Complications of Inferior Vena Caval Filters

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ABSTRACT

Inferior vena caval filters have been shown to be effective in the prevention of pulmonary embolism, with low morbidity and mortality associated with their implantation. Awareness of potential complications can further decrease the risk of filter placement and lead to early detection and management of complications to improve clinical outcomes. The purpose of this article is to review the procedure-related and delayed complications associated with inferior vena caval filters.

KEYWORDS: Inferior vena caval filters, thromboembolic disease, pulmonary embolism, complications

Objectives: Upon completion of this article, the reader should be able to discuss the avoidance, detection, and management of both procedural and delayed complications associated with inferior vena caval filter implantation.

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Venous thromboembolic disease remains a major cause of morbidity and mortality. Hospitalized patients are at a higher risk than the general population due to predisposing factors such as immobility, blood dyscrasias, altered hemodynamic states such as hypovolemia and shock, and neoplastic diseases. The most severe form of venous thromboembolic disease is pulmonary embolism (PE), which remains the most preventable cause of death among hospitalized patients.¹ Therapeutic anticoagulation is the preferred therapy for deep venous thrombosis (DVT), associated with less than 5% risk of major hemorrhage. However, despite adequate anticoagulation, there is a high incidence of PE² in patients with DVT. Numerous studies have documented the safety and efficacy of permanent inferior vena caval (IVC) filters,³⁻⁵ although the general utility of filters is not universally accepted.⁶⁻⁸ Traditionally, the indications for IVC filter implantation can be divided into absolute and relative.⁹ Absolute indications include contraindications to anticoagulation, failure of anticoagulation, significant com-

plications of anticoagulation, or inability to be properly anticoagulated. Relative indications include large, free-floating thrombus, thromboembolic disease with limited cardiopulmonary reserve, recurrent PE in a patient with an IVC filter in place, and DVT thrombolysis.¹⁰

In addition, IVC filter placement has been advocated for prophylactic use in patients with a high risk of thromboembolic disease.⁹ This group of patients includes those with massive trauma and those who have surgery with concomitant risks for development of DVT such as prolonged immobilization. It is this group of patients who would likely benefit from temporary IVC filtration using retrievable filters, as the risk of delayed complications resulting from long-term IVC filtration can be minimized.

INTRODUCTION

Familiarity with potential complications of IVC filter placement and retrieval may reduce the risks of these

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procedures, but certain complications are beyond the control of physicians. Examples of such complications include PE despite previous filter implantation and IVC thrombosis from propagation of clot trapped within the filter. In these situations, the principal goal is early detection and management to decrease morbidity and mortality. Athanasoulis and associates published their retrospective experience over a 26-year period involving 1765 filter implantations in 1731 patients and found a prevalence of PE after filter placement of 5.6% and fatal PE in 3.7%. There was a complication rate of 0.3% of procedures and IVC thrombosis rate of 2.7%.³

In general, complications can be divided into three categories: procedural complications, including those related to both venous access and filter deployment; delayed complications, including filter fracture, migration, IVC thrombosis, and recurrent PE; and complications of filter retrieval after implantation of temporary IVC filters.

PROCEDURAL COMPLICATIONS

Venous Access Site

Complications associated with venous access for filter placement are usually minor and include access site bleeding, hematoma, inadvertent arterial puncture, and infection. The rate of major complications is usually less than 1%. In their large series, Athanasoulis and associates observed only one case of a large groin hematoma compressing the femoral artery and causing leg ischemia.³ DVT at the access site and development of an arteriovenous fistula have been reported.¹¹ The incidence of complications is related to the choice of venous access site, which varies according to physician preference and the location of venous thrombus. The common femoral vein and internal jugular veins are most commonly used. The jugular approach allows for better monitoring of hemostasis after the procedure and, in our experience, better patient comfort, as the usual 2 to 4 hours of lying flat without bending the punctured groin can be avoided. In a study of over-the-wire stainless steel and titanium Greenfield IVC filters (Boston Scientific, Natick, MA), Kinney and associates concluded that the right internal jugular access site was associated with the lowest filter-caval angles and the most symmetric pattern of struts.¹² In morbidly obese patients where the femoral pulse cannot be palpated and when the common femoral vein cannot be visualized adequately with ultrasound, the jugular approach is appropriate. However, the jugular approach requires traversal of the right atrium to access the IVC. In some cases, particularly in hypovolemic patients, difficulty accessing the IVC with a catheter and guide wire can prolong the procedure and induce arrhythmia. We routinely use ultrasound guidance for jugular access and therefore are able to minimize access site complications.

For femoral access, we have a low threshold for using ultrasound as well, especially if there is any indication of femoral clot. In general, veins containing clots should be avoided, if possible, for two reasons: (1) it may be difficult to puncture and cannulate a clotted vein, and (2) manipulation of an acutely clotted vein carries a theoretical risk of clot embolization. Despite these risks, avoidance of clot-containing veins is not always possible when performing IVC filter implantation, as in the case of a patient with an occluded superior vena cava and bilateral common femoral vein DVTs. In general, when difficult venous access is encountered during filter implantation, ultrasound-guided punctures should avoid complications such as inadvertent arterial puncture or puncture of intervening structures such as herniated bowel.

Malposition

Another complication associated with filter placement is malposition, avoidable in most cases. It is recommended that the tip of the filter be positioned at the level of the renal vein (Fig. 1). This practice exposes a trapped clot to the maximal inflow of blood, possibly facilitating fibrinolysis and preventing renal vein thrombosis. Extensive laminar flow at this location may even protect against renal vein thrombosis in cases where the filter was inadvertently placed across the renal veins. Alternatively, filters can be implanted entirely above the inflow of the renal veins. There is no clinical evidence for an increased risk of complications when filters are placed well above the renal veins in the intrahepatic portion of the IVC.^{3,13,14} Nevertheless, suprarenal IVC filter placement is usually reserved for cases in which infrarenal implantation is not possible due to an inadequate length of available IVC or

Figure 1 Proper IVC filter placement. The tip of the filter is at or near the level of the renal vein inflow.

Figure 2 A 39-year-old woman with hypercoagulable state presenting with DVT. (A) IVC-gram revealed extensive infrarenal IVC clot. (B) Fluoroscopic image showed that the filter was placed above the renal vein.

the presence of a clot preventing proper placement (Fig. 2). Additional indications for suprarenal implantation include pregnancy and the intent to become pregnant. When a filter is deployed in an unintended position, repositioning the filter to the proper position or at least a position where there is the least clinical significance is recommended. If a filter is malpositioned or placed in a location of little clinical significance, placement of another filter in the correct location is appropriate (Fig. 3).

Defective Filter Deployment

A more common complication is deployment of a filter with crossed legs or incomplete expansion into the IVC, placing the patient at risk for poor filtration efficiency and potential filter migration. There have been reports of

successful manipulation to uncross or open the legs. If such attempts prove unsuccessful, then consideration should be given to placement of another filter more superiorly.

DELAYED COMPLICATIONS OF IVC FILTERS

The majority of published data focus on permanent filters, and in contrast, the long-term results of newer retrievable filters are lacking. IVC filters can cause significant morbidity and in rare instances mortality. A brief inspection of the Maude database collected between 2002 and 2005 revealed 16 cases of filter migration to the heart, two cases of migration to other locations, five cases of bleeding, three cases of IVC perforation, and eight cases of filter fractures.¹⁵

Figure 3 A 54-year-old man presented with DVT for IVC placement. (A) The first filter was deployed in a lumbar vein. (B) Another filter was placed in the infrarenal IVC.

Figure 4 A 48-year-old man with Recovery IVC filter (Bard, Covington, GA) placed for DVT prophylaxis. Approximately 1 year later, patient was admitted for unrelated reason. During this hospitalization, patient complained of palpitation and chest pain. (A) Chest X-ray revealed migration of the filter to the thorax. (B) Correlation with CT showed the filter in the right heart, straddling the tricuspid valve. Open-heart surgery was required for removal.

Migration

IVC filters can migrate from the deployed position to another part of the IVC, to the heart, or to the pulmonary outflow tract. The typical treatment is percutaneous removal of the migrated device using loop snares and appropriate retrieval devices. However, in circumstances such as migration to the heart valves, right ventricle, or pulmonary outflow tract, percutaneous removal may be difficult or impossible, and surgery may be required (Fig. 4).

Thrombosis

Although IVC filters might decrease the incidence of PE, the risk of DVT is increased. Blebea et al reported a 40% incidence of DVT after filter insertion in patients without evidence of DVT prior to insertion.¹⁶ In a follow-up of 465 patients who had at least one follow-up visit after filter insertion, Greenfield and Proctor reported an incidence of new DVT of 13.3%.¹⁷ In another study 44% of trauma patients developed DVT after filter placement.¹⁸

Reported caval thrombosis rate associated with filter implantation varies but approaches 50%¹⁹ in a few studies, likely increasing with time of implantation and conditions predisposing the patient to thromboembolus. Athanasoulis et al reported a prevalence of caval thrombosis of 3.2% overall and 2.7% if the Mobin-Uddin filters (American Edwards, Santa Clara, CA) were excluded.³ Caval thrombosis (Fig. 5) can cause significant morbidity such as lower extremity edema and phlegmasia cerulea

dolens.²⁰ In patients with retrievable filters, caval thrombosis can preclude removal.

Filter Fracture

As mentioned above, eight cases of filter fracture have been reported in the Maude database¹⁵ since the introduction of retrievable filters, though the type of filter in each case was not specified. Scattered reports of fractured permanent filters exist. One report on the Simon nitinol filter (Bard, Covington, GA) showed fractures of one strut in 6 of 38 patients, though none involved the basket portion.²¹ Fortunately, fractured struts are usually inconsequential.

IVC Perforation

Penetration of the wall of the IVC by filter struts is usually an incidental finding and typically clinically insignificant. The incidence is as high as 40 to 95%.^{21,22} Aortic penetration, ureteral perforation, and duodenal penetration by filter struts have also been reported.⁹ Recently, Putterman et al reported a case of aortic pseudoaneurysm secondary to penetration by a Simon nitinol filter.²³ Laceration of a lumbar vessel causing significant bleeding has been reported. IVC erosion with complete filter perforation causing significant morbidity has been reported.²⁴ Retrieval of temporary filters carries a theoretical risk of perforation or rupture of the IVC, particularly after extended

Figure 5 A 49-year-old man with bilateral lower extremity swelling presented for therapy. (A) Venogram showed extensive clot in the right iliac vein and thrombosed IVC with a Bird's Nest filter (Cook, Bloomington, IN) in position at the confluence of the iliac veins. (B) After thrombolysis and stenting, flow was restored through the iliac vein. The lower extremity edema resolved.

implantation when portions of the filter may be well incorporated into the vessel wall. Studies are needed to evaluate the risk of this complication in relationship to extended periods of filter implantation.

Pulmonary Embolism

The study from Massachusetts General Hospital revealed a prevalence of PE after filter implantation to be 5.6% and fatal PE to be 3.7%.³ Others report a less than 5% rate of postfilter PE.^{4,25}

Device Infection

Bacteremia is a relative contraindication to IVC filter insertion.⁹ We avoid infected access sites and use retrievable filters in bacteremic patients to reserve the option for removal in the event of bacterial colonization. Needless to say, strict sterile technique should be applied to all cases of filter insertion.

RETRIEVAL COMPLICATIONS

Long-term results for retrievable filters are lacking, though initial reports are promising.²⁶⁻²⁸ The fact that they can be removed confers advantages over traditional

permanent filters. For filter retrieval, published complications include large clot burden (Fig. 6), wall apposition (Fig. 7) preventing removal,²⁸ and difficult retrieval²⁹

Figure 6 Venogram showed clots within the cone of the filter. Large clot burden within the filter cone is a contraindication to routine removal.

Figure 7 The Tulip filter (Cook, Bloomington, IN) is tilted and the hook is apposed to the IVC wall, preventing successful removal in this patient.

requiring extended procedure time and nonstandard retrieval techniques.

CONCLUSION

The safety and efficacy of the more traditional permanent IVC filters have been well documented. Nevertheless, various complications associated with these filters have been described, and early diagnosis and management are the keys to reducing patient morbidity and mortality. Limited studies of retrievable filters are promising, but further studies are warranted to fully evaluate the risks associated with both implantation and retrieval.

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