REVIEW ARTICLE

Optional Vena Cava Filters

Indications, Management, and Results

Hanno Hoppe

SUMMARY

Background: When anticoagulation is contraindicated or ineffective, optional vena cava filters can be used to prevent pulmonary embolism. These devices can be removed within a defined period of time or can remain in the vena cava permanently.

Methods: The status of optional vena cava filters was studied by a review of the relevant literature found in a selective Medline search from 2000 to 2008, including a Cochrane review and published guidelines.

Results: Optional vena cava filter can be removed up to 20 weeks or even longer after insertion (depending on the filter model) in a small interventional radiological procedure if therapeutic anticoagulation has been achieved or the patient is no longer at risk for venous thromboembolism. Current studies show comparable results for optional filters and permanent filters, but there have not yet been any prospective studies comparing the two filter types.

Conclusions: Optional vena cava filters are an important addition to the management of venous thromboembolic disease. As only limited data are available to date, the use of optional filters should be considered on an individual case basis.

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Key words: vena cava filter, anticoagulation, pulmonary embolism, venous thromboembolic disease

Where anticoagulation is contraindicated or ineffective, optional vena cava filters can be used to prevent pulmonary embolism. The advantage of the optional vena cava filters is that they can either be removed or can remain in the vena cava permanently if needed (1). Optional vena cava filters include, among others, Günther Tulip filters from Cook (see Figure 1), Celect filters, OptEase filters (see Figure 2), G2 filters (see Figure 3) and ALN filters (see Figure 4).

Between 250 000 and 20 million cases of deep vein thrombosis requiring treatment occur in the USA annually (www.emedicine.com/Radio/topic762.htm). The use of vena cava filters has increased considerably in the USA. In the USA, approximately 30 000 to 40 000 permanent filters were inserted in 1992, while the number of inserted filters in 2007 was already approximately 213 000—an estimated growth rate of 16% per annum (2).

This article describes the current status of optional vena cava filters including indications, study results, patient management, time of filter removal, and the management of thrombus in the filter, based on relevant literature found in a selective Medline search from 2000–2008 with the key words "vena cava filter AND (optional OR retrievable OR temporary OR removable)", including a Cochrane Review (3).

Indications

Systemic anticoagulation still remains the optimal prevention and treatment of thrombosis (4). External leg compression can be used for thromboprophylaxis (5). Anticoagulant drug therapy generally carries a low risk (6). However, for up to 15% of the patients, anticoagulation therapy may be contraindicated or ineffective (7). For these patients, an optional vena cava filter can be considered. While the filter prevents pulmonary embolism by intercepting venous emboli, it does not prevent or treat venous thrombosis itself. Therefore, the anticoagulation therapy should be initiated while the filter is still placed in the vena cava. The filter can be removed once therapeutic anticoagulation has been achieved (8).

In principle, the indications for the placement of an optional filter are similar to those of permanent filters (Box 1). Generally, there are three indications for vena cava filters:

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Figure 1:

Günther Tulip filter (courtesy of William Cook Europe, Denmark). This filter is made of Coni-chrome. Insertion is performed using either a jugular or a femoral approach. The filter legs are anchored to the vena cava wall with small hooks (arrow-head). A hook at the apex (arrow) allows retrieval by means of a loop via a jugular approach.

Figure 2:

OptEase filter (courtesy of Cordis Europa, L.J. Roden, Netherlands). This filter is made of Nitinol. It can be placed in the vena cava using either a femoral or a jugular approach and is anchored to the vena cava wall with small barbed hooks (arrowhead). This filter model is approved for retrieval by means of a hook (arrow) up to 23 days after placement in the vena cava. Contrary to other filter models, the diamond shape of this filter provides two levels of filtration and has a low migration potential by design.

- Absolute indications for recurrent venous thromboembolic disease despite anticoagulation, or anticoagulation contraindications/complications.
- Relative indications, for example deep vein thrombosis with proximal expansion, massive pulmonary thrombosis treated with thrombolysis/thrombectomy, limited patient compliance with taking oral anticoagulants or high risk of anticoagulation complications such as ataxia and frequent falls.
- Prophylactic indications not concerning venous thromboembolic disease. For example, trauma patients or patients with a high risk of venous thromboembolic disease expected to undergo a surgical procedure (9).

While prophylactic indicators generally allow for a more liberal attitude towards the use of optional filters, the benefit of a vena cava filter placement should still be an interdisciplinary consideration for each individual case. When using an optional filter, it is generally expected that it may not be retrievable and for that reason remains in the patient's vena cava permanently. A contraindication for filter placement is the lack of a venous access site or if filter placement in the vena cava is impossible. Severe, uncorrectable coagulopathy is indicated as a relative contraindication (Oliva V, Geerts W: Clinical guide—inferior vena cava filters. www.tigc.org/pdf/venacava04.pdf).

Results

The data available on optional filters are even more limited than those on permanent filters. A recently published Cochrane Review (3) confirmed this fact. Only a single 8-year-long randomized follow-up study has been conducted for permanent filters, comparing follow-up of patients (n = 396) with filters plus anticoagulation to that of patients without anticoagulation for the treatment of venous thromboembolic disease (10). On the one hand this study shows that using a filter offers significant protection from a pulmonary embolism. Nine patients (6.2%) with a filter and 24 patients (15.1%) without a filter ($p = 0.008$) suffered a pulmonary embolism. On the other hand patients with filters had a higher risk of deep vein thrombosis (57 patients [35.7%]) compared to those without a filter (41 patients [27.5%]) ($p = 0.042$). After eight years, 201 patients had died (50.3%, 103 with a filter and 98 without a filter). In this study 4 types of permanent vena cava filters were placed and are still in use to date. This analysis has raised some questions with regards to the long-term use and risks associated with permanent filters. In particular, these results have led to the assumption that the vena cava filter may cause deep vein thrombosis (relative risk: 0.37). The question arises, to what extent these results are transferable to optional filters and if the use of optional filters might contribute to the decrease of potential filter complications, for example the development of deep vein thrombosis.

Previous study results for optional vena cava filters are compiled in the *Table*. They are comparable to the

results for permanent filters, provided the filter remains in the vena cava. However, there have not yet been any prospective studies comparing the optional and permanent vena cava filters. Only one retrospective study has been conducted comparing the follow-up of patients with permanent vena cava filters ($n = 275$) versus patients with optional filters ($n = 427$) (11). This analysis did not reveal a significant difference between the two types of filters with regards to safety and efficiency.

The actual filter removal is just a minor intervention (Figure 5). Depending on the type of filter, a jugular or femoral venous puncture and insertion of a sheath is necessary for filter retrieval. The filter hook will then be clasped and tightened with a loop. Next, the sheath is advanced in order to collapse and remove the filter. The complication rate of this intervention is low: a retrospective study ($n = 110$) analyzed the bleeding risk after filter retrieval for patients with ($n = 61$) and without therapeutic anticoagulation ($n = 49$). There were no patients with bleeding complications (8).

The retrieval rate and times for optional vena cava filters are variable, as shown in the Table. The average implantation period is up to 166 days (see Table), depending on the filter model. Failure to retrieve a filter can occur for several reasons. Incorporation of the filter into the vena cava wall is one reason (12). In general, the less wall contact between the filter and the vena cava, thus reducing the tendency for incorporation, the more likely is the retrieval even after extended implant duration. Filter tilt in the vena cava and large thrombus trapped by the filter are other causes of failed filter retrievals. A significant tilt of the filter can make it difficult for the loop to grasp and remove the filter. A report from the early era of optional filters indicates 10% (1/10) irretrievability due to tilt, which can be explained with a lack of experience at the time of intervention (13). In a more extensive current study of Sag et al. 17% of all filters (29/175) with a misalignment of more than 14° were removed without increased technical effort (14).

Patient management after filter placement

Patients who have received a prophylactic vena cava filter should be anticoagulated as soon as possible. Even if this is not required for the filter itself, the patient should be anticoagulated to prevent a deep vein thrombosis. The intensity and duration of a prophylactic drug therapy should be customized towards the risk factors of the patient, regardless if the patient already has a filter (5). The filter should only be removed if adequate anticoagulation was achieved or if the patient is no longer at increased risk for pulmonary embolism. A patient who develops a venous thromboembolic disease after a prophylactic filter was placed, should be anticoagulated promptly (4). Patients with acute or chronic venous thromboembolic disease should continue anticoagulation as soon as possible (4). While the risk of a life-threatening pulmonary

Figure 3: G2 filter (courtesy of Bard Peripheral Vascular, Tempe, Arizona, USA). This filter is the successor of the Recovery filter which is no longer approved in the USA as of 2005. Like its predecessor, the G2 filter is made of Nitinol. Contrary to the Recovery filter the G2 filter has improved fixation hooks (arrowhead) to reduce the tendency for migration.

Figure 4: ALN filter (courtesy of ALN, Ghisonaccia, France). This filter is made of steel. The manufacturer has not indicated a time limit regarding the retrievability of this filter model from the vena cava.

BOX 1

Indications for optional vena cava filters*

Absolute indications for venous thromboembolic disease

- Recurrent venous thromboembolic disease, acute or chronic, despite adequate anticoagulation
- Anticoagulation contraindications
- Anticoagulation complications
- Therapeutic anticoagulation impossible

Relative indications for venous thromboembolic disease

- Ilio-caval venous thrombosis
- Free-floating, large proximal venous thrombosis
- Massive pulmonary embolism treated with thrombolysis/thrombectomy
- Thrombolysis for ilio-caval venous thrombosis
- Limited patient compliance with taking oral anticoagulation
- High risk for anticoagulation complications (ataxia, frequent falls)

Prophylactic indications, unknown venous thromboembolic disease, contraindicated anticoagulant drug therapy

- Trauma patient with high risk of venous thromboembolic disease
- Surgical intervention for a high-risk patient with venous thromboembolic disease
- Underlying disease with a high risk for venous thromboembolic disease

* Guidelines as per Kaufman et al., Guidelines for the use of retrievable and convertible vena cava filters: Report from the society of interventional radiology multidisciplinary consensus conference" (9), approved by the American Venous Forum. The current level of evidence of literature in the area of optional vena cava filters is not sufficient to articulate evidence-based recommendations at this particular time.

embolism is significantly reduced in patients with a filter and deep vein thrombosis, the deep vein thrombosis is not causatively treated by the filter.

Type, dosage and duration of anticoagulation therapy solely depends on the venous thromboembolic disease and the corresponding risk factors, but not on the fact whether a filter was inserted or not.

Time of filter retrieval

The purpose of the filter is to prevent pulmonary embolism, for example in case of free-floating large proximal venous thrombosis. For that reason the filter should only be removed when there is no longer a risk. In most cases this is possible as soon as the patient is anticoagulated and at no increased risk of pulmonary embolism. Each case should be evaluated individually for an increased risk of a symptomatic pulmonary embolism. If in doubt, the decision to leave the filter in the vena cava is considered reasonable in most cases.

Certain conditions apply before a filter can be removed safely (9).

- There should be no indications for a permanent filter, for example, a chronic increased risk of a pulmonary embolism with or without anticoagulant medication.
- During therapeutic anticoagulation or with improved clinical condition the patient should no longer be at an increased risk for a pulmonary embolism. Prior to filter removal tolerance of anticoagulant medication should be ensured.
- It should be established that there is no increased future risk of a venous thromboembolic disease, caused by either an interruption of anticoagulant drug therapy or changes in patient management. For example, a filter should not be removed in patients about to undergo a surgical intervention thus leading to interruption of anticoagulant drug therapy.
- The life expectancy of a patient should be long enough to warrant filter removal. There is evidence for filter-related complications, such as the development of recurrent deep vein thrombosis (37.5% after 8 years), thrombotic occlusion of the vena cava (threshold <10%), filter migration (<18%) or filter fracture (<10%) manifesting after a long time (10, 15). For patients with a life expectancy of less than 6 months filter removal is therefore hardly beneficial. In the end the filter removal should generally be desired by the patient.

In case of prophylactic placement of a filter, the development of a deep vein thrombosis should be ruled out prior to filter removal. For this purpose an ultrasonic study is recommended for the lower extremities (9).

Patients with venous thromboembolic disease should be adequately anticoagulated for about two to three weeks prior to filter removal (4). The existence of a filter should not have any influence on indication, dosage or duration of anticoagulant drug therapy. It is

Figure 5: Removal of a Günther Tulip filter, a) a snare loops around the apical hook of the filter (EN Snare, Inter.V, Gainesville, Florida, USA) (arrowhead); b) the snare is tightened around the hook (arrowhead); next, the sheath is advanced in order to collapse and remove the filter

not clearly definable how long an increased risk of pulmonary embolism exists for patients with venous thromboembolic disease who were therapeutically anticoagulated. Several studies show a high probability of a symptomatic pulmonary embolism occurring during the first three weeks after therapy start (10, 16). Pulmonary arterial imaging prior to filter removal is generally not recommended unless the patient has clinical symptoms of a pulmonary embolism or if inefficiency of the anticoagulant drug therapy is suspected (9). The filter can safely be removed while the patient is anticoagulated (8). The anticoagulation should not be interrupted for the filter removal intervention.

In rare situations the filter itself causes complications or no longer protects effectively from a pulmonary embolism. In this case the filter should be removed. Such cases are rare. Examples for this are faulty placement of the filter, pain caused by perforation of the filter struts, filter migration, or an infection (17). Should filter removal become necessary, high-risk patients for pulmonary embolism must be re-evaluated for the necessity of placing another filter.

The use of an optional vena cava filter does not require anticoagulation. However, there are clinics continuing anticoagulation even though there is no longer a risk of venous thromboembolic disease. Chronic long-term therapy with oral anticoagulants is associated with a low, but definitely definable risk of

bleeding complications (approximately 1.3%, depending on the degree of anticoagulation, per Levine M et al.: Hemorrhagic complications of anticoagulant treatment: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. Chest 2004; 126: 287S–310S). There were no bleeding complications with therapeutically anticoagulated patients with filter removal (8).

Thrombus in filter

Generally, a venacavogram of the filter in the vena cava is performed just prior to retrieval of the filter. Alternatively the imaging can be performed up to 24 hours prior to the filter retrieval, showing the entire filter and the vena cava by means of contrast reinforcing CT. If a thrombus is found in the filter, the risk for pulmonary embolism should be assessed (18–21). According to the literature this occurs in 12% to 19% of all cases. Large filling defects of the filter present a direct pulmonary embolism risk during filter retrieval, and more importantly, may indicate a continued high embolism risk. On the other hand, smaller filling defects the size of sub centimeters which are attached to the filter do not present an acute danger for development of pulmonary embolism during filter retrieval.

If a thrombus is found in a filter of a patient without previous venous thromboembolic disease, for example due to prophylactic placement of the filter, these findings indicate the presence of a venous thromboembolic

TABLE

Data from studies of different models of optional vena cava filters including clinical progress

Study	Study design	Filter type	Size of filter	Thrombus in filter	Filter removed	Implan- tation period (days)	Follow- up (months)	Pulmo- nary embolism	Deep vein thrombosis	Filter migration	Vena cava thrombosis
Millward 2001 (19)	retrospektive, multicenter	Günther Tulip	91	5 (1 not removed)	52	9	3.4	0	1 (post filter removal)	0	2
Asch 2002 (22)	prospective, not randomized	Recovery	32	7 (4 not removed)	24	53	7.4	0	0	1	0
Wicky 2003 (20)	retrospective	Günther Tulip	75	14	35	8	30	1 (post filter removal)	1 (post filter removal)	2	0
Terhaar 2004 (23)	prospective, not randomized	Günther Tulip	53	2 (2 not removed)	16	34	13	1 (pre filter removal)	0	0	0
Grande 2005 (24)	retrospective	Recovery	107	0	14	150	3.2	3 (pre filter removal)	0	0	0
Imberti 2005 (25)	prospective, not randomized	ALN	30	3	14	123	18.2	0	2 (pre filter removal)	1	0
Oliva 2005 (e1)	prospective, multicenter, not randomized	OptEase	27	2 (2 not removed)	21	14	1	0	1 (pre filter removal)	0	0
Rosenthal 2005 (e2)	retrospective	OptEase	40	All removed	40	16	—	0	0	0	0
Hoppe 2006 (e3)	prospective, multicenter, not randomized	Günther Tulip	42	5 (5 not removed)	23	11	3	1 (pre filter removal)	1 (pre filter removal)	1	1
Meier 2006 (e4)	prospective, not randomized	OptEase	37	12 (4 initially not removed)	32	16	3	1 (post filter removal)	0	1	0
Mismetti 2007 (e5)	prospective, not randomized	ALN	220	4 (4 initially not removed)	55	166	11.3	5 (pre filter removal)	33 (pre filter removal)	0	0
Keller 2007 (e6)	retrospective	Günther Tulip	93	13 (5 not removed)	46	11	41	0	0	1	4
Keller 2007 (e6)	retrospective	OptEase	83	24 (4 initially not removed)	58	14	7	0	0	0	2
Lobby 2007 (e7)	retrospective	Günther Tulip	147	2 (2 not removed)	36	34	8.2	1 (pre filter removal)	0	0	0
Yavuz 2008 (e8)	retrospective	Günther Tulip Recovery, OptEase	72	—	72	33	20.6	1 (post filter removal)	2 (post filter removal)	—	—
Kim 2008 (11)	retrospective	OptEase, Günther Tulip, Recovery, G2	427	26 (19 not removed)	46	16	12	20 (pre filter removal)	54 (pre filter removal)	0	2

disease even if the patient has no symptoms and the deep vein sonography was negative. At this moment the planned filter retrieval should be cancelled and a suitable anticoagulation therapy initiated, provided there are no contraindications. A re-evaluation regarding the filter-removal can be performed after approximately two to three weeks of successful anticoagulation.

A large thrombus found in the filter of an anticoagulated patient with known venous thromboembolic disease during filter removal, may point to inadequate or ineffective anticoagulation therapy. In this case the filter should remain in the vena cava and drug therapy should be re-evaluated. After at least two weeks of effective anticoagulation the filter removal can be re-attempted.

Conclusion

Optional vena cava filters are an important addition to the management of venous thromboembolic disease, although the clinical value of filter removal still needs to be validated by means of randomized and controlled studies.

As data are partially based on speculation, the use of optional filters should be considered on an individual case basis.

Key messages

- A vena cava filter can be used when anticoagulant drug therapy is contraindicated or ineffective.
- An optional filter can be used if the vena cava filter is needed on a temporary basis.
- An optional filter can generally be retrieved, provided therapeutic anticoagulation was achieved, or respectively, there is no longer an increased risk of venous thromboembolic disease.
- The use of an optional vena cava filter should be evaluated for each individual case.

Conflict of interest statement

Dr. Hoppe explains that there is no conflict of interest in terms of the guidelines by the International Committee of Medical Journal Editors.

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