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Pictorial Review

Inferior vena cava filters: What radiologists need to know

J.J. Harvey*, J. Hopkins, I.J. McCafferty, R.G. Jones

Department of Diagnostic and Interventional Radiology, Queen Elizabeth Hospital Birmingham, Birmingham, UK

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Inferior vena cava (IVC) filters are a controversial mechanical adjunct in the prevention of pulmonary embolism, the most serious result of venous thromboembolism. Despite modern IVC filters being in clinical use for more than 45 years, there is still uncertainty amongst many radiologists about the indications for IVC filter placement and their removal, particularly the more recent prophylactic use in patients without confirmed deep vein thrombosis (DVT) or pulmonary embolism (PE). Recently published guidelines on filter use from the National Institute of Health and Clinical Excellence (NICE) and other professional bodies are discussed. The vast majority of IVC filters in the UK are inserted by interventional radiologists, so radiologists may be the first point of contact for information requested by other clinicians. The increasing use of filters means that radiologists will encounter filters increasingly often during abdominal cross-sectional imaging. Awareness of common filter-related complications, such as tilting, thrombosis, and caval perforation, is useful to reassure or alert other clinicians. The potential role of filters in upper extremity DVT and requirement for concomitant anticoagulation is discussed.

Introduction

Venous thromboembolism

Venous thromboembolism (VTE) is the umbrella term covering deep vein thrombosis (DVT) and pulmonary embolism (PE). In 2009, the National Institute of Health and Clinical Excellence (NICE) reported that more patients died in the UK from VTE than the total combined number of deaths from breast cancer, road traffic accidents, and AIDS.[1] Table 1 shows the relative risk of VTE from several common clinical conditions. Patients surviving their first VTE episode are at an increased risk of further VTE events and the development of complications such as post-thrombotic syndrome (PTS) and pulmonary hypertension.[2]

Most cases of PE are potentially preventable[3]; however, despite widespread information campaigns, VTE in hospitalized patients continues to rise.[4] Up to 95% of PE are caused by emboli from thrombi in the deep veins of the lower limbs.[5] This offers an attractive target for mechanical interruption, such as inferior vena cava (IVC) filters, to prevent the passage of emboli from the systemic to the pulmonary circulation. This is particularly useful in patients for whom anticoagulation is contraindicated or undesirable. It should be recognized that the sole function of caval filters is to trap venous emboli, reducing the risk of significant PE.[6] Caval filters do not treat or prevent venous thrombosis. Consequently, a prophylactic filter does not provide prophylaxis for DVT, only clinically significant PE.[6]

The latest guidance from NICE (2012) confirms that pharmacological methods with low-molecular-weight heparins (LMWHs) and vitamin K antagonists (e.g., warfarin) remain the first-line treatment for proximal DVT or PE.[7] Patients for whom systemic anticoagulation is contraindicated or not effective can be offered IVC filters.[7] Of interest, the NICE guideline neither recommends nor refutes the use of prophylactic caval filters.

* Guarantor and correspondent: J.J. Harvey, Department of Diagnostic and Interventional Radiology, Queen Elizabeth Hospital Birmingham, Mindelsohn Way, Edgbaston, Birmingham B15 2TH, UK. Tel.: +44 121 627 2000.
E-mail address: julesharvey@gmail.com (J.J. Harvey).

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Table 1
Increased relative risk of venous thromboembolism associated with common risk factors.[2]

Condition	Relative risk of VTE
Factor V Leiden thrombophilia	3-80
Pregnancy and post-partum period	4-14
Cancer	4-7
Anti-phospholipid antibodies	2-10
Oral contraceptive pill/hormone-replacement therapy	2-6
Non-group O group	2-4
Obesity	2-3

The evolution of IVC filters

Surgical ligation of the IVC to prevent PE was described in the late 19th century, but was considered a last resort procedure due to acute profound decreases in cardiac output, as well as extremely high rates of PTS.[8,9] In 1967, Dr Kazi Mobin-Uddin described the first modern IVC filter, consisting of a perforated silicone disc with metal supporting struts. This was placed during surgical venotomy and could not be easily removed (i.e., it was a permanent filter; see Fig 1).[10] The Mobin-Uddin umbrella filter resulted in a high rate of lower limb PTS due to disruption of caval blood flow and it was withdrawn.

In 1973, vascular surgeon, Dr Lazar Greenfield, introduced his eponymous conical permanent IVC filter, which was also inserted via surgical venotomy (Fig 2).[11] The Greenfield filter traps emboli within the solid apical cap, but allows caval blood flow around the edges. This provided the first successful long-term IVC filter and is the basic design upon which modern filters are based.[12]

Modern IVC filters

Contemporary IVC filters still have an apical cone for trapping caval emboli, but the designs and filter materials have evolved in attempts to minimize filter complications, yet retain good caval filtration. Modern filters are made from electropolished laser cut alloys, rather than stainless steel and silicone. This makes them compatible with magnetic resonance imaging (MRI), less thrombogenic, and less prone to breakage. Specific filter characteristics are available from the filter manufacturers. These changes do make a difference clinically: no instances of filter fracture or structural failure were reported in the British Society of Interventional Radiology (BSIR) IVC filter registry, using data from 2008–2010.[13]

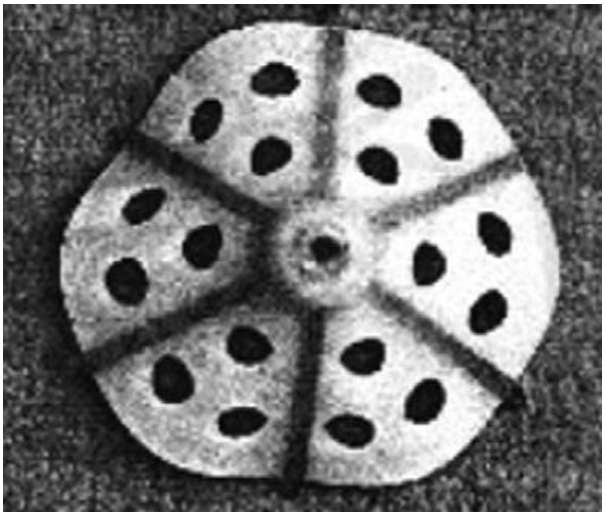

Figure 1 Mobin-Uddin umbrella filter. Courtesy of Dr D. Ohja, University of Toronto, Canada. Used with permission.

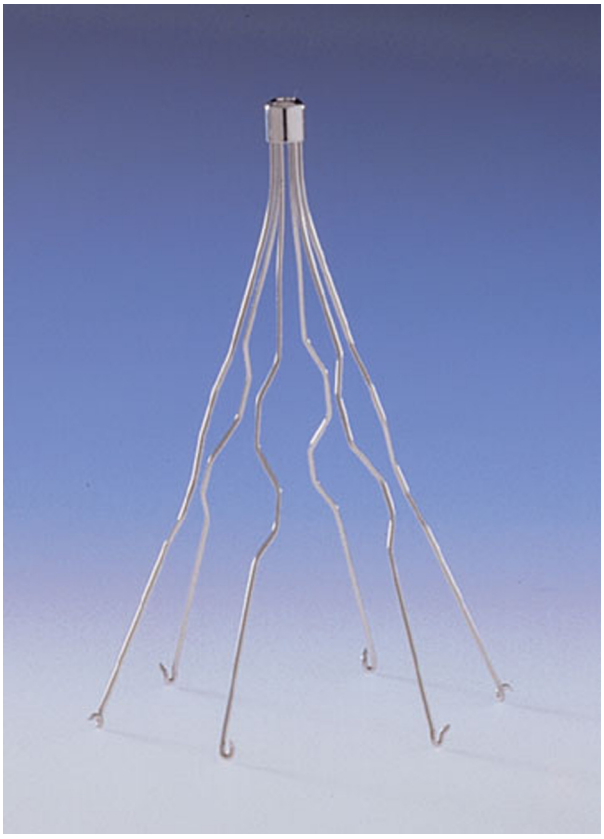

Figure 2 Greenfield filter. Courtesy of Boston Scientific, Natick, USA. Used with permission.

Today, a variety of manufacturers produce retrievable and permanent filters, each with slightly different properties. Some filters have hooks to prevent cranial migration, others have “legs” to reduce filters tilting within the IVC. Filter delivery systems have reduced in size (to as small as 7 F) allowing percutaneous placement through a variety of approaches (via the brachial, jugular, and femoral arteries).

Filter nomenclature

Caval filters can be categorized by their anatomical site: infrarenal, suprarenal, or superior vena caval (for upper limb VTE, discussed later). Filters can be further categorized as permanent for patients with a lifelong risk of PE, or optional filters for patients with a defined high-risk period (such as peri-operatively). A subtype of permanent filters are convertible filters, which are permanent filters whose