The use of vena caval filters

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Deep vein thrombosis with pulmonary embolus is a frequent event, which is usually treated by anticoagulant drug therapy alone. Caval filters tend to be used infrequently in most centres in the UK. This article intends to help hospital doctors make use of these devices appropriately.

Pulmonary emboli (PE) have long been a major cause of hospital morbidity and mortality. It is estimated that 75–90% of PE arise in the lower limbs or pelvis. Before anticoagulant therapy was shown to be effective, inferior vena cava (IVC) ligation or clipping was performed to interrupt the flow of emboli to the lungs. However, these operations carried a mortality of 10–15% and serious morbidity as a result of venous stasis in up to 65% of cases (Piccone et al, 1970; Donaldson et al, 1980). Treatment changed dramatically in 1960 when controlled trials demonstrated the effectiveness of anticoagulation in treating deep vein thrombosis (DVT) and preventing PE (Barrit and Jordan, 1960).

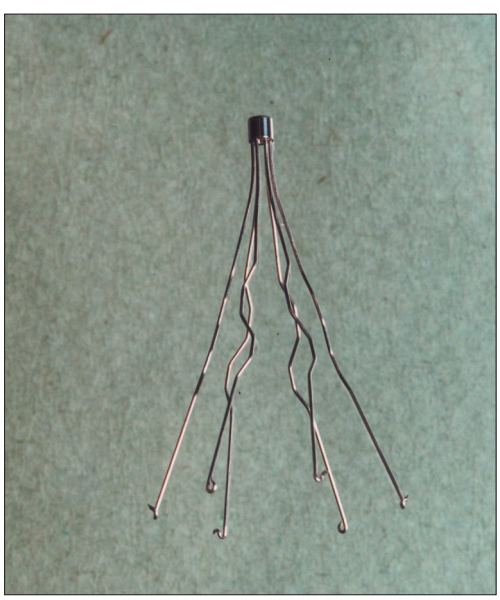
However, occasions arise where anticoagulation is either contraindicated or ineffective in the prevention of PE. The earlier caval filters introduced in the mid-1960s as an alternative to surgical caval interruption were associated with a high caval occlusion rate. The Greenfield filter (*Figure 1*) (Boston Scientific, Watertown, Ma, USA), introduced in the early 1970s, combined good filtration with low blood flow impedance and demonstrated >95% caval patency after 18 months of follow-up (Streiff, 2000). The first stainless steel Greenfield filter was large bore (29.5 Fr), necessitating surgical venotomy as excessive access site thrombosis was associated with percutaneous insertion. More recently, the development of a whole range of lower profile devices for percutaneous insertion has rendered open surgical procedures obsolete.

INDICATIONS

Despite the array of devices available and the numbers being deployed around the world, the published follow-up of long-term complications is scanty. A recent comprehensive review of the literature showed that most studies are small and retrospective, with follow-up data rarely exceeding 18 months (Streiff, 2000). In one study of patients followed for up to 5 years, caval occlusion increased from 1% at 1 year to 30% at 5 years (Crochet et al, 1993). In view of the lack of data on relative safety and efficacy of these devices compared with anticoagulation, they should not be regarded as an alternative to anticoagulation.

The only study to prospectively compare anticoagulation with caval filters in the prevention of PE in patients with DVT did show filters to be effective in the short term (Decousus et al, 1998). In this study, of the 200 patients assigned to receive IVC filters and anticoagulation for 3 months, there was a significant reduction in recurrent PE at day 12 compared with the 200 patients who received anticoagulation alone. However, there was no improvement in mortality at 2 years, and there was a significant increase in recurrent DVT in those with filters.

Figure 1. Greenfield filter (Boston Scientific, Watertown, Ma, USA).



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Taking these facts into consideration, the indications for filter insertion are best divided as follows:

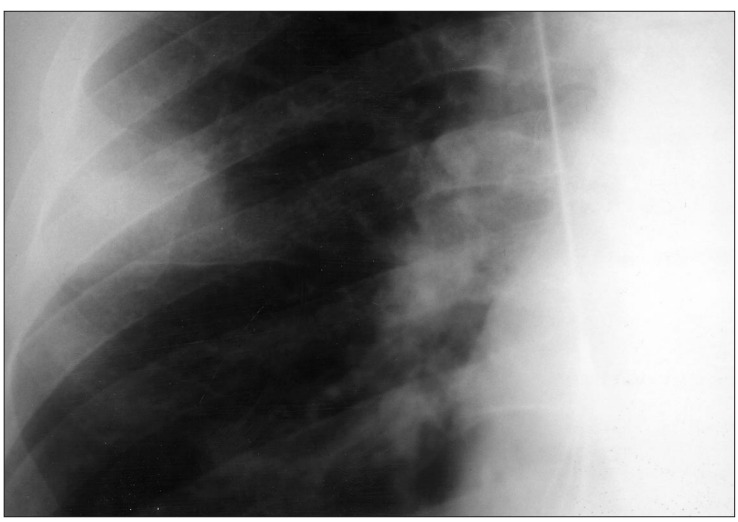
Definite indications

1. Contraindication to anticoagulation treatment and recent proximal (above knee) DVT or PE
2. Failure of anticoagulation: either documented PE during adequate treatment for DVT, documented propagation of DVT during adequate therapy or non-compliance with therapy.

Possible indications

1. PE and proximal free-floating DVT (fronds of floating thrombus anchored only at a distal mural attachment). However, there is no evidence that the risk of thrombus migration during anticoagulation treatment is any greater than for occlusive thrombus (Parcouret et al, 1997; Streiff, 2000)
2. Compromised cardiorespiratory function or pulmonary hypertension with DVT. While it is clear that further PE may well be fatal, there is no clear evidence that caval interruption is indicated in addition to anticoagulation
3. Prophylactic insertion in high-risk patients. Patients undergoing joint replacement or major surgery with a past history of PE or DVT are high-risk. Studies have shown low-dose heparin to reduce the risk of PE to less than 1%, with a less than 2% risk of major bleeding (Geerts et al, 1996)
4. During fibrinolytic treatment of venous thrombosis. There is no trial evidence for filters in this situation (Hyers et al, 1998; Thery et al, 1990)
5. DVT in the elderly. This is an attractive idea because these patients are less likely to be affected by long-term complications of the device, there is less risk of haemorrhage and they do not have to attend for regular blood tests. Also, polypharmacy is common in the elderly, leading to a greater risk of an adverse interaction with warfarin. However, recurrent DVT and venous stasis (resulting from the filter) may cause leg ulceration and further immobility with significant morbidity and mortality
6. PE or proximal DVT in patients with disseminated malignancy. There are, at present, no evidence-based data to advocate this practice.

Figure 2. Migration of Tempofilter into right atrium. Note right lung infarct.



A number of temporary devices have been designed in view of the long-term problems with caval filters. At present, manufacturers advise that these should be removed after 10–12 days to avoid endothelialization. 'Long-term' temporary filters are not, at present, available. The Gunther Tulip filter (Cook Group, Bloomington, Ind, USA) is retrievable up to 10 days after insertion, but if left in place, it can act as a permanent filter. This type of filter is indicated when anticoagulation is temporarily contraindicated, such as DVT in late pregnancy, patients requiring surgery or following major trauma with pelvic fractures. In addition, this type of filter should always be considered in younger patients and in those with a normal life expectancy. Studies have shown that they are easy to insert and that they are at least as efficient at clot capture when compared with permanent filters (Linsenmaier et al, 1998).

COMPLICATIONS

Procedure-related complications

In a recent review of over 1700 filter insertions over 26 years, major complications occurred during placement in only 0.3% of patients (Athanasoulis et al, 2000). Trauma at the access site can be minimized by accurate location of the vein with venography or ultrasound and by the use of lower profile introducer sets. Access site thrombosis can still be expected in 23–36% of patients (Streiff, 2000). Complications of jugular and femoral access are the same as can be expected with other procedures involving central venous access.

Placement errors and filter migration are, perhaps, the most alarming complications. There have been a number of reports of devices being prematurely deployed or migrating to the heart (*Figure 2*) or pulmonary veins (Kaufman et al, 1995). The optimal management for an intra-cardiac filter is unknown. Some patients remain

asymptomatic, but fatal arrhythmias and pericardial tamponade have occurred. Percutaneous removal with a loop snare (Deutsch, 1988) or repositioning has been performed successfully, but surgical removal may be more prudent, and individual assessment of each case is required. Filters have also been misplaced in the iliac, ascending lumbar, renal and hepatic veins. These positions will compromise filter function, and they should be percutaneously manipulated and repositioned or removed. If neither option is possible, then a second device can be placed more proximally. If a filter fails to open correctly, its filtering capabilities will be compromised, and the same measures should be taken.

The ideal filter position is just below the renal veins. However, when filters have been placed supra-renally for specific indications such as IVC thrombosis, there has been no evidence of significant renal morbidity (Streiff, 2000).

Other reported early complications include air embolism and arteriovenous fistula.

Post procedure complications

Review of the literature reveals that most of the complication rates quoted for the different devices came from retrospective case series (*Table 1*). There are no randomized comparison studies, and the different studies that are available have different methods and reporting standards. A recent meta-analysis of placement of approximately 6500 devices in nearly 90 different studies concluded that follow-up after placement of these devices has generally been insufficient and no particular device is clearly superior to the others (Streiff, 2000). Structural failure is uncommon and usually asymptomatic but carries the important risks of migration of filter fragments and recurrent PE. In recent years, the Anthéor (Boston Scientific, Watertown, Ma, USA) permanent caval filter was withdrawn from the market for this reason (*Figure 3*).

Filter migration is defined as caudal or cranial movement in excess of 1 cm. Migration with clinically significant sequelae occurs in approximately 0.4% of patients (Streiff, 2000).

The Greenfield filter was found to be susceptible to tilting following placement. In-vitro studies have shown that an angle of greater than 15° reduces the clot-capturing capabilities of the device (Thompson et al, 1989), and 5.3% of Greenfield filters were found to have tilted more than 10° from the central axis (Streiff, 2000). The newer 'over-the-wire' delivery system addressed this particular problem by allowing manipulation during deployment.

IVC wall penetration is rarely symptomatic but case reports of perforation of the small bowel, urethra and aorta as well as erosion of lumbar vertebra are described.

TABLE 1.
Long-term complications of inferior vena caval filters

Complication	Incidence
Recurrent pulmonary embolism	2.6–3.8%
Recurrent deep vein thrombosis	6–32%
Inferior vena caval thrombosis	3.6–11.2%
Insertion site thrombosis	23–36%
Post phlebitic syndrome (leg swelling +/- ulceration)	13–41%

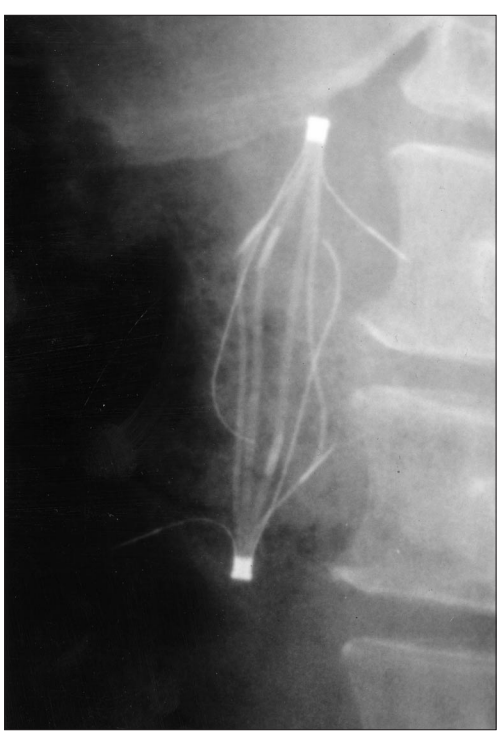
FILTER DEVICES AVAILABLE

Permanent

There are currently five permanent filter devices available:

- Greenfield filter (Boston Scientific, Watertown, Ma, USA)
- Bird's Nest filter (Cook Group, Bloomington, Ind, USA)
- LGM Vena-Tech filter (Braun, Evanston, Ill, USA)
- Simon Nitinol filter (Bard, Covington, Ga, USA) (*Figure 4*)
- TrapEase filter (Cordis, Johnson and Johnson, Brentford, UK).

Figure 3. Structural failure of Anthéor filter.



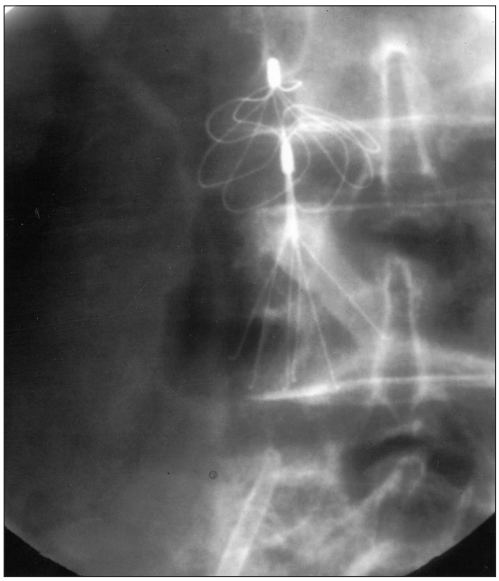


Figure 4. Simon Nitinol filter (Bard, Covington, Ga, USA).

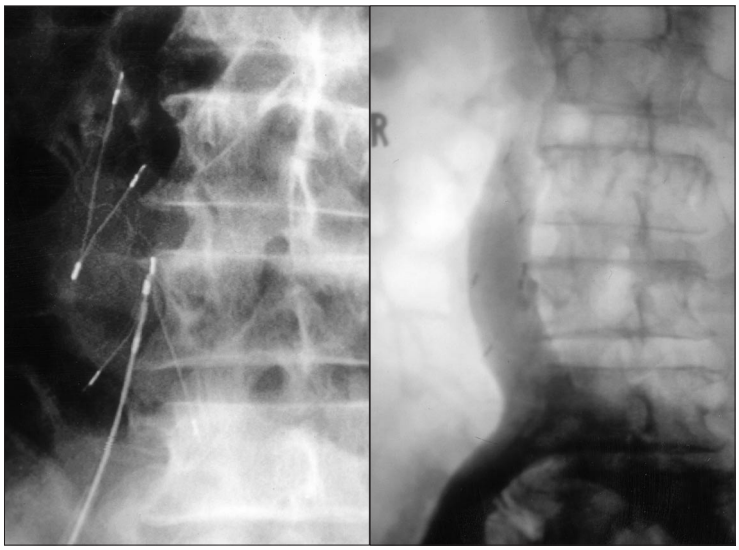


Figure 5. a. Deployment of Bird's Nest filter. Fine wires forming a random mesh between the V-shaped struts are just visible. b. Bird's Nest filter in satisfactory position at cavography.

These devices vary in their appearance, deployment mechanisms and construction materials but, as yet, there is no controlled trial to show that any one device is superior to the others. It should be noted that the Bird's Nest filter (*Figures 5a* and *b*) is the filter of choice for patients with a large caval lumen. The most recent addition to the market, the TrapEase filter, comes with a 7.5 Fr delivery system, which is the smallest available to date.

Permanent/retrievable

The only device currently available in this category is the Gunther Tulip vena cava filter (Cook Group, Bloomington, Ind, USA).

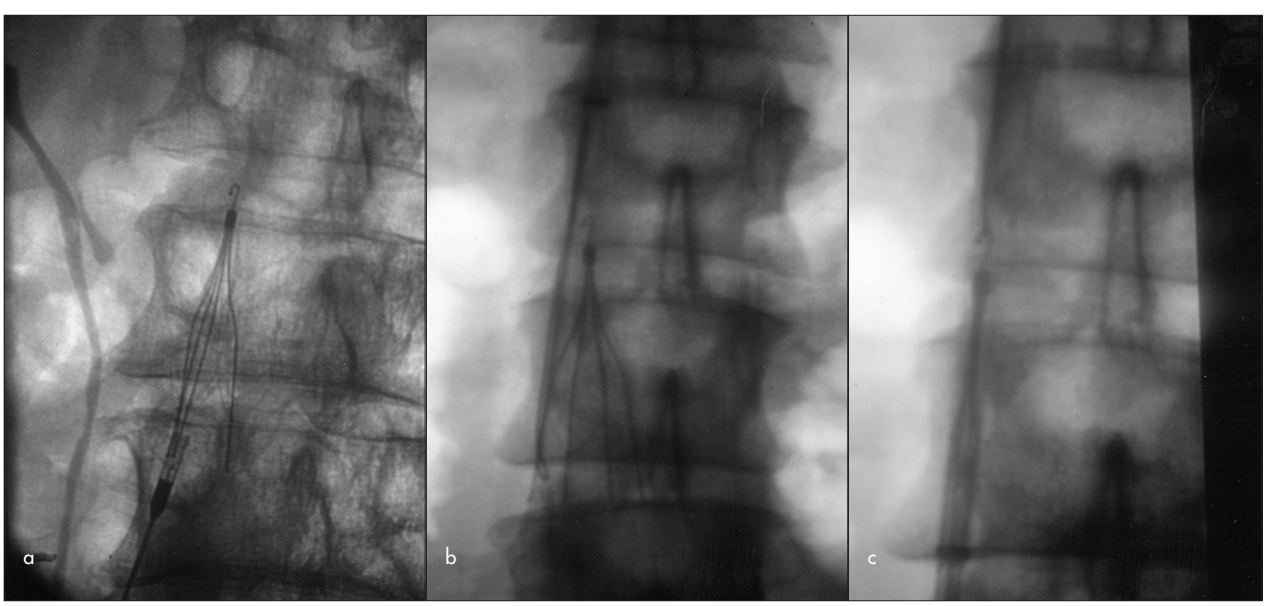
It consists of a stainless steel half basket with four wires meeting at the apex. Smaller wires are attached to the main wires giving a 'tulip' appearance (*Figure 6a*). It can be retrieved via an 11 Fr coaxial sheath by snaring a hook attached to the apex of the device (*Figures 6b* and *c*). If not retrieved within 10 days, it becomes a permanent filter.

Temporary

There are four temporary filter devices available:

- Günther temporary IVC filter (Cook Group, Bloomington, Ind, USA)
- Anthéor temporary filter (Boston Scientific, Watertown, Ma, USA)

Figure 6. a. Insertion of Gunther Tulip filter. b. Snaring the hook of Gunther Tulip filter. c. Retrieval of Gunther Tulip filter.



- LGT temporary filter (Braun, Evanston, Ill, USA)
- Prolyser Temporary filter (Cordis, Johnson and Johnson, Brentford, UK).

With the Günther temporary IVC filter (Cook Group, Bloomington, Ind, USA) (*Figures 7* and *8*), an oversize (22 Fr) retrieval sheath can be used for its removal if there is extensive clot trapped in the device, while the other three devices have a central lumen to allow thrombolysis of retained clot before removal.

CONCLUSION

Vena caval filters are relatively easy to insert with very few early major complications. They are effective in the prevention of recurrent DVT but controlled prospective trials to compare the different devices and assess the true incidence of long-term complications are required. HM

Conflict of interest: none.

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Figure 7. Gunther Temporary filter.

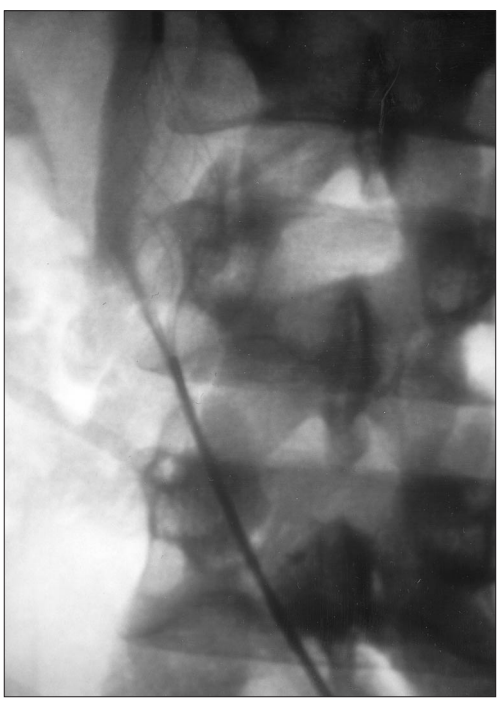
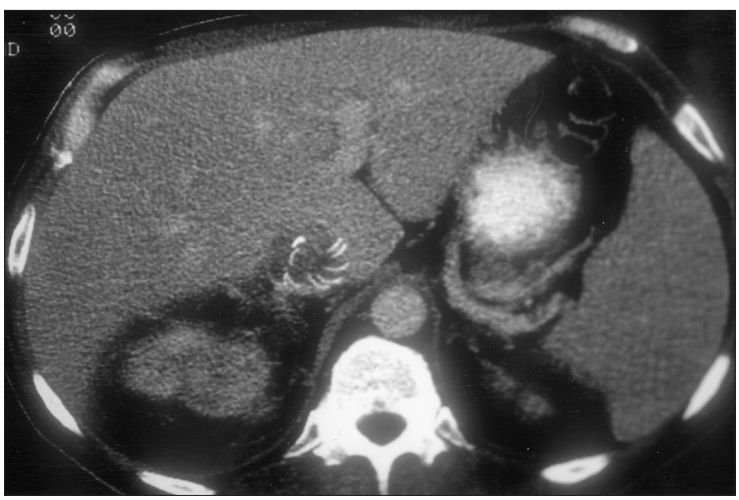


Figure 8. Computed tomography appearance of Gunther Temporary filter in patient with right renal cell carcinoma. Note tumour thrombus extension into inferior vena cava.



KEY POINTS

- Vena caval filters are probably underutilized in the UK.
- Many devices are now available which can be inserted quickly and safely by percutaneous methods under X-ray control.
- Greater awareness and appropriate use of these devices may improve outcome in prophylaxis against pulmonary embolism.
- Although there are definite indications for these devices, they should not be considered as an alternative to anticoagulation.
- There are few data on the long-term complications of these devices.
- An increased incidence of recurrent deep vein thrombosis and venous stasis is seen with permanent devices. Use of temporary filters, where possible, avoids these long-term complications.