The use of retrievable inferior vena cava filters in orthopaedic patients

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This study was undertaken to evaluate the safety and efficacy of retrievable inferior vena cava filters in high-risk orthopaedic patients. A total of 58 patients had a retrievable inferior vena cava filter placed as an adjunct to chemical and mechanical prophylaxis, most commonly for a history of previous deep-vein thrombosis or pulmonary embolism, polytrauma, or expected prolonged immobilisation. In total 56 patients (96.6%) had an uncomplicated post-operative course. Two patients (3.4%) died in the peri-operative period for unrelated reasons.

Of the 56 surviving patients, 50 (89%) were available for follow-up. A total of 32 filters (64%) were removed without complication at a mean of 37.8 days (4 to 238) after placement. There were four filters (8%) which were retained because of thrombosis at the filter site, and four (8%) were retained because of incorporation of the filter into the wall of the inferior vena cava. In ten cases (20%) the retrievable filter was left in place to continue as primary prophylaxis. No patient had post-removal thromboembolic complications.

A retrievable inferior vena cava filter, as an adjunct to chemical and mechanical prophylaxis, was a safe and effective means of reducing the acute risk of pulmonary embolism in this high-risk group of patients. Although most filters were removed without complications, thereby avoiding the long-term complications that have plagued permanent indwelling filters, a relatively high percentage of filters had to be left *in situ*.

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doi:10.1302/0301-620X.90B5.19743 $2.00

J Bone Joint Surg [Br] 2008;90-B:662-7.
Received 25 May 2007; Accepted after revision 22 January 2008

In 1998, Decousus et al[1] reported that early placement of an inferior vena cava filter in patients with a proximal deep-vein thrombosis (DVT) significantly reduced the risk of pulmonary embolism. However, after two years, patients with an indwelling inferior vena cava filter were at a higher risk for the subsequent development of a DVT than patients managed with anticoagulation alone. Permanent filters have been associated with a risk of migration, infection, vena caval thrombotic occlusion and venous stasis.[2-6]

The complications of permanent inferior vena cava filters led to the development of a retrievable filter, which could be used to reduce the risk of developing an acute DVT and minimise the risk of long-term complications if retrieved.[7,8] Since their introduction, many studies have investigated their use in multiply-injured patients, in whom the risk of thromboembolic disease is elevated.[7-19] Retrievable filters, however, are also associated with potential complications. They may become incorporated into the wall of the inferior vena cava and are subject to the same risks as indwelling filters.[12,20,21] Removal of the retrievable filter may not be possible due to the local formation of thrombus or changes in its position.[9,22]

The incidence of venous thromboembolism in patients with major fractures of the lower limb may be as high as 67% in the absence of prophylaxis.[23,24] Up to 50% of patients with a DVT of the lower limb may be asymptomatic.[25] Mechanical and/or pharmacological prophylaxis may be contraindicated in these patients, increasing the risk of peri-operative thrombotic complications. Thromboembolic complications may also occur in multiply-injured patients who receive chemical and mechanical prophylaxis.[26] Retrievable filters may be appropriate for these patients, providing temporary protection at a time of increased risk.

To date, there have been no published studies reporting the safety and efficacy of retrievable inferior vena cava filters in orthopaedic patients. The current study was undertaken in order to assess their use in this high-risk group of patients.

Patients and Methods

This was a retrospective study of all orthopaedic patients in whom a retrievable Günther

Table I. Indications for placement of an inferior vena cava filter in 58 patients

Reason for hospital admission	Pathology	Number of cases
Trauma (32 patients: 9 with polytrauma)	Fracture of:	
	Acetabulum	5
	Pelvis	5
	Hip	15
	Humerus	4
	Femur	5
	Tibial plateau	4
	Tibial shaft	1
	Distal radius	2
	Ankle	3
	Calcaneum	2
Tumours	Impending fracture secondary to osteosarcoma	2
	Pathological fracture secondary to multiple myeloma	2
	Vertebral metastases secondary to breast carcinoma	2
	Malignant lymphoma right humerus	1
Osteoarthritis	Hip	3 (1 bilateral)
	Knee	4 (1 bilateral)
Infection requiring incision and drainage	Total hip replacement	3
	Total knee replacement	2
	Ankle hardware	1
Spinal disorders	Disc herniation	4 (2 one-level lumbar and 2 cervical herniations)
	Lumbar spondylolisthesis	2

Tulip inferior vena cava filter (Cook Inc., Bloomington, Indiana) was placed between August 2003 and November 2005. The study had ethical approval. Unless contraindicated by active gastrointestinal bleeding, a recent haemorrhagic cerebrovascular accident and/or severe uncontrolled hypertension, each patient received both chemical (low-molecular-weight-heparin (LMWH) 30 mg subcutaneously every 12 hours) and mechanical (foot pump) thromboembolic prophylaxis in the peri-operative period. The demographic information, including past medical history, diagnosis on admission and indication for the retrievable filter placement was documented for each patient.

Each filter was introduced by a fellowship-trained interventional radiologist, using a standard sterile technique, via the femoral vein on the side contralateral to the DVT, if one was present. The femoral vein was accessed using real-time ultrasound and a 19-gauge needle, and a 5-French pigtail catheter (Angiodynamics, Queensbury, New York) was advanced over a standard guidewire, with anteroposterior and lateral fluoroscopic angiography of the inferior vena cava. Once the appropriate location was reached, the filter was advanced through a 12-French introducer sheath.[11] Data on the insertion of the filter and the incidence of complications relating to its insertion or the use of contrast were recorded.

Details of the surgical and medical interventions that were undertaken, including peri- and post-operative complications and length of hospital stay, were recorded for each patient. The subsequent course was evaluated, noting whether the filter was removed, when it was removed, and if retained, the reason for this decision.

Results

A retrievable inferior vena cava filter was introduced into 58 patients during the study period. There were 26 men and 32 women, with a mean age of 62.5 years (17 to 92). The reason for admission to hospital was trauma in 32 patients, neoplasia in seven, osteoarthritis requiring joint replacement in seven, infected hardware in six, and spinal disorders in six (Table I).

Indications for the introduction of a filter included a DVT (pelvic, thigh or calf) in 20 patients, a history of pulmonary embolism in 14, polytrauma in nine, prolonged immobilisation in nine, malignancy in four, and a hypercoagulable state (factor V Leiden mutation[27]) in two. Filters were placed a mean 2.9 days (1 to 12) after admission. There were no complications relating to the insertion of the filters.

A total of 52 patients (90%) also received LMWH therapy. Of the six patients who did not receive chemoprophylaxis, three had an active gastrointestinal haemorrhage and three had a DVT complicated by a recent cerebrovas-

Table II. Nature of the operation performed in 58 patients with inferior vena cava filters*

Operation	Indication	Number of patients
Open reduction internal fixation	Fracture	27 (41 fractures)
Hip hemiarthroplasty	Hip fracture	3
Shoulder hemiarthroplasty	Proximal humeral fracture	1
Total hip replacement	Osteoarthritis of the hip	3 (1 bilateral)
Total knee replacement	Osteoarthritis of the knee	4 (1 bilateral)
One-level discectomy	Herniated lumbar disc	2
Lumbar spinal fusion	Spondylolisthesis	2
Anterior cervical spinal fusion	Herniated disc	2
Irrigation and debridement with removal of hardware	Infection	6
Tumour resection/biopsy	Malignancy	6
Above-knee amputation	Malignancy	1

* one patient was managed non-operatively because of cardiac risks

cular accident. There were three patients who had their chemical prophylaxis stopped because of gastrointestinal haemorrhage and one because of a cerebrovascular accident. Mechanical prophylaxis (Venodyne foot pumps; Microtek Medical Inc., Columbus, Mississippi) was also used in these patients. Where only one limb was available for a foot pump, unilateral mechanical prophylaxis was used. This was the case in seven patients; two with a fractured calcaneum, three with an ankle fracture, one who underwent removal of hardware and one who had an above-knee amputation.

The operations that were undertaken are shown in Table II. One patient, a 72-year-old woman with a hip fracture, was managed non-operatively because of cardiac risk factors.

The post-operative hospital stay was unremarkable for 56 patients (96.6%). The overall mean length of stay was 17.5 days (3 to 60). No patient had a symptomatic pulmonary embolism after introduction of the filter. Two patients died during the post-operative period for reasons unrelated to venous thromboembolism. One had a cardiac arrest and one a respiratory arrest. Both patients were elderly, with many medical problems.

Of the 56 surviving patients, six (10.7%) were lost to follow-up. In the remaining 50 patients, 32 filters (64%) were removed without complication at a mean of 37.8 days (4 to 238) after placement. There were four filters (8%) that were retained secondary to thrombosis at the filter site, and four (8%) because of incorporation into the wall of the inferior vena cava as noted on a pre-retrieval venacavogram (Fig. 1). In ten patients (20%), the filter was left in place to continue as thromboembolic prophylaxis when chemical prophylaxis was contraindicated. This occurred in six patients with gastrointestinal bleeding and in four patients with a DVT or cerebrovascular accident.

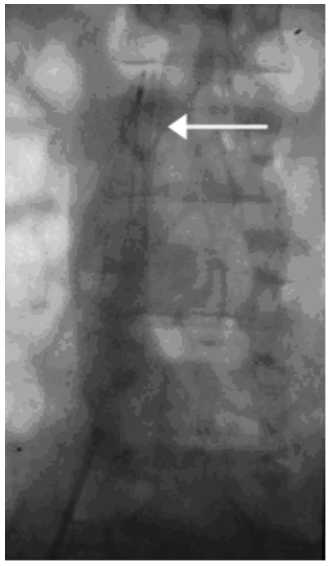

Fig. 1

A radiograph showing a retrievable inferior vena cava filter placed in a 32-year-old man who sustained multiple fractures in a motor vehicle accident. The filter was left *in situ* because of incorporation within the wall of the inferior vena cava.

Discussion

For high-risk orthopaedic patients, we found that placement of a retrievable inferior vena cava filter as an adjunct to standard chemical and mechanical prophylaxis was an effective means of preventing a pulmonary embolism. There was minimal morbidity associated with the placement and removal of the filters; the two deaths that occurred were unrelated to the filter. A total of 64% of the filters were removed at a mean of 37.8 days, while others were left *in situ* for up to 238 days, allowing them to serve as temporary prophylaxis and avoiding the development of long-term complications. Of the filters that were left *in situ*, 55.6% (10 of 18) were retained as primary thromboembolic prophylaxis.

The risk of venous thromboembolism in multiply-injured patients is high.[23,28,29] In a prospective evaluation of 349

patients admitted to a level 1 trauma centre, Geerts et al[23] reported that 58% had evidence of a DVT and 18% had proximal-vein thrombosis on venography. The patients who only had musculoskeletal injuries had even higher rates of DVT. Those with tibial and femoral fractures had a 77% and 80% incidence of thrombosis, respectively. These authors subsequently undertook a prospective, randomised investigation comparing low-dose heparin with LMWH for thromboembolic prophylaxis in these high-risk trauma patients.[26] They found that even with pharmacological prophylaxis, the rate of DVT remained significant, with an incidence of 44% and 31% for each treatment group, respectively. Similarly, Knudson et al,[28] when randomising 113 trauma patients to either sequential compression devices, or low-dose heparin, found that the rate of venous thromboembolic complications was 8% and 12%, respectively. Neither compression devices or subcutaneous low-dose heparin offered a significant reduction in the incidence of DVT compared with controls.[28,30]

Inferior vena cava filters offer the advantage of preventing pulmonary embolism in trauma patients when anticoagulation or compression devices are contraindicated, or when the patients are at a high risk despite prophylaxis. Filters may prevent pulmonary embolism in patients who have already suffered a DVT and prevent further embolism in those who have suffered a pulmonary embolism despite anticoagulation. Since the advent of the Greenfield filter (Boston Scientific, Natick, Massachusetts), several studies have shown a reduced incidence of pulmonary embolism when using permanent, indwelling filters in high-risk patients.[3,5,31-35] However, in a large randomised series, Decousus et al[1] showed a higher risk of DVT at two years follow-up in patients with an inferior vena cava filter compared with those without.

In a survey of over 600 trauma surgeons, it was estimated that the availability of a retrievable inferior vena cava filter would increase prophylactic placement from 29% to 53% when treating patients with multiple fractures of the lower limb.[36] Morris et al[37] reported that 4% of trauma patients received a retrievable filter compared with a historical series in which 2% of patients had a permanently placed filter. A more recent study[9] showed a threefold increase in the use of prophylactic filters at a single institution after the introduction of the retrievable inferior vena cava filter. Interestingly, before retrievable filters became available, 73% of the patients in this study undergoing filter placement met the study's high-risk criteria, compared with only 42% of patients meeting those criteria after the introduction of the retrievable filter.

Good results have been obtained with retrievable inferior vena cava filters. Hoff et al[7] showed no evidence of pulmonary embolism in 35 trauma patients in whom a retrievable filter was used; 74% of their patients had at least one orthopaedic injury, and 49% of patients had a pelvic fracture. Filters were subsequently removed in 51% of patients. Among the patients whose retrievable filters were retained, 11 (31.4%) had injuries that required prolonged immobility and four (11.4%) had thrombosis at the site of the filter at the time of attempted removal. In this study, patients with musculoskeletal injuries were more likely to have the filter retrieved (over 60%) than those with spinal cord, spine, chest or head injuries. In a retrospective evaluation of 147 patients receiving retrievable inferior vena cava filters, Looby et al[13] reported successful retrieval at a mean of 33.6 days in 80% of their intended retrieval cases (45 patients: 31% retrieval rate). Reasons for failed retrieval included incorporation of the filter into the wall of the inferior vena cava (five cases), extreme tilting of the filter (two cases) and filter-related thrombi (two cases). One pulmonary embolism occurred (0.7%). The reasons for leaving the filters *in situ* included an increased risk of thromboembolism due to underlying malignancy in 30 cases, poor prognosis due to comorbidities in four cases, advanced age in 26 patients, recurrent thromboembolism despite anticoagulation in 23 cases and a history of thromboembolism with a contraindication to chemical prophylaxis in 19 cases. Yamagami et al[18] similarly reviewed the use of 86 retrievable filters over a four-year period and reported no cases of pulmonary embolism. They described successful retrieval of the filter in 96% of 80 attempts after a mean implantation time of 13.4 days. Other studies[22,38,39] have reported lower retrieval rates and longer filter retention times. Karmy-Jones et al,[38] in a retrospective multicentre review of retrievable filters used in trauma patients, reported a 22% retrieval rate in 446 patients. Filters were placed a mean of six days after admission, and in the patients who underwent retrieval the mean retention time was 50 days. There were two cases of pulmonary embolism (0.4%). The primary reason for leaving the filter *in situ* was loss to follow-up (31%). Other reasons included prolonged immobilisation secondary to injury (30%), a history of thromboembolism despite anticoagulation (11%), the need for further surgery (6%), and patient refusal (3%). The ability to retrieve filters after a long period has been evaluated in two recent studies. Rosenthal et al[22] described successful retrieval after more than 25 weeks in 31 of 41 patients (76%). The mean retention time was 37.3 weeks (26 to 57.6). In all ten cases of failed retrieval, the filters were found to be excessively tilted. In a similar retrospective review, Binkert et al[39] described 13 cases of successful retrieval after implantation times ranging from 26 to 59.8 weeks.

Our findings are similar to those previously reported with the retrievable filter providing protection from pulmonary embolism in the high-risk period. The percentage of patients undergoing filter retrieval in our series (64%) is higher than in most series (10% to 93%).[7,10-12,14-18,37] Our radiologists make extensive efforts to educate both patients and referring physicians about the feasibility and benefits of filter removal, which may explain our higher rates of retrieval. However, a relatively high percentage of patients still had their filter left *in situ*, potentially exposing them to further risk.

Although there were no filter-related complications, reports of both insertion-related and longer term complications have been described.[40] Immediate and early complications, including filter misplacement, pneumothorax, haematoma, infection and insertion-site thrombosis, have been reported in 0.02% to 8.5% of cases.[40] Retrievable filters left *in situ* to act as primary prophylaxis, or secondary to technical issues preventing retrieval, assume the risks associated with permament filters. These include recurrent DVT, inferior vena cava thrombosis, filter migration, post-thrombotic syndrome and chronic venous stasis.[40]

The appropriate indications for the use of a retrievable inferior vena cava filter have been debated in the interventional radiology, critical care and trauma literature.[41-44] Recently, the British Committee for Standards in Haematology published guidelines for inferior vena cava filter placement.[40] According to these guidelines, filters are indicated in patients at increased risk of venous thromboembolism in whom anticoagulation is contraindicated; those who have a thromboembolic event despite adequate anticoagulation; pregnant patients with a thromboembolic event in whom anticoagulation is contraindicated; and pre-operative patients with a recent (within one month) venous thromboembolic event in whom anticoagulation must be interrupted. Other authors include prophylaxis in high-risk trauma and selective orthopaedic patients in their list of indications.[42,43] At our institution we recommend the insertion of a retrievable filter in orthopaedic patients under the following circumstances: when standard DVT prophylaxis, including mechanical and/or chemical methods may be contraindicated or deemed inadequate; patients with a history of venous thromboembolic events, particularly if the previous events were idiopathic, as these patients have an approximately 30% risk of a recurrence over an eight-year period;[45] patients with either a severely impaired cardiopulmonary reserve or acute cardiopulmonary decompensation on presentation, because in these high-risk patients an acute pulmonary embolism can be life-threatening; patients who have acute thromboembolism on presentation and require surgery; and patients with a thrombophilic disorder. The immediate investigation of a thrombophilic disorder in the high-risk orthopaedic patient requires blood tests for which the results may not be available for one week. This delay may be prohibitively long. Furthermore, a negative thrombophilia result does not exclude an underlying thrombophilic disorder.

The limitations of our study include the relatively small patient numbers and the retrospective nature. As it was an observational series, there was no control group. A future prospective randomised study may validate the findings. We focused on the in-hospital course of the patients, following them to the time of removal of the filter, potentially missing complications that occurred later. Additionally, six patients (10.3%) were lost to follow-up.

Retrievable inferior vena cava filters as an adjunct to chemical and mechanical prophylaxis appear to be a safe and effective option for high-risk patient populations.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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