

Inferior Vena Cava Filters

Current Indications, Techniques, and Recommendations



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KEYWORDS

• Vena cava filter • PE Prevention • DVT

KEY POINTS

- Anticoagulation is the first-line treatment of venous thromboembolic events (VTEs).
- Vena cava filters (VCFs) provide a mechanical barrier to prevent progression of lower extremity deep venous thrombosis to pulmonary embolism.
- Absolute indications for VCF are presence of VTE with contraindication or failure of anticoagulation.
- Available VCF types can be divided into permanent and retrievable filters with increasing use of the latter in recent years.
- Complications include filter tilt, migration, strut fracture, malposition, and inferior vena caval thrombosis.

INTRODUCTION

Venous thromboembolism remains the most common cause of preventable in-hospital mortality with a mortality rate ranging from 5% to 10%, and the prevalence of venous thromboembolic events (VTEs) is increasing with time. In a retrospective analysis of health care claims data in the United States from 2002 to 2006, there was a 33.1% increase in prevalence of VTEs from 2002 to 2006.¹ Left untreated, VTEs can be a significant source of morbidity and mortality. Although anticoagulation remains the first-line treatment of VTEs,² a small percentage of patients will experience recurrence despite anticoagulation, up to 7% at 6 months.³ In addition, there is a subset of patients that cannot tolerate anticoagulation or may have other barriers that require alternative therapies for prevention of pulmonary embolism (PE). As a

The authors have nothing to disclose.

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Surg Clin N Am 98 (2018) 293–319

<https://doi.org/10.1016/j.suc.2017.11.011>

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result, vena cava filters (VCFs) remain an important tool in the armamentarium of the treating physician.

HISTORY

Vena caval interruption to prevent the occurrence of PE in the setting of deep venous thrombosis (DVT) has been in practice for centuries. It was first suggested by Trouseau in 1868, and the first successful inferior vena caval (IVC) ligation was performed by Bottini in 1893.⁴ In the 1930s, Homan⁵ recognized the relationship between DVT and PE and advocated femoral vein ligation. Femoral vein ligation eventually fell out of favor due to relatively high rates of recurrent VTE, with 5% to 8% fatal PE, in particular, due to the risk of PE from the contralateral lower extremity.⁶ Around the same time, other surgeons, such as Ochsner and colleagues,⁷ and others, proposed IVC ligation as Bottini had performed it almost a century earlier. By the 1960s, it became the preferred treatment of the prevention of massive PE. Unfortunately, IVC ligation was also associated with significant morbidity and mortality, including recurrent PE rate of 6% and venous stasis rate of 33%.⁶ The collateral venous channels that provided venous return over time became a source of recurrent emboli.⁸ Mortality with IVC ligation was reported at approximately 15% and was especially high in patients with preexisting cardiac disease, with mortality up to 55% in patients with class 4 heart failure.⁹ Acute ligation of the vena cava was associated with up to 47% decrease in cardiac output.¹⁰ Later, attempts to plicate or clip the vena cava were performed^{11,12} but they also were associated with poor results, with operative mortality rates of 12%, IVC patency rates of 67%, and recurrent PE rates of 4%.⁶ With lackluster results from surgical ligation and plication for vena caval interruption, the stage was set for the development of intraluminal filters.

The Mobin-Uddin umbrella, the first VCF, was introduced in 1967. This filter was initially placed via venotomy and consisted of a perforated silicone filter in the shape of an inverted umbrella with 6 stainless steel struts.^{13,14} Although the transvenous approach avoided the previous morbidity and mortality of laparotomy, the filter itself was associated with migration and high rates of IVC occlusion and postthrombotic syndrome.¹⁵ In 1973, the Greenfield filter (Boston Scientific, Natick, MA, USA) was developed.¹⁶ It consisted of multiple struts arranged in a conical shape with the apex directed cephalad and struts that imbedded it into the caval wall. It was placed via an open venotomy, such as the Mobin-Uddin umbrella, but could be placed by either a femoral or an internal jugular approach, the former unique to it. The conical shape allowed for a significant clot packing ability within the center of the IVC while preserving caval flow and pressure gradients, which in turn provided exposure of the trapped clot to endogenous fibrinolysis.¹⁷ It was also associated with much lower rates of caval occlusion and migration.¹⁵ The percutaneous Greenfield filter was introduced in 1984¹⁸ and, since then, it has become the template for multiple generations of filters to follow (see later discussion of currently available filters).

The purpose of the VCF was to prevent the progression of DVT to PE and, since its advent, the absolute indications have remained relatively unchanged. Over the recent years, however, the indications for VCF placement have expanded, likely due in part to newer retrievable IVC filters and minimally invasive techniques.

INDICATIONS

In 1960, Barritt and Jordan¹⁹ established therapeutic anticoagulation as the treatment of VTEs, which then consisted of heparin and vitamin K antagonists. Since then, anticoagulation remains the cornerstone for treatment of VTE, including in the most

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