER FRACTURE/MIGRATIONFilter fractures are not a common complication andhave been reported in < 1% of cases; however, pregnantpatients may be at greater risk for IVC filter fracturesdue to extrinsic compression from a gravid uterus.16 When placing a filter in women of childbearing age, possiblelong-term outcomes should be discussed with thepatient and the referring physician, and the indicationsfor filter placement should be carefully assessed.Filter migration as a whole is also a rare complication.17,18 It is important to keep in mind that fractureand migration of an IVC filter or recurrent PE should besuspected in a patient presenting with sudden, unexplainedcardiopulmonary compromise and a known IVCfilter in place. Although it is a rare complication, IVC filterscan migrate to the heart and potentially lead todeath. In most of these cases, the filter placed was notsized appropriately for the diameter of the IVC, thehooks of the filter did not adequately engage the cavalwall, and/or a large thrombus caused the filter tobecome dislodged. Early detection of a migrated IVC filtermay save a life. Once detected, a migrated filter maybe retrieved endovascularly or surgically, depending onits location and its relationship with the cardiac structures(valves, chordae tendineae, papillary muscles, etc.).Filters can also become dislodged when intravascularprocedures are performed and devices or guidewiresbecome entangled with the filter. Most filters becomefairly well endothelialized within 6 weeks, so a fairamount of force is needed to displace an appropriatelysized and placed filter if it has been in place for a fewmonths.Filter Hooks and Strut/Leg Caval PenetrationAsymptomatic penetration of a filter hook and/orstrut/leg through the IVC wall is not uncommon.6Probably the most important factor to assess is howdeep the hook or strut/leg has penetrated. Is the penetratinghook and strut/leg at risk for injuring or penetratingan adjacent organ such as the aorta, duodenum(or any bowel), vertebral body, or ureter? Fortunately,most patients with this problem are asymptomatic.However, some patients may develop pseudoaneurysms,infections, bowel injuries, or pain. If the filter is retrievableand the patient is symptomatic, retrieval of the filtershould be performed. It may be necessary to placeanother filter if the patient remains at risk for PE. If thepatient is asymptomatic, retrieval can be consideredepending on the estimated risk of doing nothing. Insome instances, surgical removal of the filter may benecessary.Fractures of the filter legs/struts have been moreproblematic with older versions of nitinol-based filters.Despite the many benefits of nitinol technology and itsthermal memory characteristics, nitinol material tendsto be more prone to fracturing.19 Even more recentdesigns have led to numerous case reports of fractured struts/legs, with the free fragments migrating intohepatic veins and pulmonary artery branches; however,there is an effort to change the structure of newer nitinolfilters. Because the fragments are small and often difficultto see, they become difficult to retrieve. Whetheror not these fragments may lead to future problems isnot clear; however, microscopic evaluation of theretrieved filter and limbs revealed bending metal fatigueat the fracture sites. Percutaneous retrieval of filters witharm fracture or arm migration is recommended.20FILTER RETRIEVALIVC filter retrieval success depends on filter dwelltime, the amount of filter hook and strut/leg penetration/endothelialization, the amount of metal materialin contact with the IVC wall, and accessibility of theretrieval hook on the filter to the retrieval device. Avariety of techniques and devices have been used tomaximize the filter retrieval success rate.6 In our institution,the retrieval success rate for the Gnther Tulip filteris approximately 95% without significant complications,even with filters in place for > 6 months. Afterfilter retrieval, a repeat IVC gram is performed to evaluatethe integrity of the IVC. In our reported experience,there were no IVC stenoses > 40% and no extravasation.6In our unpublished experience of more than 350optional filter retrievals (seven different optional filtertypes), < 1% of retrieval patients have undergone balloondilation for IVC stenoses > 70%. Several patientswho had stenoses between 40% and 70% were managedconservatively and underwent repeat venographyor cross-sectional imaging at follow-up. These patientswere asymptomatic and shown to have improvementin their IVC stenoses. Although we have not experiencedperforation or laceration of the IVC during filterretrieval, theoretically minor IVC perforations couldpotentially be managed with observation and gentleballoon tamponade because the IVC is a relatively lowpressuresystem. Frank extravasation of contrast suggestseither a longitudinal or circumferential laceration,which would potentially require open repair or treatmentwith a covered endograft.FILTER SAFETYOverall, IVC filters do what they were designed todomechanical prevention of PE by trapping thrombus.Data demonstrate that in-hospital recurrent PE isless and survival greater with the use of anticoagulationand filters than with anticoagulation alone.21 The judicioususe of filters appears safe in appropriately selectedpatients, and long-term data suggest that filters do provide outcome benefits with regard to prevention ofPE at a cost of a slightly increased risk for developinglower extremity swelling and recurrent deep veinthrombosis.10,22,23CONCLUSIONWith the development of optional IVC filters, theiruse has dramatically increased during the past decadedespite the absence of level I data supporting its use.For this reason, the most important aspect of using anIVC filter is to ensure that there is an appropriate andgood indication for its use. The operator should bevery familiar with the device and the anatomy in whichthe filter is to be placed, knowledgeable and aware ofnormal variants, and use thoughtful and meticulousprocedural planning and techniques to optimize theefficacy of the IVC filter, while minimizing the chancefor a misadventure during device deployment.Acknowledgements: The authors thank Leanne DoreLessley, RT (R) VI, for her artistic contribution of Figures 2and 4, and Lauren J. Germain for her help in preparing thisarticle.Ulku Cenk Turba, MD, is Assistant Professor of Interventional Radiology in the Department of Radiologyat the University of Virginia in Charlottesville, Virginia. Hehas disclosed that he holds no financial interest in anyproduct or manufacturer mentioned herein. Dr. Turba maybe reached at turba@virginia.edu.Saher S. Sabri, MD, is Assistant Professor ofInterventional Radiology in the Department of Radiologyat the University of Virginia in Charlottesville, Virginia. 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Ivc location. Ivc placement. Ivc body. Ivc important sites. Ivc placement procedure. Ivc manual. Ivc guidelines. Ivc catheter placement.