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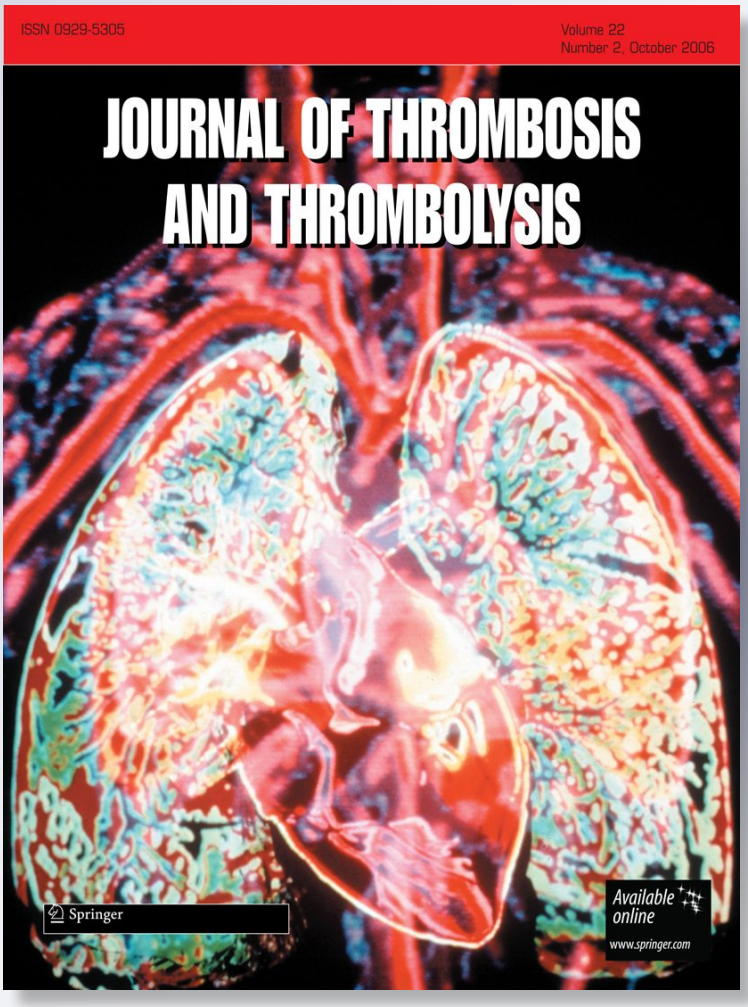
Journal of Thrombosis and Thrombolysis
A Journal for Translation, Application and Therapeutics in Thrombosis and Vascular Science

ISSN 0929-5305

J Thromb Thrombolysis
DOI 10.1007/s11239-011-0671-9



Springer

J Thromb Thrombolysis
DOI 10.1007/s11239-011-0671-9

Retrievable vena cava filters: a clinical review

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Abstract Venous thromboembolism (VTE), including deep vein thrombosis and pulmonary embolism (PE), is a major cause of morbidity and mortality. Parenteral anticoagulant treatment with full-dose unfractioned heparin, low-molecular-weight-heparin, or fondaparinux, followed by oral treatment with the vitamin K antagonists, is recommended for the majority of patients. However, in the presence of contraindications to anticoagulant treatment, bleeding complications during antithrombotic treatment, or VTE recurrences despite optimal anticoagulation, interruption of the inferior vena cava with a filter is a potential option aimed to prevent life-threatening PE. Currently, the vast majority of filters implanted worldwide are of the permanent type, but their use is associated with a number of long term complications. Non-permanent filters represent an important alternative, and in particular retrievable filters are an attractive option because they may be either left in place permanently or safely retrieved after a quite long period when they become unnecessary. In this review, we summarize the currently available literature regarding retrievable vena cava filters and we discuss current evidences on their efficacy and safety. Moreover, the appropriate indications for their use in daily clinical practice are reviewed.

Keywords Retrievable vena cava filters · Venous thromboembolism · Review

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Introduction

Full dose anticoagulation is the standard therapy of venous thromboembolism (VTE). In case of contraindications to anticoagulant treatment, bleeding complications during antithrombotic treatment, or VTE recurrences despite optimal anticoagulation, interruption of the inferior vena cava (IVC) with a filter can be performed to prevent life-threatening pulmonary embolism (PE) [1–4]. Currently, the vast majority of the filters worldwide implanted are of the permanent type [5–8]; nevertheless, placement of such filters presents a number of long term complications. Decousus et al. [9] demonstrated that in high-risk patients with proximal deep vein thrombosis (DVT), the initial benefit of IVC filters for the prevention of PE was counterbalanced by an excess rate of recurrent DVT after two years of follow-up. Moreover, one of the most important long-term complications of definitive filters is the thrombotic occlusion of the IVC, which is reported in 6 to 30% of cases [2]; other significant complications include vena cava perforation, filter dislocation, migration and rupture [4]. Thus, alternative strategies for IVC interruption are required, especially in patients with a long life expectancy and in whom the period of risk from anticoagulant therapy is short. Non-permanent filters are classified as temporary or retrievable devices [2]. Temporary filters remain attached to a wire or catheter that exits the skin; they are

Published online: 13 January 2012

often difficult to manage and present frequent complications such as thrombosis, infections or migrations. They must be removed within few days of placement, that is often not enough to solve the clinical problem that had led to their placement. Retrievable filters are a new generation of IVC filters and may represent a more attractive option because they may be either left in place permanently or safely retrieved after a quite long period when they become unnecessary [10, 11].

The purpose of the present review is to summarize the currently available literature regarding retrievable IVC filters, discussing on their efficacy and safety and assessing the appropriate indications for their use. The available results of the most important studies on retrievable filters are summarized in Table 1.

Gunther Tulip filter

The Gunther Tulip filter consists of four struts of stainless wheels with hooks at the end acting as anchors. The filter can be placed either from the femoral or the jugular access, and retrieval is from the right jugular site [12]. In the registry of the Canadian Interventional Radiology Association [12] 91 filters were placed in 90 patients; the main reason for implantation was contraindication to anticoagulation. Retrieval was attempted in 53 patients and was successful in 52 (98%); mean implantation time was 9 days (range 2–25 days). In the remaining 39 patients retrieval was not attempted because of ongoing contraindication to anticoagulation ($n = 17$) and large trapped emboli within the filter ($n = 10$). Two patients developed filter occlusion and 8% of the patients did require insertion of a permanent filter after the temporary filter had been removed. Other reports have demonstrated the feasibility of retrieval of Gunther Tulip IVC device, after a maximum implantation time of 139 days (mean 14 days), with a low rate of recurrent PE while the filter was in place (0–3.6%); IVC thrombosis occurred in 0–9.6% [13–17].

ALN filter

The ALN filter is a hydrodynamic steel retrievable IVC filter. It has six short legs that ensure its adherence to the IVC walls, and three long legs that guarantee the correct central positioning into the vena cava [18]. ALN filter can be placed from the femoral, brachial or jugular vein approach, and can be retrieved only from the jugular approach.

Table 1 Main results of retrievable filters studies

Study	Filter	Number of filters removed and placed	Mean duration between filter placement and retrieval (days)	Retrieval technical success (%)
Ponchon [13]	Gunther Tulip	8 of 10	12; range 8–14	88
Millward et al. [12]	Gunther Tulip	52 of 91	9; range2–25	98
Offner et al. [14]	Gunther Tulip	37 of 44	14; range 3–30	97
Asch [26]	Recovery	24 of 32	53; range 5–134	100
Pieri et al. [18]	ALN	7 of 18	63; range 49–192	100
Barral et al. [19]	ALN	13 of 54	22; range 11–90	100
Pancione and Mecozzi [20]	ALN	28 of 96	72; range 30–120	100
Morris et al. [15]	Various	14 of 130	19; range 11–41	93
Imberti et al. [21]	ALN	14 of 30	123; range 30–345	78
Grande et al. [27]	Recovery	14 of 107	150; range 0–419	93
Oliva et al. [30]	OptEase	21 of 27	11; range 5–14	100
Rosenthal et al. [34]	OptEase	40 of 40	16; range 3–48	100
Ray et al. [17]	Various	80 of 197	19; range 1–139	85
Stefanidis et al. [28]	Various	47 of 83	142; range 17–475	87
Mismetti et al. [22]	ALN	56 of220	51; range 6–352	93
Karmy et al. [48]	Various	90 of 446	28.2 ± 26.3	78
Pancione et al. [23]	ALN	71of 276	74; range 30–130	93
Pellerin et al. [24]	ALN	122 of 123	93; range 6–722	99
de Villiers et al. [29]	Recovery	22 of 54	48; range 7–90	96
Oliva et al. [30]	Recovery	51 of 120	53; range 7–242	100
Binkert et al. [32]	Recovery	61of 100	140; range 5–300	95
Onat et al. [36]	OptEase	124 of 228	11; range 4–23	91
Kalva et al. [37]	OptEase	14 of 71	9; range 5–21	85

A number of trials have investigated the efficacy and safety of long-term retrieval of the ALN device [18–24].

Pieri et al. [18] evaluated this device in 18 patients with pelvic trauma ($n = 11$), hip replacement ($n = 3$) or for primary prophylaxis before surgery in patients with very high thromboembolic risk ($n = 4$). Filter retrieval was attempted in 7 patients, being successful in all of them; ALN was removed after a mean permanence of 63 days (range 49–192) with no cases of PE, filter thrombosis or trapped emboli inside the filters.

A French trial included 54 patients [19] submitted to a ALN insertion; after a median follow-up of 4.3 months, one case of PE and two of thrombosis of the filter were registered, while in 13 of 13 cases filter retrievals were successful after a median implantation period of 22 days (range 11–90 days).

Pancione and Mecozzi [20] safely and easily implanted ALN filters in 96 patients; the filter was successfully removed in all the 28 patients in whom the removal was attempted after a mean implantation time of 72 days (range 30–120 days).

A prospective, multicenter, clinical trial enrolled 30 patients undergoing placement of ALN filters [21]. Indications for implantation were acute VTE with contraindication to anticoagulation in 26 cases (86%), primary prophylaxis after major trauma in 2 cases (7%) or before surgery in 2 patients with very high thromboembolic risk (7%). The filter was successfully placed in all patients. After a median follow-up of 18.2 months, there were three cases (10%) of trapped emboli within the filter, one case (3%) of asymptomatic migration of the filter towards the heart and two DVT recurrences (7%). ALN retrieval was attempted through transjugular approach in 18 patients (60%) and the manoeuvre was successful in 14 of them. Interestingly, when the decision of removal was taken within 3 months after the implantation, the retrieval was possible in 10 of 10 patients (100%); otherwise, when the attempt of retrieval was performed more than 3 months after the implantation, the retrieval was possible only in four of the eight patients (50%).

220 consecutive patients scheduled for placement of a ALN filter were included in a prospective cohort study with a 18-month follow-up [22]. Main indications for IVC filtration were recurrent VTE despite adequate anticoagulation therapy (10.9%), transient bleeding event (21.8%), definitive contraindication for anticoagulant therapy (26.8%) or obligation to stop anticoagulant therapy due to major surgery, major trauma, or invasive procedures (37.7%). The median duration of filter implantation was very long (166 days; first to third quartiles, 34 to 478 days). During follow-up, 17% (37 of 217 patients) had at least one VTE event. Filter retrieval was attempted in 25.3% of the patients after a median of 51 days (range 6 to 352 days) and was successful in 92.7 of them.

An Italian study reported the results of a multicentre experience concerning ALN permanent/removable vena cava filters in a total of 276 patients [23]. The filter was removed in 43 patients after 3 months and in 28 patients after 6 months. In one case, due to incomplete opening of the filter, immediate percutaneous removal was performed and another filter was positioned. In five cases it was not possible to remove the filter, in one case due to inexperience and in the remaining cases due to adhesion of the head or claws of the filter to the wall of the vein.

A multicenter study evaluated the feasibility and results of percutaneous removal of the ALN removable filter in a large patient cohort [24]. 123 consecutive patients were referred for percutaneous extraction of the ALN filter at three centers. Filter removal was attempted after an implantation period of 93 ± 15 days (range 6–722 days); successful extraction was achieved in all but one case. No immediate IVC complications were observed according to the postimplantation cavography.

Recovery filter

The Recovery Nitinol Filter (RNF) is composed of 12 nitinol wires that extend from a nitinol sleeve and has six arms and six legs [25].

Efficacy and safety of the Recovery filter were evaluated in a preliminary study of 32 patients [26]. RNF was successfully placed in 32 patients with no complications related to filter insertion. Trapped thrombi were seen within the filter in seven cases. In all the patients RNF was successfully retrieved after a mean implantation period of 53 days (range 5–134 days). In two patients the filter was kept in place for more than 100 days; notwithstanding, the removal after such a long period was easily feasible and safe. There were no episodes of PE or insertion-site thrombosis.

In a recent retrospective clinical trial 107 RNFs were implanted in 106 patients with indication for temporary IVC filtration [27] such as acute VTE with contraindication to anticoagulation (33 cases), complications of anticoagulation (8 cases), poor cardiopulmonary reserve (6 cases), large clot burden (3 cases), PE while receiving anticoagulation (1 case). In the other 55 patients filter was inserted as primary prophylaxis without proven VTE, with multiple indications for placement. Three patients (2.8%) had symptomatic PE during placement of the filter; neither caval thrombosis nor symptomatic filter migration occurred. RNF removal was attempted only in 15 of 106 patients (14%) at a mean of 150 days after placement (range 0–419 days); the manoeuvre was successful in 14 of 15 patients, while in one patient removal was impossible at 210 days after placement. Favourable results were also reported by Stefanidis et al. [28] who implanted 58 RNF mostly for trauma. Successful removal was 85% (29/34) after a mean of 200 days (17–466).

In a recently published series, 54 Recovery filters were placed in Australian centres [29]. The most common indication for filter placement in this series was established thromboembolic disease with a temporary contraindication to anticoagulation. Twenty-two filters were successfully retrieved without complication. In one case, it was not possible to retrieve the filter because of extensive contained thrombus. No complication was experienced at filter placement or retrieval; however, a fatal complication occurred as a result of filter migration. Mean time from placement to retrieval was 48 days (range 7–90 days).

A Recovery G2 inferior vena cava (IVC) filter was placed in 120 consecutive patients in a single center [30]. Patients had DVT ($n = 63$), PE and DVT ($n = 55$), and high risk for PE without recent thromboembolic disease ($n = 2$). Indications for filter placement included contraindication to anticoagulation ($n = 106$), failure of anticoagulation ($n = 11$), and prophylaxis in addition to anticoagulation ($n = 3$). In the 51 patients who met the criteria for filter removal, filter tilting (>15 degrees) was seen in six patients (12%), small thrombi were seen in filters of 15 patients (29%), presumed caval penetration was seen in nine patients (18%), and caudal filter migration was seen in two patients (3.9%). There were no fractures or cephalic migrations. Removal attempts were successful in all 51 patients (100%). The mean implantation time was 53.4 days (range 7–242 days).

Recovery ($n = 128$) and G2 ($n = 113$) filters were placed in the IVCs of 241 patients with the intent of retrieval [31]. Filter placement was technically successful in 95% of Recovery filters ($n = 122$) and 100% of G2 filters ($n = 113$). Recovery filter retrieval was attempted in 55% of patients ($n = 71$) at a mean of 228 days (range 0–838 days) after filter placement. G2 filter retrieval was attempted in 55% of patients ($n = 62$) at a mean of 230 days (range 7–617 days) after filter placement. Technical success rates of filter retrieval were 94% ($n = 67$) and 97% ($n = 60$) in the Recovery and G2 filter groups, respectively. The G2 filter group had significantly fewer cases of (i) filter tilt at placement, (ii) filter tilt at attempted retrieval, and (iii) filter fracture than the Recovery filter group. In the G2 filter group, there was a significantly higher technical success rate of filter placement and there were more cases of caudal filter migration than in the Recovery filter group.

In a prospective, multicenter study 100 patients with temporary indication for caval interruption with Recovery G2 filter were enrolled [32]. There were 67 men and 33 women with a mean age of 52.1 years (range 19–82 years). Indications for filter placement were trauma ($n = 56$), perioperative risk ($n = 16$), and medical indications ($n = 28$). Forty-two patients had VTE at filter placement. Fifty-eight filters were placed prophylactically. Retrieval was attempted in 61 patients. Fifty-eight of the 61 filters (95%) were successfully retrieved after a mean dwell time of 140 days (range 5–300 days). In all failed retrievals, the filter tip was against the caval wall. Although there were no cases of cranial migration, caudal migrations were observed in 12% of cases (10 of 85 patients with a complete data set). Other device-related complications included filter fracture (1/85, 1.2%), filter tilt of more than 15 degrees (15/85, 18%), and leg penetration (16/61, 26%). The recurrent pulmonary embolism (PE) rate was 2%, with no PE in the 30-day period after filter retrival.

OptEase filter

The OptEase filter is a nitinol-MRI compatible filter and it is the only filter retrievable from a femoral vein approach; the filter has a symmetrical double-basket design with six straights struts connecting the proximal and distal baskets [33].

Several trials have recently investigated the efficacy and safety of retrieval of the OptEase device [33–37].

Oliva et al. [33] enrolled in a multicenter study 27 patients; inclusion criteria were acute VTE with a contraindication to anticoagulation ($n = 23$) and primary prophylaxis in very high thromboembolic risk patients ($n = 4$). Retrieval was planned in 21 patients and in all of them it was uneventful; in the remaining 6 patients removal was not attempted as a result of ongoing contraindication to anticoagulation ($n = 3$), large trapped emboli within the filter ($n = 2$) and poor patient prognosis ($n = 1$). No adverse events were seen during a mean time of implantation of 11.1 days (range 5 to 14). In a multicenter clinical trial 40 patients with clinical indication for temporary IVC filtration underwent insertion and retrieval of OptEase [34]. No symptomatic PE, caval thrombosis or filter migration occurred. In all the patients OptEase filter was successfully removed after a mean of 16.4 days from insertion (range 3 to 28 days).

A non-randomized, multicenter trial prospectively evaluated all patients receiving an OptEase vena cava filter for the prevention of PE [35]. A 1-month postimplantation follow-up examination was performed to determine potential filter migration and the presence of symptomatic thrombosis of the inferior vena cava (IVC) or lower extremities. At 6-month postimplantation follow-up, patients were again assessed for the safety and stability of the filter and any clinical evidence of symptomatic thrombosis. One hundred fifty patients were enrolled in this study. Fifty-five patients (36.6%) were unable to complete all of the necessary follow-up at 6 months. At 1 month, filter migration and filter-related symptomatic deep vein thrombosis was observed in one patient each (0.9 and 0.8%, respectively). At 6 months, no new cases of filter migration or filter-related symptomatic thrombosis were

observed. Filter tilting (≥15 degrees off the IVC axis) was observed in one patient at baseline (0.7%), four patients at 1-month follow-up (3.6%), and three patients (11.4%) at 6-month follow-up. Incidental findings on follow-up radiographs included filter fracture in two patients (1.8%) at 1 month and in one additional patient (4.3%) at 6 months. There were no clinical sequelae associated with the filter fracture.

In a single center study, OptEase (permanent/retrievable; $n = 228$) or TrapEase (permanent; $n = 30$) vena cava filters were placed in 258 patients [160 female and 98 male; mean age 62 years (range 22 to 97)] [36]. Indications were as follows: prophylaxis for PE ($n = 239$), contraindication for anticoagulation in the presence of PE or DVT ($n = 10$), and development of PE or DVT despite anticoagulation ($n = 9$). Clinical PE did not develop in any of the patients. However, radiologic signs of segmental PE were seen in 6 of 66 patients with follow-up imaging data. Migration or fracture of the filter or cava perforation was not seen in any of the patients. Except for a single case of asymptomatic total cava thrombosis, no thrombotic occlusion was observed. One hundred forty-one patients were scheduled to undergo filter removal; however, 17 of them were not suitable for such based on venography evaluation. Removal was attempted in 124 patients and was successful in 115 of these (mean duration of retention 11 days [range 4 to 23]). Nine filters could not be removed.

In a single centre retrospective study, data of 71 patients who received an OptEase filter were reviewed [37]. Thirty-nine (55%) patients had symptoms of VTE before filter placement. The indications for filter included contraindication to anticoagulation in 31 (44%) patients, prophylaxis against PE in 29 (41%) patients, and failure of anticoagulation in 11 (15%) patients. Seventy (99%) filters were placed successfully. Retrieval was attempted in 14 (20%) patients, and 12 filters were successfully retrieved. Clinical follow-up was available for 20 ± 21 months. Symptoms of postfilter PE and DVT occurred in 15% ($n = 11$) and 10% ($n = 7$) patients, respectively. None of these patients had computed tomography (CT)-proven PE, and only one had ultrasound-proven new DVT. One patient had symptomatic IVC occlusion. Follow-up abdominal CT in 20 patients showed thrombus in the filter in two of them. There were no instances of filter migration, filter tilt, or caval wall penetration.

Indications for filter implantation

Contraindications to anticoagulation

According to the 8th ACCP Evidence-Based Clinical Practice Guidelines on Antithrombotic and Thrombolytic Therapy [3, 38], IVC filter placement is recommended when there is a contraindication or complication of anticoagulant therapy in a patient with proximal DVT or PE. Frequently, the contraindication to anticoagulation is temporary (i.e. haemorragic stroke, trauma) and antithrombotic therapy can be started as soon as it is resolved; for this reason, retrievable IVC filters may be the ideal "bridge" to anticoagulation for these patients [39]. Main indications for retrievable vena cava filtration are reported in Table 2.

Trauma

Thromboprophylaxis is an important issue in patients with major trauma [40], and PE is the cause of death in 20% of severely injured patients [41]. Management of thromboprophylaxis may be problematic because of the limited efficacy of standard prevention (low dose heparin, sequential compression devices) and concern about potential bleeding complications associated with anticoagulant treatment. For these reasons, in the last few years an increasing interest in the use of IVC filter for PE prophylaxis in this clinical setting has been observed [38]. Unfortunately, there are no randomized trials demonstrating a clear benefit of IVC insertion in trauma patients [40–48]. Three small studies have reported a low rate of PE in patients with severe polytrauma who underwent prophylactic IVC filter insertion [46–48]. In a large prospective study 127 multitrauma patients underwent a prophylactic placement of a retrievable IVC filters (Gunther Tulip $n = 49$; Recovery $n = 41$; OpTease $n = 37$), without any complication [45]. Sixty-six patients underwent uneventful retrieval of IVC filters after 5–116 days from implantation (mean 71 days), while in 45 retrieval was not attempted (41 due to contraindication to anticoagulation and 4 because of trapped emboli within the filter). Finally, a retrospective review of 446 trauma patients receiving retrievable IVC filters in 21 different participating centers was performed (Gunther Tulip $n = 152$; Recovery $n = 224$; OpTease $n = 37$) [48]. Of interest, only 22% of the implanted filters were retrieved; the main reason for which IVC filters were not removed was because of loss to follow-up (31%). Of 115 patients in whom retrieval was attempted, removal

Table 2 Indications for retrievable IVC filters implantation

Appropriate indication
Temporary contraindication to anticoagulation
Potential indications
Prophylaxis in high risk trauma patients
Thrombolysis of ilio-caval thrombus
Pregnancy
Prophylaxis in high risk major orthopedic surgery
Prophylaxis in bariatric surgery

failed for technical reasons in 15 patients and because of significant residual thrombus within the filter in 10 patients.

Thrombolytic therapy

Systemic thrombolysis of proximal DVT and IVC thrombi has resulted in several cases of fatal and non fatal PE; therefore, prophylactic placement of IVC filters has been proposed as a strategy to prevent PE in patients undergoing thrombolysis. A European multicenter registry of temporary IVC filters used during systemic thrombolysis showed an incidence of fatal PE of 2.1% and of non fatal PE of 1.6% [49]. To our knowledge, no data have been published regarding retrievable IVC filters during thrombolysis for DVT; because of their ease of use and of their advantages, these devices appear as potentially attractive alternatives to temporary filters. On the other hand, thrombolysis is in principle contraindicated as a first approach to DVT treatment [3], thus the potential use of filters in this setting would be extremely limited.

Pregnancy

The overall incidence of VTE complications during pregnancy ranges from 0.2 to 1.2%, and is even higher during the puerperium [50]. Since pregnancy is typically a temporary risk factor for VTE, the use of a non-permanent filter is particularly appealing when anticoagulation is contraindicated. In a multicenter study, about 3% of all temporary filters inserted were placed in pregnant women who were undergoing caesarean section and thrombectomy [51]. Few case reports showed that retrievable IVC filters offer a safe and effective prevention to PE during pregnancy and puerperium and can be removed without complications [52, 53]. On the other hand, there are no strong data supporting the routine use of IVC filters in patients suffering from acute DVT during pregnancy and this device should be reserved for selected and specific situations.

Major surgery associated with a high risk of DVT

Patients undergoing major orthopaedic surgery such as hip and knee replacement carry a very high risk of VTE complications [38]. Several case series showed the efficacy of IVC filters in the prevention of PE in orthopaedic patients, but none of these studies included a control group and follow-up was of limited intensity and duration [23]. Furthermore many recent advances in pharmacological prophylaxis (low-molecular weight heparin, synthetic factor Xa and thrombin inhibitors) have contributed to significantly reduce the risk of VTE in this setting. Retrievable filters remain a useful option for highly selected cases, i.e. patients at very high thromboembolic risk because of a previous, recent massive PE or recurrent VTE episodes or patients with a major contraindication to pharmacologic therapy [21].

PE is considered the leading cause of death after bariatric surgery and common pharmacologic prophylactic strategies have not been adequately tested in morbidly obese patients [42, 54]. Placement of IVC filters has become a common prophylactic strategy among some bariatric surgeons, even if no prospective randomized clinical trials have compared IVC filters with alternative methods. However, filter placement can be challenging in these patients, especially in the super obese (BMI $>$ 60). In conclusion, there are no data supporting the routine use of retrievable IVC filters in bariatric patients, and this device should be reserved for specific situations.

Filter complications

The most important filter complications are reported in Table 3.

Filter occlusion and inferior vena cava thrombosis

Occlusion of the filter is the most frequent complication of vena cava filters and its incidence varies from 6 to 30% of cases [39]. The reasons for this complication include thrombogenicity of the device, natural cephalic progression of DVT from the lower limb and entrapment of emboli within the filter. Thrombosis of the filter and vena cava occlusion may be associated with important clinical side effects, including decreased protection against PE, migration of the filter, post-thrombotic syndrome and chronic venous stasis. New generation filters offer the advantage of a lower thrombogenicity compared with older ones.

Lower extremity vein thrombosis and post-thrombotic syndrome

Vena cava filters themselves have sometimes been observed to obstruct blood flow and contribute to an increase of

Table 3 Main complications of inferior vena cava filters

Complication	Rate (%)
Complications from insertion	4–11
Insertion site thrombosis	2–28
IVC thrombosis	6–30
Filter migration	3–69
IVC perforation	9–24
Post-thrombotic syndrome	5–70

recurrence of DVT of the lower extremity [9, 55]. For these reason, the ACCP guidelines recommend, if the filter is positioned as an alternative to anticoagulation, beginning of adequate anticoagulant therapy as soon as possible if the risk of bleeding resolves [3]. Otherwise, the optimal duration of anticoagulation in patients with permanent or optional filter that is left in situ is still uncertain. A recently published cohort study followed patients who had VTE, followed by treatment with permanent IVC filter placement and were anticoagulated long-term as soon as safety allowed [55]. Patients underwent annual physical examinations and ultrasound surveillance of the lower extremity deep veins and of the IVC filter site. Symptomatic DVT occurred in 24 of 121 patients (20%; 95% CI, 14–28%); symptomatic PE (one fatal) was diagnosed in six patients (5%; 95% CI, 2–10%). There were 45 episodes of filter clot in 36 patients (30%; 95% CI, 22–38%). The rate of major bleeding (6.6%) was similar to that of a concurrent persistently anticoagulated cohort without IVC filters (5.8%). Thus, the authors suggest indefinite anticoagulation to IVC filter recipients if contraindications to anticoagulation remit. On the contrary, other data of the literature, although limited, do not seem to show significant differences in the risk of DVT recurrences after IVC filter placement with or without anticoagulation [56]. To sum up, in absence of strong evidence in the literature and waiting for the results of well-designed clinical trials, patients with IVC filter should receive anticoagulation therapy according to current guidelines in any specific clinical situation; it is not suggested to continue indefinite anticoagulation just because the filter is still present. Finally, the association of vena cava filters with an increase of post-thrombotic syndrome is still matter of debate; the available data suggest the potential risk of post-thrombotic syndrome during long-term follow-up in patients with permanent IVC filters [9, 57].

Vena cava perforation

Vena cava perforation is a usually asymptomatic complication, and without substantial clinical importance. Frequently, it is only a radiological finding which occurs when filter components extend more than 3 mm outside of the wall of the IVC [58]. More rarely, bleeding complications are associated with vena cava perforation, usually when the filter leg is withdrawn leaving an open hole; other severe consequences have been rarely reported [59].

Filter migration

The migration of the filter towards the heart is a potentially life-threatening complication of IVC filters, even if, in the majority of cases, migration is minor and does not result in any significant morbidity [21]. A multicenter registry found that temporary IVC filters had a dislocation rate of 4.8%; no death due to this complication was reported [49]. A recently published paper reported a high rate of strut fracture (16%) and fragments embolization (25%) of the Bard retrievable IVC filter; of interest, three out of 28 patients experienced life-threatening cardiac complications related to migration of fragments to the heart [60].

Conclusions

Concerns regarding the long term safety of permanent IVC filters and the problematic management of temporary devices have created significant clinical interest in using retrievable IVC filters to provide temporary protection against PE. The results of our review support the important role of retrievable filters in the management of selected patients with VTE. Retrievable filters are a very attractive alternative to either permanent or temporary filters, due to their easier management and the possibility to be left in place for a long time and removed when they become unnecessary. This optimism must be tempered by important unresolved issues, including the appropriate maximum implantation time, the possibility to safely and efficaciously remove the filters without being compromised by entrapped clots, and the use of anticoagulation during the implantation and periremoval periods [10, 11]. In addition, so far the real benefit associated with the use of retrievable filters relies only on limited observational data and up-to-date rigorous clinical trials are lacking. Well conducted large prospective cohort studies or randomized trials are strongly warranted to definitely clarify the beneficial role of these devices.

References

1. White RH (2003) The epidemiology of venous thromboembolism. Circulation 107:I-4–I-8
2. Dentali F, Ageno W, Imberti D (2006) Retrievable vena cava filters: clinical experience. Curr Opin Pulm Med 12:304–309
3. Kearon C, Kahn SR, Agnelli G et al (2008) American College of Chest Physicians. Antithrombotic therapy for venous thromboembolic disease: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th edition). Chest 133(6 Suppl):454S–545S
4. Imberti D, Prisco D (2008) Retrievable vena cava filters: key considerations. Thromb Res 122:442–449
5. Young T, Tang H, Hughes R (2010) Vena caval filters for the prevention of pulmonary embolism. Cochrane Database Syst Rev 2(2):CD006212
6. Athanasoulis C (2000) Inferior vena cava filters: review of a 26-year single center clinical experience. Radiology 216:54–66
7. Stein PD, Kayali F, Olson RE (2004) Twenty-one year trends in the use of inferior vena cava filters. Arch Intern Med 164: 1541–1545

8. Spencer FA, Bates SM, Goldberg RJ et al (2010) A population-based study of inferior vena cava filters in patients with acute venous thromboembolism. Arch Intern Med 170:1456–1462
9. Decousus H, Leizorovicz A, Parent F et al (1998) A clinical trial of vena cava filters in the prevention of pulmonary embolism in patients with proximal deep-vein thrombosis. N Engl J Med 338:409–415
10. Duszak R, Parker L, Levin D et al (2011) Placement and removal of inferior vena cava filters: national trends in the medicare population. J Am Coll Radiol 89:483–489
11. U.S. Food and Drug Administration (2010) Removing retrievable inferior vena cava filters: initial communication. Available at http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm221676.htm. Accessed 1 Nov 2010
12. Millward SF, Oliva VL, Bell SD et al (2001) Gunther Tulip retrievable vena cava filter: results from the registry of the Canadian Interventional Radiology Association. J Vasc Interv Radiol 12:1053–1058
13. Ponchon M (1999) Temporary vena cava filtration. Preliminary experience with removable vena cava filters. Acta Clin Belg 54: 223–228
14. Offner PJ, Hawkes A, Madayag R et al (2003) The role of temporary inferior vena cava filters in critically ill surgical patients. Arch Surg 138:591–595
15. Morris CS, Rogers FB, Najarian KE et al (2004) Current trends in vena cava filtration with the introduction of a retrievable filter at a level I trauma center. J Trauma 57:32–36
16. Neuerburg GM, Gunther RW, Vorwerk D et al (1997) Results of a multicenter study of the retrievable Tulip vena cava filters: preliminary early clinical experience. Cardiovasc Intervent Radiol 20:10–16
17. Ray CE, Mitchell E, Zipser S et al (2006) Outcomes with retrievable inferior vena cava filters: a multicenter study. J Vasc Interv Radiol 17:1595–1604
18. Pieri S, Agresti M, Morucci M et al (2003) Optional vena cava filters: preliminary experience with a new vena cava filter. Radiol Med 105:56–62
19. Barral F, Tardy B, Guillot K et al (2003) Clinical experience with optional cava filters. J Thromb Haemost 1(Suppl 1):OC441
20. Pancione L, Mecozzi B (2004) Permanent/removable vena cava filter ALN (France): our experience with 96 patients. Abstract SSJ03, Proceedings of 90th Annual Meeting of the Radiological Society of North America, Chicago, 28 Nov–3 Dec 2004
21. Imberti D, Bianchi M, Farina A et al (2005) Clinical experience with retrievable vena cava filters: results of a prospective observational study. J Thromb Haemost 3:1370–1375
22. Mismetti P, Rivron-Guillot K, Quenet S et al (2007) A prospective long-term study of 220 patients with a retrievable vena cava filter for secondary prevention of venous thromboembolism. Chest 131:223–229
23. Pancione L, Pieri S, Agresti P et al (2006) Use of the ALN permanent/removable vena cava filter. A multi-centre experience. Minerva Chir 61:501–507
24. Pellerin O, Barral FG, Lions C et al (2008) Early and late retrieval of the ALN removable vena cava filter: results from a multicenter study. Cardiovasc Intervent Radiol 31:889–896
25. Rosenthal D, Wellons ED, Lai KM, Bikk A, Henderson VJ (2006) Retrievable inferior vena cava filters: initial clinical results. Ann Vasc Surg 20:157–165
26. Asch MR (2002) Initial experience in humans with a new retrievable inferior vena cava filter. Radiology 225:835–844
27. Grande WJ, Trerotola SO, Reilly PM et al (2005) Experience with the Recovery filter as a retrievable inferior vena cava filter. J Vasc Interv Radiol 16:1189–1193
28. Stefanidis D, Paton BL, Jacobs DG et al (2006) Extended interval for retrieval of vena cava filters is safe and may maximize protection against pulmonary embolism. Am J Surg 192:789–794
29. de Villiers L, Mackenzie S, Gibbs H et al (2008) Initial Australian experience with the recovery inferior vena cava filter in patients with increased risk of thromboembolic disease. J Med Imaging Radiat Oncol 52:124–129
30. Oliva VL, Perreault P, Giroux MF et al (2008) Recovery G2 inferior vena cava filter: technical success and safety of retrieval. J Vasc Interv Radiol 19:884–889
31. Cantwell CP, Pennypacker J, Singh H et al (2009) Comparison of the recovery and G2 filter as retrievable inferior vena cava filters. J Vasc Interv Radiol 20:1193–1199
32. Binkert CA, Drooz AT, Caridi JG et al (2009) Technical success and safety of retrieval of the G2 filter in a prospective, multicenter study. J Vasc Interv Radiol 20:1449–1453
33. Oliva VL, Szatmari F, Giroux MF et al (2005) The Jonas study: evaluation of the retrievability of the Cordis OptEase inferior vena cava filter. J Vasc Interv Radiol 16:1439–1445
34. Rosenthal D, Swischuk JL, Cohen SA, Wellons ED (2005) OptEase retrievable inferior vena cava filter: initial multicenter experience. Vascular 13:286–289
35. Ziegler JW, Dietrich GJ, Cohen SA et al (2008) PROOF trial: protection from pulmonary embolism with the OptEase filter. J Vasc Interv Radiol 19:1165–1170
36. Onat L, Ganiyusufoglu AK, Mutlu A et al (2009) OptEase and TrapEase vena cava filters: a single-center experience in 258 patients. Cardiovasc Intervent Radiol 32:992–997
37. Kalva SP, Marentis TC, Yeddula K et al (2011) Long-term safety and effectiveness of the "OptEase" vena cava filter. Cardiovasc Intervent Radiol 34:331–337
38. Geerts WH, Bergqvist D, Pineo GF et al (2008) Prevention of venous thromboembolism. American College of Chest Physicians. Antithrombotic therapy for venous thromboembolic disease: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest 133(6 Suppl): 381S–453S
39. Imberti D, Ageno W, Carpenedo M (2006) Retrievable vena cava filters: a review. Curr Opin Hematol 13:351–356
40. Geerts WH, Code JI, Jay RM et al (1994) A prospective study of venous thromboembolism after major trauma. N Engl J Med 331: 1601–1606
41. Sevitt S (1968) Fatal road accidents: injuries, complications, and causes of death in 250 subjects. Br J Surg 55:481–505
42. Rutherford RB (2005) Prophylactic indications for vena cava filters: critical appraisal. Semin Vasc Surg 18:158–165
43. Imberti D, Squizzato A, Ageno W (2005) A survey of thromboprophylaxis management in patients with major trauma. J Pathophysiol Haemost Thromb 34:249–254
44. Rectenwald JE (2005) Vena cava filters: uses and abuses. Semin Vasc Surg 18:166–175
45. Gosin IS, Graham AM, Ciocca RG et al (1997) Efficacy of prophylactic vena cava filters in high risk trauma patients. Ann Vasc Surg 11:100–105
46. Rogers FB, Shackford SR, Ricci MA et al (1995) Routine prophylactic vena cava filter insertion in severely injured patients decreases the incidence of pulmonary embolism. J Am Coll Surg 180:641–647
47. Spain DA, Richardson JD, Polk HC et al (1997) Venous thromboembolism in the high-risk trauma patient: do risks justify aggressive screening and prophylaxis? J Trauma 42:463–467
48. Karmy-Jones R, Jurkovich G, Velmahos G et al (2007) Practice patterns and outcomes of retrievable vena cava filters in trauma patients: an AAST multicenter study. J Trauma 62:17–25
49. Lorch H, Welger D, Wagner V et al (2000) Current practice of temporary vena cava filter insertion: a multicenter registry. J Vasc Intervent Radiol 11:83–88
50. Bates SM, Greer IA, Pabinger I et al (2008) Venous thromboembolism, thrombophilia, antithrombotic therapy and pregnancy.

American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th edition). Chest 133(6 Suppl):844S–886S
51. Neil AM, Appleton DS, Richards P (1997) Retrievable inferior vena cava filters for thromboembolic disease in pregnancy. Br J Obstet Gynaecol 104:1416–1417
52. Neri E, Civeli L, Benvenuti A et al (2002) Protected ileofemoral venous thrombectomy in a pregnant woman with pulmonary embolism and ischemic vein thrombosis. Tex Heart Inst J 29: 130–132
53. Ishikawa T, Okabe T, Ogawa K et al (2003) Usefulness of a second temporary vena cava filter for preventing acute pulmonary thromboemblism. Circ J 67:718–720
54. Rajasekhar A, Crowther M (2010) Inferior vena caval filter insertion prior to bariatric surgery: a systematic review of the literature. J Thromb Haemost 8:1266–1270
55. Hajduk B, Tomkowski WZ, Malek G, Davidson BL (2010) Vena cava filter occlusion and venous thromboembolism risk in persistently anticoagulated patients: a prospective, observational cohort study. Chest 137:877–882
56. Pons M, Riglietti A, Van den Berg JC (2010) The role of vena cava filters in the management of venous thromboembolism. J Cardiovasc Surg 51:355–364
57. The PREPIC Study Group (2005) Eight-year follow-up of patients with permanent vena cava filters in the prevention of pulmonary embolism. Circulation 112:416–422
58. Failla PJ, Reed KD, Summer WR, Karam GH (2005) Inferior vena caval filters: key considerations. Am J Med Sci 330:82–87
59. Brender E (2006) Use of emboli-blocking filters increases, but rigorous data are lacking. JAMA 295:989–990
60. Nicholson W, Nicholson WJ, Tolerico P et al (2010) Prevalence of fracture and fragment embolization of Bard retrievable vena cava filters and clinical implications including cardiac perforation and tamponade. Arch Intern Med 170:1827–1831