IVC filter and foreign body retrieve

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Treatment of Venous Thromboembolism

The preferred method of both treatment and prophylaxis for venous thromboembolism (VTE) is anticoagulation. Even with appropriate anticoagulation therapy, VTE recurrence is noted in ~7% of patients during the first 6months, with most recurrences occurring within 3 months. Most patients with acute pulmonary embolism (PE) who receive adequate anticoagulation therapy survive with a 3-month overall mortality rate of ~15 to 18%. However, anticoagulation therapy is associated with a small but real risk of major hemorrhage (<5%). Treatment for these patients is often with an inferior vena cava (IVC) filter for prevention of clinically significant PE.

Inferior Vena Cava Filters

IVC filters were first introduced in the 1970s for prevention of PE. The Prevention du Risqué d'Embolie Pulmonaire par Interruption Cave (PREPIC) trial is the only randomized controlled trial to evaluate the effectiveness of permanent filter. In this trial, 400 patients with proximal DVT, at high risk for PE, were randomized to anticoagulation with a permanent IVC filter versus anticoagulation alone. Twelve days after randomization, the filter group had a statistically significant reduction of 78% in the risk of PE ($p = 0.03$). After two years, however, this PE risk reduction was no longer statistically significant, and there were significantly more recurrent DVTs in the filter group (20.8%) versus the no-filter group (11.6%; $p = 0.02$). In follow-up reporting at 8 years, there were significantly fewer symptomatic PEs in the filter group (6.2%) versus the no-filter group (15.1%; $p = 0.008$), with significantly more symptomatic DVT in the filter group (35.7%) compared with the no filter group (25.5%; $p = 0.042$). No survival difference was present between the two patient groups at 12 days, 2 years, or 8 years; and interestingly, no difference in the prevalence of postthrombotic syndrome was reported. Because all patients in this trial received anticoagulation therapy, it provides little guidance in IVC filter placement in patients who cannot receive anticoagulation. The recently published PREPIC 2 randomized trial found that placement of an IVC filter for 3 months did not reduce recurrent PE, including fatal PE, in anticoagulated patients with PE and DVT who had additional risk factors for recurrent VTE (Table 16, e-Table 16).

Although the PREPIC 2 study has improved the quality of evidence, overall quality is still moderate because of imprecision. Because it is uncertain if there is benefit on placement of an IVC filter in anticoagulated patients with severe PE (eg, with hypotension), and this is done by some experts, the AT10 (10th Edition of the

Antithrombotic Guideline by American College of Chest Physicians) recommendation against insertion of an IVC filter in patients with acute PE who are anticoagulated may not apply to this selected subgroup of patients. The AT10 panel decided against combining the results of the PREPIC and PREPIC 2 studies because of differences in the type of filters used, the duration of filter placement, and differences in the length of follow-up.

Type of Inferior Vena Cava Filters

The two basic IVC filter types are permanent and nonpermanent. Permanent filters have been available for approximately past 35 years. Nonpermanent filters were developed to reduce the long-term complications of permanent filters, notably increased risk of DVT. There are two primary subgroups of nonpermanent filters: temporary filters, which must be retrieved, and retrievable (or optional) filters, which can be retrieved. Temporary filters are tethered to the skin by a wire/catheter for short-interval retrieval. Retrievable filters seek to offer the benefits of permanent filters for a limited duration of time; they also maintain the "option" to be left in situ as a permanent device because many designs were initially approved for permanent placement. There is a subtype of retrievable filters, namely convertible filters, which can be structurally altered after implantation to no longer function as filters. Therefore, the filter is not removed, but the filtering capacity is eliminated by a percutaneous catheter–based procedure.

Indications

The American College of Chest Physicians (ACCP) and American College of Radiology (ACR)/Society of Interventional Radiology (SIR) have each published evidence-based guidelines for the placement of IVC filters. The ACCP recommends placement of an IVC filter in patients with acute proximal DVT or PE if anticoagulant therapy is impossible because of the risk of bleeding and does not recommend IVC filters as primary prophylaxis for any patient group. It is estimated that approximately half of all filters placed are consistent with these guidelines. ACR/SIR (2010) practice guidelines divide indications for filter placement into therapeutic and prophylactic. Therapeutic guidelines mirror ACCP recommendations with several additions, including the failure of or inability to achieve/maintain adequate anticoagulation, free-floating central venous thrombus, massive PE with residual DVT, and severe cardiopulmonary disease with VTE. Prophylactic indications occur in patients without VTE but who are at increased risk of PE and cannot receive effective primary prophylaxis (i.e., anticoagulation, compression stockings). Prophylactic indications are often seen in the setting of severe trauma or prior to major surgery. SIR also recognizes indications for placement of retrievable filters; specifically, VTE with transient inability to anticoagulate, PE prophylaxis in high-risk patients, and caval filtration in children.

Relative Contraindications

Contraindication to IVC filter placement is rare: Uncorrectable severe coagulopathy and bacteremia are two specific relative contraindications.

Filter Usage

IVC filter usage has increased each year since their introduction. The use of retrievable filters in the prophylactic setting is largely responsible for the overall increase in number of filters placed. Today, prophylactic indications account for >50% of all filter placements and 86.7% of filters placed in 2006 were retrievable versus 10.7% placed in 2002. This shift may be attributed to a relaxation of thresholds for placement of retrievable filters.

Placement Technique

IVC filter placement can be performed in both an inpatient and an outpatient setting, while most filters placed in an inpatient setting due to active management of VTE. The ACR-SIR practice guideline includes a detailed description of IVC filter placement. Vascular access for placement of the filter is commonly performed via the right femoral or right internal jugular vein. The IVC should be assessed, preferably with vena cavography, prior to filter placement; this allows evaluation of the diameter of infrarenal IVC, location and number of renal veins, IVC anomalies (e.g., duplication), and intrinsic IVC disease including caval thrombus or extrinsic compression. About 2% of the population have a duplicated IVC, and 0.5% have a left-sided IVC. If a patient has compromised renal function or an iodinated contrast allergy, preplacement venography can be accomplished without iodinated contrast by using carbon dioxide gas with a high imaging frame rate. Prior cross- sectional imaging studies should be evaluated to assess caval anatomy and pathology. The ideal location for a filter is the infrarenal IVC; the apex of the filter should be at or immediately caudal to the level of the lowest renal vein. This decreases the potential 'dead space' between the filter and the renal veins, in case of IVC thrombosis. In specific patients, other target locations may be appropriate including the suprarenal IVC, iliac veins, and superior vena cava. According to ACR-SIR practice guidelines, technical success for percutaneous IVC filter placement should be at least 97%.

Filter Follow-Up

Due to the increasing use of retrievable IVC filters, dedicated methods for filter follow-up and potential retrieval are important. Because of a growing number of reported adverse events related to retrievable filters remaining in the body for long periods, FDA alerted in August 2010 that implanting physicians and clinicians responsible for the ongoing care of patients need to consider IVC filter removal as soon

as protection from PE is no longer required. A SIR multidisciplinary consensus conference recommends the following criteria be met before discontinuing IVC filtration:

1. An indication for a permanent filter is not currently present.
2. The risk of clinically significant PE is estimated to be acceptably low due to sustained primary treatment (therapy or prophylaxis), or change has occurred in clinical status.
3. The patient will not return to high risk of PE in the near future because of interruption of primary treatment or an anticipated change in clinical management or condition (e. g., discontinuing anticoagulation therapy for planned surgery).
4. Life expectancy of the patient is long enough that presumed benefits of filter removal can be realized. Patients not anticipated to survive >6 months are unlikely to benefit from filter retrieval.
5. The filter can be safely removed including suitable venous access.
6. The patient agrees to have the filter removed.

Technique for Inferior Vena Cava Filter Removal

Filters with thrombus occupying <25% of the conical volume in patients with known VTE are usually removed. Trapped thrombus >25% of the cone volume typically necessitates starting/continuing anticoagulation for several weeks before retrieval. Finally, caval thrombus detected above an indwelling filter often necessitates placement of an additional filter above the clot.

Routine filter retrieval involves engaging the device, usually with a snare around the retrieval hook, and collapsing the filter into a sheath. Coaxial sheaths can be used to increase inline filter collapsing forces and to prevent injury at the access site by protruding filter struts. If the filter is incompletely removed, imaging evaluation is undertaken to locate the missing pieces. There are no universally accepted guidelines for management of retained filter elements, and retroperitoneal and intrapulmonary fragments are rarely symptomatic. Fragments in the heart should be evaluated in consultation with a cardiac specialist.

There are a variety of retrieval techniques for difficult IVC filters. These filters are often tilted with longer dwelled times, which makes standard engagement of the device challenging. Several techniques of varying complexity to remove difficult filters are detailed by Van Ha et al. Postretrieval caval imaging is recommended after difficult or prolonged procedures or if the patient reports pain during retrieval. Findings compatible with caval injury include contrast extravasation and intimal irregularity.

Improving Filter Retrieval

Minochoa et al published results of a dedicated IVC filter clinic on optional filter retrieval rates. A nurse coordinator and interventional radiologist conducted a medical record review beginning 2 to 3 weeks after filter placement. In collaboration with the

referring physician, a decision was made to remove the device, continue to monitor it, or declare it permanent. After establishment of a filter clinic, the retrieval rate increased from 29% to 60% ($p < 0.001$) with 1.5 months of the mean time to retrieval.

Filter Complications

Complications associated with IVC filters include both periprocedural and longer term complications. Periprocedural complications are rare and largely avoided by using imaging guidance for each step of filter placement. Through a systematic review of the literature and the Manufacturer and User Facility Device Experience (MAUDE) database, Angel et al summarized the most common complications associated with the use of retrievable IVC filters.4 The rate of DVT was 5.4% over a mean follow-up of 9.9 months; however, reporting of this complication was variable. Significant filter migration, defined as migration >2 cm from placement location or filter embolization (e.g., heart, lungs), occurred in 1.3% of filters, with the highest incidence (4.5%) in the G2 filter. Most of these migration incidents occurred >30 days after placement. Filter fracture rates were not consistently reported in the literature; however, in the MAUDE database most reported events occurred with the G2 filter. In a review by Strieff, the filter fracture rate was 2.7%, and the incidence of vena cava thrombosis or stenosis was 2.8%. Filter perforation, defined as visualization of filter elements >3 mm beyond the lumen of the IVC or within an adjacent structure, has not been systematically reported in the literature. However, 20% of the complications reported in the MAUDE database were perforations; in addition, Stawicki et al reported the rate of clinically significant penetration to be 0.4%.

Retrieval of iatrogenic intravascular foreign bodies

Intravascular foreign bodies consist of CV catheter fragments, IVC filters, stents, guidewires, coils, plugs, pacemaker leads, IVUS probes, vertebroplasty cement, etc. Routine axial CT is not enough to detect and diagnose foreign bodies due to the small fragmentation and discontinuation. Plain X-ray pictures or 3D-CT are desirable. Symptoms due to an embolized foreign bodies are variable from only 5.6% to 32% of patients. Foreign bodies adjacent to the heart document many patients with severe symptoms. Thus, the decision to retrieve a foreign body must be made on a case-by-case basis, considering the patient's overall life expectancy, the hazards involved with retrieval, the current symptoms, and the likelihood of serious complications or further migration. The current mainstay for endovascular retrieval is the snare, but endovascular graspers (forceps), balloons, and stone baskets are alternatives. Endovascular repositioning of an object facilitates a less morbid open retrieval. Immediate surgical retrieval should be attempted for plugs for ASD/PDA.

Conclusions

To elucidate the appropriate role of IVC filters in the treatment of VTE, further research is required to indicate that filter tracking methods improve retrieval rates and limit time-sensitive complications.

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