Inferior Vena Cava Filters – Percutaneous Insertion?

K Y Lau, K W Sniderman, D J Roebuck

ABSTRACT

The incidence of deep venous thrombosis (DVT) and pulmonary embolism (PE) among Chinese is much lower than in Caucasians. The total number of inferior vena cava (IVC) filters inserted in regional hospitals in Canada (about 700 beds in Toronto General Hospital) and Hong Kong (about 1,250 beds in Pamela Youde Nethersole Eastern Hospital) also reflects this. Thirty-six IVC filters were deployed in Toronto General Hospital, compared to 8 IVC filters inserted in Pamela Youde Nethersole Eastern Hospital from August 1997 to September 1998. Despite this, the physician may encounter patients with thromboembolic disease who require inferior vena cava interruption. The usual indication will be pulmonary embolism with contraindications to, or failure or complications of, anticoagulation therapy. It is important for angiographers to be familiar with the technique of percutaneous insertion of IVC filters. The types of IVC filters, techniques of insertion and guidelines relating to the choice of a filter would be discussed.

Keywords: IVC, filters

Department of Diagnostic Radiology
Pamela Youde Nethersole Eastern Hospital
3 Lok Man Road
Chai Wan, Hong Kong

K Y Lau, MBBS, FRCR
Consultant Radiologist

Department of Medical Imaging
The Toronto Hospital
Toronto Ontario
Canada

K W Sniderman, MD, FRCPC
Director of Angiography

Department of Diagnostic Radiology & Organ Imaging
Prince of Wales Hospital
Hong Kong

D J Roebuck, MBBS, FRCR, FRACR
Associate Professor

Correspondence to:
Dr K Y Lau

INTRODUCTION

Indications for filter placement

The purpose of the inferior vena cava filter (IVC) is to prevent fatal pulmonary embolism (PE). It should be noted that IVC filters do not prevent thrombosis, and anticoagulation should be continued when this is not contraindicated. The principal indications (Table I) include contraindications to anticoagulant therapy, or its failure, in patients with thromboembolic disease. The introduction of newer and safer IVC filters have helped to extend the indications of filter insertion. These include prophylaxis from PE in iliofemoral or infrarenal IVC thrombus and in high risk surgical patients.

Types of IVC filters

The IVC filters currently available include the Bird's Nest (Cook Bloomington, Indiana, USA), Greenfield (Medi-Tech, Boston Scientific, Watertown, Massachusetts, USA), Vena-Tech (L G Medical, Chasseneuil, France; marketed by B Braun Medical, Evanston, USA) and Simon Nitinol (Nitinol Medical Technologies, Lincoln, Illinois, USA). In general, the filters are designed to trap emboli greater than 5 mm in size. Each type of filter has its advantages and disadvantages. We use Bird's Nest and Vena-Tech filters.

The Gianturco-Roehm Bird's Nest vena cava filter was first tested clinically in 1982 and has the advantage of requiring a small sheath, 12-French in the modified version (Fig 1). Its mesh configuration consists of a series of preshaped wires that are formed by the operator in a series of manoeuvres with a special applicator so that the wires assume an original shape that resembles a bird's nest[1]. The filter requires deposition of an initial anchoring strut, formed of four stainless steel wires into a compact mesh, deposition of a second anchoring strut, then separation of the filter from the delivery system. It is a longer filter and needs at least 7 to 8 cm of infrarenal IVC. Learning to deploy the filter takes a longer period because there are more steps for the angiographer to follow. The open diameter of the filter is 40 mm and it can therefore be used in larger IVCs.

The Vena-Tech filter (Fig 2) is constructed of a cone with six flat, metallic diagonal struts and side rails that run parallel to the walls of the IVC with additional small barbs to hold the filter in place. The filter comes prepacked in a loading syringe and requires a 12-French sheath. The preloaded filter in the syringe permits either a jugular or femoral approach. The filter is short, requiring only a 5 cm length of infrarenal IVC, but is limited by its opening diameter of 28 mm. Deployment is easy to learn. There is a tendency for the filter to 'pop' open suddenly, with consequent slight displacement from the delivery catheter tip.

Special precautions

Heparin or urokinase should usually be discontinued before the procedure to allow haemostasis to be achieved. The half-life of heparin is about 90 minutes; infusion should be stopped about two hours prior to the procedure and restarted one hour after haemostasis is achieved. The half-life of urokinase is 20 minutes. If the plasma fibrinogen level exceeds 1.0 to 1.5 g/L, urokinase need not be stopped before filter insertion. If fibrinogen is less than 1 g/L, urokinase should be stopped, and one or two units of fresh frozen plasma should be given to restore coagulation factors.

Table I – Indications for filter placement

Indications	Explanation
A. Principle indications	
1. Contraindications to anticoagulant therapy	Bleeding disorders, severe hypertension, active internal bleeding, recent ophthalmic or neurological surgery, following major trauma. Hepatic or renal dysfunction if warfarin is considered.
2. Failure of anticoagulant	Recurrent PE, progressive DVT despite anticoagulant therapy, antithrombin III deficiency.
3. Complication of anticoagulant therapy	Haemorrhagic complications.
B. Extended indications	
1. Thrombus in high risk position	Iliofemoral or infrarenal IVC thrombus.
2. High risk patients immobility,	History of recurrent DVT, malignancy, sustained complicated neurological procedures and multiple trauma.
3. Failed previous placed IVC filters	Misplacement, migration or failure of initial IVC filter.

PE = pulmonary emboli; DVT = deep vein thrombosis; IVC = inferior vena cava

Technique of filter placement

Filters can be placed by either a femoral or jugular approach. The basic principle for femoral insertion is to choose the side that has patent and preferably thrombus-free veins. Right femoral puncture is preferable because there is less angulation in the iliac veins. A careful left femoral approach may be successful if a right-sided puncture is contraindicated (Fig 3). A jugular approach can be used when there is IVC or bilateral iliofemoral thrombosis (Fig 4). For the femoral approach, the common femoral vein should be punctured at the level of the femoral head. For the jugular approach, the puncture site should be the internal jugular vein midway between the mastoid tip and the sternal notch. A single wall needle is recommended in order to avoid the possibility of causing an arteriovenous fistula[2].

Before filter placement, an inferior vena cavogram is obtained to assess caval diameter and patency, the extent of thrombus and any venous anomalies. The location of the renal veins and any large collaterals should be noted. For the inferior vena cavogram, a 5-French pigtail catheter and 0.035-inch 3-mm J guide wire are used. One can use cut films with power injection, 2 films per second for 3 seconds, then 1 film per second for 4 seconds, injecting 30 to 40 mLs of contrast at 20 mLs/s. Alternatively, one can use digital subtraction with hand injection of 10 to 15 mLs of

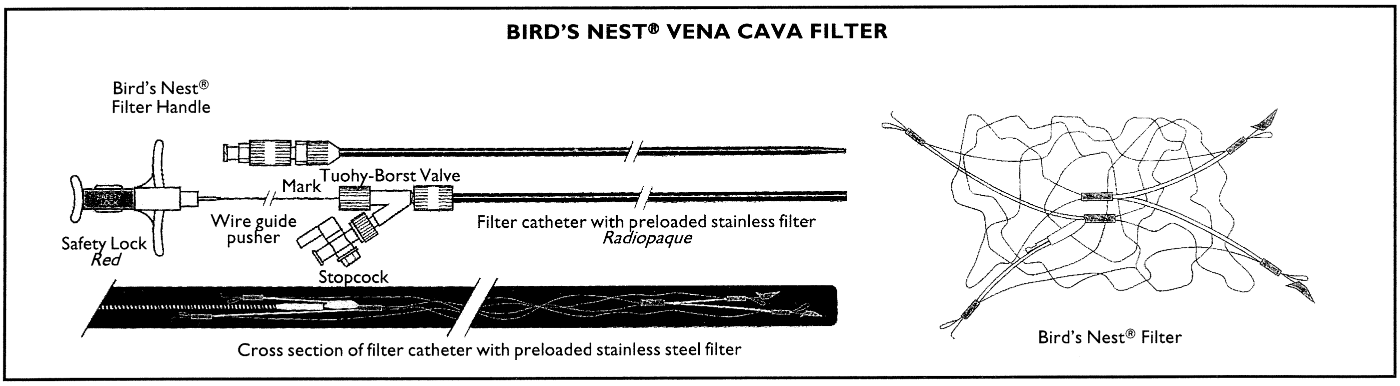

Fig 1 – Gianturco-Roehm Bird's Nest vena cava filter (reprinted with permission from Cook Inc, Bloomington, Indiana, USA).

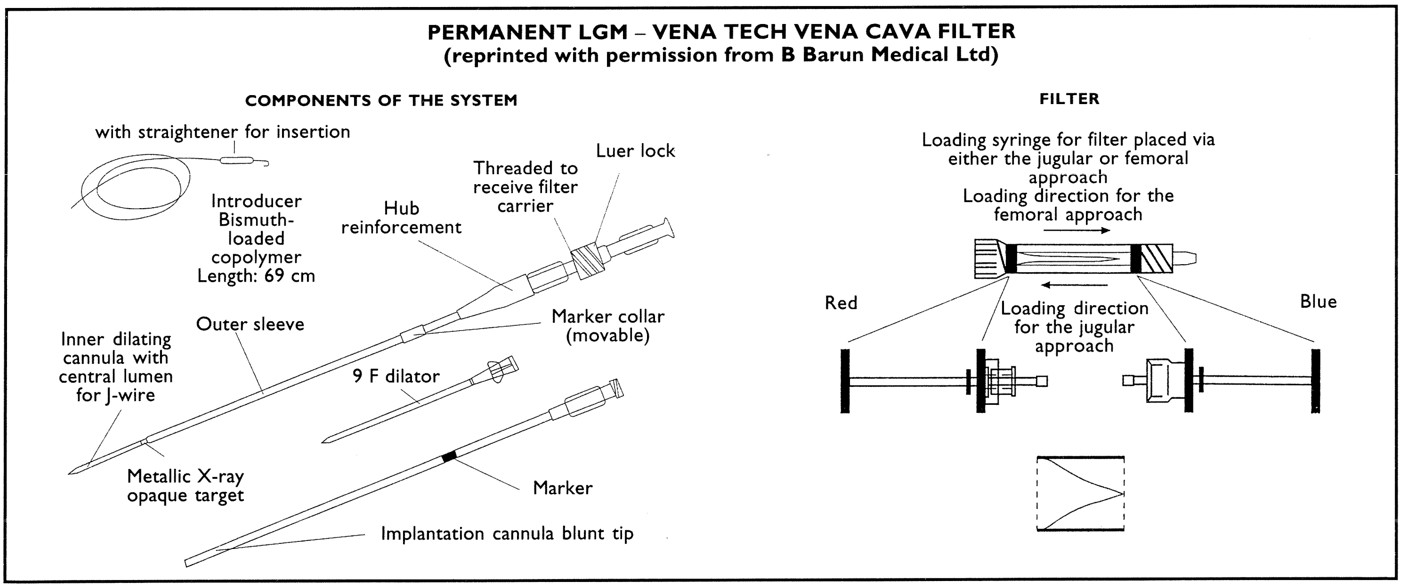

Fig 2

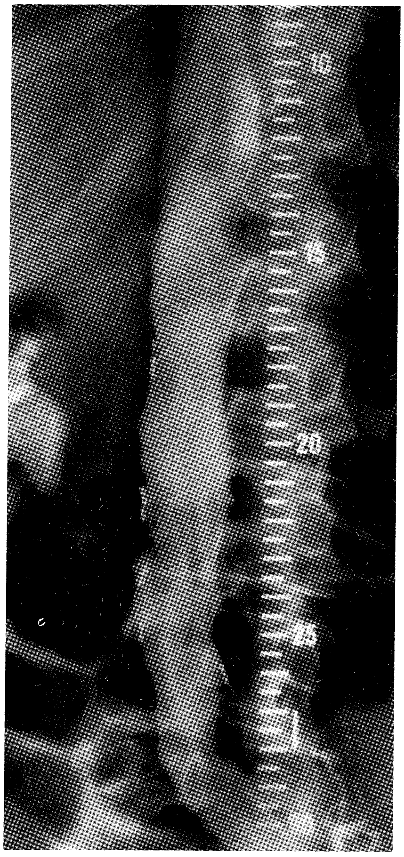

Fig 3 – Inferior vena cavogram showing a Bird's Nest filter that was inserted via the left femoral approach. Note a ruler with radiopaque calibration was placed at the right side of the abdomen to mark the position of the renal veins and to guide the positioning and adjustment of the final length of the Bird's Nest filter.

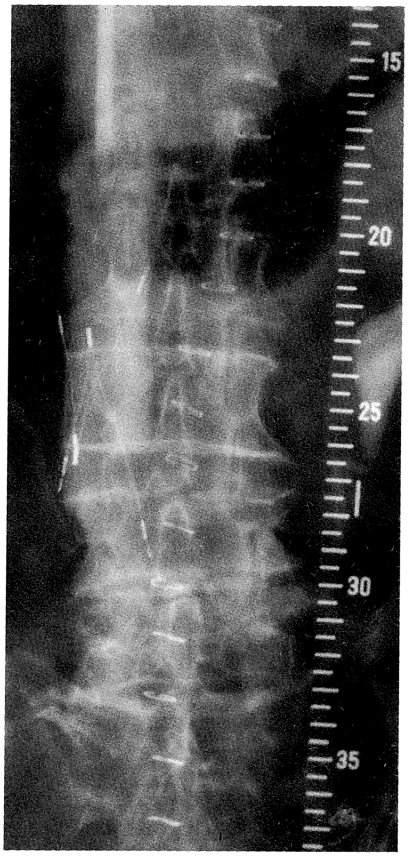

Fig 4 – Inferior vena cavogram following deployment of the Bird's Nest filter via a jugular approach.

contrast, obtaining two images per second. A ruler with radiopaque calibrations is placed behind the patient to the right of the midline to allow measurement of the IVC diameter and to mark the position of the renal veins and therefore the final position of the filter. This also allows adjustment of the final length of the Bird's Nest filter (Fig 3).

The information booklets which are enclosed with each filter describe in detail the method of deployment. It is important to work quickly to decrease the amount of manipulation of the vein.

Following filter insertion

Another inferior vena cavogram is performed after filter placement to check the position and stability of the filter. This can be done via the vascular sheath. Gentle manual compression of the puncture site for about five minutes and bed rest for four hours are recommended to ensure haemostasis. Following femoral puncture, the blood flow is maximised after haemostasis by applying an anti-embolic stocking to the leg, and by raising it 10 to 15 degrees for 24 hours. Following jugular puncture, the head should be propped up about 30 degrees to secure haemostasis.

DISCUSSION

Even though the incidence of PE among the Chinese is much lower than in Caucasians[3,4], the need for IVC filter placement will occasionally arise. It is important, therefore, for radiologists to be familiar with the technique of percutaneous insertion of IVC filters. With recent advances in technology and modification of the existing systems, percutaneous IVC filter placement is an effective, safe and precise procedure that is crucial to the management of patients with DVT and PE. Surgical plication of the IVC is now almost obsolete. In addition, filter insertion can be combined with pulmonary angiography in a single procedure.

As the filters are permanent devices, careful selection of candidates is important. Traditionally, filter insertion is discouraged in patients with a long life expectancy. In addition, it is necessary to ensure that the emboli are coming from the pelvis or lower limbs as IVC filters obviously do not prevent emboli from the level of the renal veins or above.

Contraindications to percutaneous filter placement include uncommon situations in which surgical venotomy and closure may be preferred such as severe coagulopathy predisposing to bleeding from the puncture site, patients who cannot comply with postprocedure rest orders, and the presence of thrombus at all possible points of access to the venous system[5]. Occasionally, the filter is placed in the suprarenal portion of the IVC. The only definite indications for this is extensive thrombosis of the infrarenal IVC or involvement of the renal veins by thrombus.

A perfect IVC filter should have 100% filtering efficiency without migration, occlusion or other morbidity, and should be retrievable. A balance must be struck from the strengths and weaknesses of the available products. The choice of filter is at the discretion of the angiographer. However, there are certain guidelines. The Bird's Nest filter is the only currently available device for an IVC diameter between 29 and 40 mm. For IVC diameter less than 29 mm, all the other filters can be used. Percutaneous translumbar placement of an IVC clip has been evaluated for patients with an IVC diameter greater than 40 mm[6]. Placement of the Bird's Nest filter requires more practice than the other filters. Though the Bird's Nest requires a longer learning curve, the entire procedure can be still be completed within 30 minutes.

The Bird's Nest filter has the additional advantage that in case of a very large IVC, the wire mesh can be positioned to cover collaterals or anomalous veins. Bilateral iliac vein filters are therefore not necessary[7]. Also because of its free form-configuration within the IVC, centering is not needed as in other filters. For the Bird's Nest filter, the rate of recurrent pulmonary embolism is reported to be 2.7% and the rate of thrombotic occlusion is 2.9%[7]. Mohan et al[8], however, reported that the Bird's Nest filter is associated with higher incidence of symptomatic IVC thrombosis and increased morbidity and mortality compared with the stainless steel Greenfield filter, the titanium Greenfield filter with modified hook and the Vena-Tech filter. Vena caval occlusion with fatal phlegmasia caerulea dolens has been reported in one case[9] and a significant perforation of the caval wall has also been identified[10].

The older version of the Vena-Tech filter had some problems. Some jugular filters failed to open fully (Fig 5). An initial failure rate of 2% and a 16% rate of malpositioning (filters tilted 15 degrees or more, filters incompletely opened and correctly aligned, and filters incompletely opened and tilted) were reported[11]. A rapid technique of deployment from the introducer is recommended to ensure full opening of the struts. It is reported that the new version of the Vena-Tech filter functions much better. For Vena-Tech filters, the rate of recurrent emboli is 2% and of thrombotic occlusion is 7% during a 1-year follow up[11].

Each type of filter has its own advantages. The Simon Nitinol filter is made of a thermal memory alloy composed of nickel and titanium, and has a catheter with a 7-French outer diameter. It can, therefore, be inserted through an antecubital vein. It is shorter (3 cm in length) and is useful when the longitudinal distance between the renal veins and the iliac bifurcation is small. A retrievable percutaneous vena cava filter, the Gunther Tulip filter, is now on the market[12]. Tempofilter, marketed by the same company as the Vena-Tech filter, is recently available. This is a retrievable temporary filter that can be implanted for up to six weeks for medium term temporary protection against PE during the pre- and postoperative risk period, especially in younger patients.

Magnetic resonance (MR) imaging has introduced new considerations for filter design. It is likely that in future, all IVC filters will be constructed of high strength non-ferromagnetic material. Of the Bird's Nest, Greenfield, Vena-Tech and Simon Nitinol filters, the Bird's Nest has shown to be the most ferromagnetic and creates significant local artifact on MR images[13]. However, diagnostic MR images at 1.5 T of the pelvis, spine and brain have been obtained without complication or symptomatic filter displacement from 11 patients with Bird's Nest filters[14]. Nevertheless, for the Bird's Nest filter, it is recommended that MR imaging should be postponed for six weeks following filter implantation to ensure device incorporation into the vessel wall. The Vena-Tech filter is composed of non-ferromagnetic alloy and is therefore MR compatible and produces minimal artifact. The Simon Nitinol filter has also been claimed to be MR compatible and safe.

In conclusion, percutaneous insertion of IVC filters is a safe procedure that is crucial to the management of PE, and every angiographer should be familiar with this technique. Although the choice of filter depends to some extent on the angiographer's preference, some general guidelines may be helpful in filter selection in individual patients.

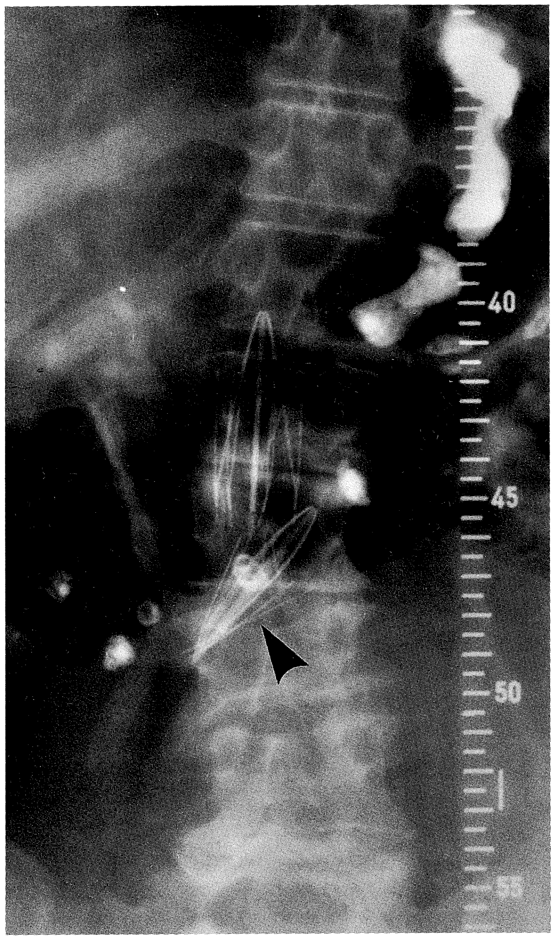

Fig 5 – The initial jugular Vena-Tech filter failed to open properly (arrow head). A second Vena-Tech jugular filter was then deployed successfully.

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