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## Research progress in the application of inferior vena cava filter on acute venous thrombosis

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### ABSTRACT

Anticoagulant therapy using heparins or *per os* vitamin K antagonists has been the treatment of choice in patients with venous thromboembolic disease for decades. However, the introduction of inferior vena cava (IVC) filters recently has provided new therapeutic choices appropriate for specific groups of patients with venous thromboembolic disease. This review aims to present all current evidence on the indications and precautions for the proper IVC filters utilization. There is still a great challenge in identifying the proper populations that would benefit from an IVC filter implantation or extraction. New randomized trials are needed to produce safe and clear guidelines of proper use.

## 1. Introduction

Venous thromboembolic disease, comprising deep vein thrombosis and/or pulmonary embolism (PE), is one of the commonest cardiovascular disorders as well as one of major causes for in-hospital morbidity and mortality worldwide[1]. Parenteral treatment with unfractionated heparin or low molecular weight heparin, followed by *per os* therapy with vitamin K antagonists has remained the therapeutic strategy of choice in the majority of patients for years. Recently, newer *per os* anticoagulants have been introduced showing promising results[2]. Castellucci *et al.* have concluded in an extensive meta-analysis of randomized studies that the newer anticoagulants have shown a similar efficacy and safety, although their bleeding risk seems to be lower[3].

The latest guidelines on acute venous thromboembolism (VTE) management recommend anticoagulant treatment duration of at least three months

initially, although the presence of certain risk factors could prolong treatment duration[4]. Patients with a transient and reversible risk factor (such as surgery, immobilisation, and recent trauma) show a lower annual risk of recurrent VTE after three months of oral anticoagulation and thus, they could safely discontinue treatment. Patients with an unprovoked VTE or with a proved permanent thrombotic factor (*e.g.* genetic mutation and antiphospholipid syndrome) have a higher risk of recurrence and hence could warrant longer anticoagulation treatment[5].

However, there is a subgroup of patients where anticoagulants are contraindicated or are not safe to use. For such patients, the indication for filter implantation should be carefully evaluated, and final decision should be based on full understanding of the filter's characteristics as well as consideration of the alternative choices. This study aims to collect and present all current data on proper selection and utilization of the inferior vena cava (IVC) filters.

## 2. Indications and contraindications for IVC filters

The presence of a proximal deep vein thrombosis

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in combination with an absolute contraindication for anticoagulative treatment, remains the only absolute indication for IVC filter placement<sup>[4,6]</sup>. Table 1 demonstrates the most important indications for IVC filter placement.

**Table 1**

Indications for IVC filter placement.

Absolute indications	Relative indications
VTE and contraindications to anticoagulation	Unstable patients with VTE or patients with poor cardiopulmonary reserve with VTE
Failure of anticoagulation	Massive PE treated with thrombolysis
Complication of anticoagulation	Iliocaval DVT Floating proximal DVT Prophylaxis in patients undergoing high-risk surgery or after major trauma Floating proximal DVT Recurrent PE with filter in place

DVT: Deep venous thrombosis.

Based on international literature data, absolute contraindications for therapeutic dosage of anticoagulatives in patients with a recent proximal DVT include the following<sup>[6]</sup>:

1. Active or recent bleeding that could not be addressed immediately;
2. Intracranial bleeding during the last five days;
3. Need for major surgical procedure within the following two weeks;
4. Severe prolonged thrombocytopenia.

However, there are also contraindications for IVC filter placement, such as the following:

1. Uncorrectable severe coagulation disorders;
2. Extended IVC thrombosis leading to impossible filter placement proximal to the thrombosis;
3. Bacteraemia;
4. No access route for IVC filter placement.

Trauma continues to be the leading indication for prophylactic filters in a number of series, but studies so far have demonstrated heterogenous results on the use of prophylactic filters in different populations. In a recent systematic review by Haut *et al.*, the authors showed that prophylactic placement of IVC filters is associated with lower incidence of PE and fatal PE in trauma patients, although the strength of evidence was low<sup>[7]</sup>. However, the newer studies evaluating the use of IVC filters in bariatric patients show no benefits and no significant risks, and thus they do not encourage the use in this population<sup>[8,9]</sup>. Additionally, studies referring to patients undergoing spine surgery have shown that filter placement is associated with a lower VTE-related events<sup>[10,11]</sup>. The

IVC filter complication rate remains low; however, so does the retrieval rate for potentially removable filters<sup>[12]</sup>. Overall, the use of IVC filters, especially in prophylactic situations, will remain controversial until randomized, controlled trials are performed within each specific patient population.

Finally the recommendations of the latest guidelines regarding the proper utilization of IVC filter placement are the following<sup>[13]</sup>:

1. In adult patients with acute proximal DVT of the upper extremity and contraindication for anticoagulant use, placement of IVC filter is recommended (Grade 1B);
2. In adult patients with acute proximal DVT of the lower extremity and an already placed IVC filter as an alternative to anticoagulants, the typical anticoagulative treatment is recommended, if the risk for bleeding has passed (Grade 1B);
3. In adult patients with acute PE and contraindication for anticoagulant use, placement of IVC filter is recommended (Grade 1B);
4. In adult patients with acute PE and an already placed IVC filter as an alternative to anticoagulants, the typical anticoagulative treatment is recommended, if the risk for bleeding has passed (Grade 1B);
5. In patients that a temporary IVC filter has already been placed, the possibility of retrieval should be periodically evaluated (Grade 1C);
6. In patients with DVT or PE who will need long-term IVC filter protection, placement of a permanent IVC filter is justified (Grade 2C);
7. In patients with DVT or PE who will need IVC filter protection for a short term, placement of a temporary IVC filter is justified (Grade 2C);

However, the placement of a permanent IVC filter is not by itself an indication for prolonged use of anticoagulants.

### 3. Complications of IVC filters

As all other interventional procedures, placement of an IVC filter may be followed by potential complications that one should always take into consideration. These complications can be classified into two groups, namely early and late complications (Table 2)<sup>[14]</sup>. Recent data indicate that complications occur with significantly higher frequency with retrievable IVC filters compared with permanent IVC filters<sup>[15]</sup>. Especially long-term

complications are a serious concern with the use of these filters<sup>[16]</sup>. As highlighted by Ho *et al.*, significant delay of a retrievable IVC filter removal in patients with major trauma is significantly associated with an increased risk for subsequent DVT, VTE or other mechanical complications of the filter<sup>[17]</sup>.

**Table 2**

Complications of IVC filter implantation.

Early complications	Late complications
Contrast media reaction	Subsequent PE due to large venous collaterals by an occluded IVC
Arrhythmia	Recurrent DVTs
Air embolism	Central or distal migration
Pneumothorax/Hemothorax	Perforation of IVC wall
Incomplete filter opening	Filter fracture
Angulation	IVC occlusion with oedema, hyperpigmentation and ulceration of lower extremities
Guide wire entrapment	IVC syndrome
Migration	Low back pain
Filter fracture	Rarely pyelphlebitis
Filter embolization	
Renal function deterioration	
Arteriovenous fistula	
Recurrent PE	
Deadly PE	
Symptom aggravation of DVT	

Complications may occur during filter implantation or retrieval or when a filter is retained. Insertion-related complications have been reported in up to 15% of patients and include puncture site-related problems, misplacement, migration, not proper filter deployment, and vena cava perforation<sup>[18]</sup>. An uncommon complication is symptomatic access site DVT (3%), although asymptomatic thrombi that can be detected by ultrasound are much more common (35%) and their clinical significance has been questioned. Complications of retained filters and their reported incidence, when available, include filter migration or embolization (3% to 69%), strut fracture and penetration (9% to 24%), IVC thrombosis (6% to 30%), lower extremity edema, post-thrombotic syndrome (5% to 70%), DVT (0% to 20%), and recurrent PE (3% to 7%)<sup>[14,19]</sup>. It is noteworthy that retained thrombus within the filter is often cited as proof of filter effectiveness, and, indeed, some break-through PE are fatal.

In the only to date randomized clinical trial concerning the effectiveness of IVC filters (PREPIC trial; Prevention du Risque d'Embolie Pulmonaire par Interruption Cave), almost 400 patients with proximal DVT (with or without PE) were included<sup>[20]</sup>. They were classified into two groups, either receiving low molecular weight heparin for at least three months or undergoing an IVC filter implantation. After eight years of follow-up, the IVC

filters were associated with a reduction of PE presentation or recurrence. However, IVC filters were followed by an increased risk for new venous thrombosis and had no effect on survival.

#### 4. Special considerations

The large experience acquired during the last decades concerning the implantation of IVC filters as well as the introduction of new 'temporary' retrievable filters, caused a trend towards expansion of indications without actual evaluation of the benefits from such an expensive interventional technique.

Special considerations regarding the utilization of IVC filters are as following<sup>[4,13,14]</sup>:

1. Repeated episodes of PE despite the therapeutic dosage of anticoagulants are actually a failure of medical treatment, and are managed by increasing the dosage or changing the type of medical treatment at the beginning. If these measures fail, the implantation of IVC filters is justified.

2. If there is a recent PE without proof of deep vein thrombosis in patients with absolute contraindication for anticoagulants, they can receive anticoagulants in prophylactic dosage temporarily. When the risk for bleeding is reduced, they can further receive anticoagulants in therapeutic dosage.

3. DVT/PE in patients with high risk for bleeding, but without active bleeding: The majority of these patients will not present severe bleeding or bleeding threatening the patient's life, when treated with anticoagulants in reduced dosage.

4. PE presented in the first days after the initiation of full anticoagulant treatment for recent DVT: This is expected due to the fragmentation of the venous thrombi, and it does not mean failure of treatment. An implantation of an IVC filter is not necessary in this case.

5. PE or proximal DVT in patients with low cardiovascular reserve: There are no official definition for this type of patients, and therefore no official restriction.

6. Extensive proximal DVT or PE, with a present free-floating proximal thrombus: There is no higher risk for PE in such patients receiving full therapeutic dosage of anticoagulants.

In conclusion, the utilization of IVC filters in combination with the appropriate anticoagulant treatment, or even

without it, is a safe measure for DVT/PE management, when it is indicated. However, there is still a great challenge to identify and define the patient group that will benefit from the implantation of an IVC filter, as well as the patients who will benefit from the extraction of a filter, when the risk for PE has resolved. New randomized trials are needed in order to produce clear guidelines for placement and removal as well as to form a 'best practice model' for all indications.

### Conflict of interest statement

The authors report no conflict of interest.

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