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Invited Commentary

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Since its introduction in 1972, the Greenfield filter has been inserted in more than 70,000 patients in this country alone and has established a record of safety and effectiveness for periods of follow-up in excess of 12 years [1]. Therefore, the unusual complication of recurrent embolism reported by Richenbacher and associates deserves careful consideration. This report actually describes 2 cases with complications, the first of which is described as filter "thrombosis." We know on the basis of both experimental and clinical observations over prolonged periods that the filter is not thrombogenic and remains patent with or without anticoagulant administration. Therefore, the sudden development of "marked bilateral lower extremity swelling" is the expected result of an embolus to the filter sufficiently large to produce total caval obstruction. This has occurred 3 times in our experience, always within 2 weeks of insertion, and resulted in relative hypovolemia requiring fluid resuscitation to replace the vascular volume sequestered in the lower extremities. Although a significant complication, it compares favorably with the consequences of a similar volume of embolus into the pulmonary vascular bed. The use of lytic therapy should be considered under these circumstances to restore vena caval patency.

The second case report describes a patient with preoperative pulmonary embolism of an unknown configuration affecting perfusion of the right upper lobe. The patient developed postoperative deep vein thrombosis which required increasing levels of heparin for control and then the patient died suddenly on the fourth postoperative day with evidence at autopsy of thrombi in both pulmonary arteries and within the caval filter with cephalad propagation. This complication is, fortunately, rare, and although recurrent embolism was seen in 4% of our 469 patients over a 12-year period of follow-up, none was fatal. The circumstances which favor this thrombotic progression seem to be related to poor control of a hypercoagulable state. In general, a dose of 5,000 u heparin IV in a patient with active thrombosis as used by the authors is inadequate because of the elevated levels of circulating thrombin. A dose of 150 u/Kg would be preferable and more effective in achieving therapeutic control. Unfortunately, this is no guarantee that an embolism will be prevented since we have demonstrated that the presence of a proximal floating tail on iliofemoral venous thrombi is associated with a 10 times greater likelihood of embolism than when the thrombus is attached circumferentially [2]. The volume of embolus that was trapped in the filter in this case was also sizeable, as demonstrated in Fig. 1, and appeared to occlude the cava. Even if there were still some flow in the cava, the degree of stagnation would be another factor favoring thrombus propagation.

In their review of other reported cases of recurrent embolism, the authors perpetuate the error of ascribing misplacement of the filter into an iliac vein as caudal migration (patient no. 6). As indicated in a previous editorial [3], in order for the filter to migrate into the smaller iliac vein, it would have to detach itself from the caval wall and refold itself into the smaller diameter of the iliac vein, a talent it does not possess. Misplacement into an iliac vein obviously fails to protect the patient from emboli originating from the opposite side. In another unusual case of recurrent embolism (patient no. 3), the authors in that report demonstrated apparent lack of contact of the filter with the anterior wall of the vena cava and postulated that the entrapped embolus had caused retraction of the limbs and disengagement

of the hooks from the vena cava. An alternative explanation that has been observed on more than one occasion is that a thrombus formed within the carrier at the time of insertion, tethering the limbs of the filter and resulting in nonuniform fixation at the time of insertion. This complication is preventable by irrigation of the carrier system with dilute heparin during insertion. Although we have little information regarding all the effects of thrombus capture on the filter once it is inserted, the only limb contracture after insertion has been when the filter is totally obstructed by a massive embolus and the cava contracts by fibrotic organization.

The algorithm proposed for the follow-up of patients with Greenfield filters (Fig. 2) is based on symptoms and perfusion lung scans which are known to be of very poor specificity for thromboembolism [4]. It also relies on signs and symptoms for detecting recurrent venous thrombosis or a change in filter diameter on the radiograph which will only occur if the cava is thrombosed as described above. Our preference is to use noninvasive duplex examinations on an annual basis which provide β-mode imaging of the vena cava and filter as well as Doppler flow studies of the appropriate veins including the site of insertion. We also use abdominal radiographs to monitor the position of the filter and will perform a vena cavagram for any suggestion of thrombus proximal to the filter or any signs of recurrent embolism. The magnetic resonance imaging study has also been utilized to demonstrate intracaval thrombus. The use of thrombolytic therapy for thrombi attached to the filter may be appropriate unless there is a long tail of thrombus that is susceptible to detachment; in which case, a second filter should be placed above the level of the renal veins as suggested by the authors. For the patient with an uncontrolled upper extremity source of thromboembolism, it may be necessary to insert a filter into the superior vena cava as we have reported [5]. It seems clear that many of these patients will continue to manifest an aggressive thrombotic disorder, often in spite of anticoagulation, and therefore they all deserve very careful long-term follow-up care.

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