Introduction

The initial symptoms of deep venous thrombosis (DVT) in the lower extremities may be quite severe, and, additionally, there is a substantial risk of pulmonary embolism in patients with DVT. Moreover, when DVTs remain, there is the possibility of delayed complications, including the spectrum of debilitating symptoms referred to as post-thrombotic syndrome. Therefore, treatment of DVT is necessary. Traditionally, therapy for DVT has consisted in systemic IV administration of heparin. Other options have been systemic IV administration of fibrinolytic agents such as urokinase or streptokinase. Recombinant tissue plasminogen activator has gained attention as an effective fibrinolytic agent. Systemic thrombolysis is more effective than heparinization but less effective than catheter-directed thrombolysis. Catheter-directed thrombolysis, an endovascular therapy, has become a widely accepted treatment for DVT. Other endovascular procedures: manual aspiration of the thrombus, mechanical thrombectomy, percutaneous transluminal angioplasty and placement of self-expandable metallic stents. Here, we present an overview of the literature and analysis on the application of prophylactic implantation of an inferior vena cava filter during endovascular therapy for DVT of the lower extremities.

Key words: embolism, pulmonary, endovascular therapies, extremities, thrombosis, vena cava, filters

Prophylactic Implantation of Inferior Vena Cava Filter during Endovascular Therapies for Deep Venous Thrombosis of the Lower Extremities

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Patients with deep venous thrombosis (DVT) of the lower extremities have an increased risk of pulmonary emboli and post-thrombotic syndrome. Traditionally, they are treated medicinally, with anticoagulation therapy. Currently, endovascular therapies, with their higher efficiency, have replaced previously attempted systemic fibrinolytic therapies. There is a continuing controversy in the temporary use of filters in the inferior vena cava during these endovascular therapies, which may include catheter-directed thrombolysis, manual aspiration, mechanical thrombectomy, percutaneous transluminal angioplasty and placement of self-expandable metallic stents. Here, we present an overview of the literature and analysis on the application of prophylactic implantation of an inferior vena cava filter during endovascular therapy for DVT of the lower extremities.

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INTRODUCTION

The initial symptoms of deep venous thrombosis (DVT) in the lower extremities may be quite severe, and, additionally, there is a substantial risk of pulmonary embolism in patients with DVT. Moreover, when DVTs remain, there is the possibility of delayed complications, including the spectrum of debilitating symptoms referred to as post-thrombotic syndrome. Therefore, treatment of DVT is necessary. Traditionally, therapy for DVT has consisted in systemic IV administration of heparin. Other options have been systemic IV administration of fibrinolytic agents such as urokinase or streptokinase. Recombinant tissue plasminogen activator has gained attention as an effective fibrinolytic agent. Systemic thrombolysis is more effective than heparinization but less effective than catheter-directed thrombolysis. Catheter-directed thrombolysis, an endovascular therapy, has become a widely accepted treatment for DVT. For improving the quality of treatment for DVT, other endovascular procedures: manual aspiration of the thrombus, mechanical thrombectomy, percutaneous transluminal angioplasty and placement of self-expandable metallic stents are sometimes used in combination with catheter-directed thrombolysis.

Theoretically, a thrombus released from the DVT during catheter-directed thrombolysis could move to the pulmonary artery, resulting in pulmonary thromboembolism. DVT and pulmonary thromboembolism comprise venous thromboembolism (VTE). Then, implantation of inferior vena cava filters has been applied prophylactically to prevent such an occurrence. However, this is considered to be unnecessary by some, with the result that this procedure is very controversial. This article presents an overview of the literature regarding the application of prophylactic implantation of an inferior vena cava filter during endovascular therapy for DVT of the lower extremities. We also present our conclusions drawn through examination of the literature on this topic.
TYPE OF FILTERS

There are 3 types of filters: permanent, temporary or optional. When only short-term protection is required, ideally, a permanent inferior vena cava filter would not be placed, particularly if a long life is expected for the patient, considering the demerits of permanent filter implantation with high frequency of recurrence of DVT.22) Thus, a temporary vena cava filter has been widely used for this purpose.23, 24) However, paralleling the increased use of temporary vena cava filters, complications have been described that were mainly associated with their structure, in that part of the device projects from the insertion site.24–26) Some of these complications were serious, and included infection where the device protruded from the insertion site;27) air embolism through a defective sheath,24) worsening of proximal thrombosis along the attached catheter,25) and migration of the filter into the pulmonary artery.26) Moreover, temporary filters must be replaced by permanent filters24) when the maximal implantation period is reached before successful completion of therapy for DVT. Because of the above-mentioned complications and problems with temporary vena cava filters, the use of an optional vena cava filter that could be implanted without an attached catheter or guide-wire would be advantageous. If necessary, this filter could also serve as a permanent filter.28, 29)

PROPHYLACTIC USE OF AN INFERIOR VENA CAVA FILTER DURING ENDOVASCULAR THERAPIES FOR DEEP VENOUS THROMBOSIS

The use of filters in the inferior vena cava temporarily during endovascular therapies for DVT of the lower extremities remains controversial.

Placement of an inferior vena cava filter during catheter-directed thrombolysis has been proposed as necessary in patients who have large, mobile, free-floating thrombi within the inferior vena cava.1) Some investigators,9–11) insist that the prophylactic use of an inferior vena cava filter during catheter-directed thrombolysis is unnecessary because of the low rate of pulmonary embolism. For these patients, the viewpoint is supported by Bjarnason et al.13) who reported only 2 (0.9%) of 214 patients developing pulmonary embolism, and by Mewissen et al.11) who reported only 6 (1.3%) of 473 patients; however, 1 of these was a fatality.

On the other hand, support of the use of temporary vena cava filters can be found in the literature. In a summary of their experience with implantation of temporary vena cava filters in 132 patients with DVT who were receiving thrombolytic therapy, Thery et al. 30) had observed lysing of a clot by thrombolytic therapy in the filter in 41 (31%) of 132 patients. Since none of the 132 patients experienced pulmonary embolism, they suggested that the filter might have prevented the pulmonary embolism during thrombolytic treatment in at least 41 of the patients. It has been proposed17–21, 27, 31, 32) that the prophylactic use of an inferior vena cava filter is necessary, in view of the high rate of trapping a thrombus in these filters during therapies for DVT as revealed by Thery et al.10) and great importance has been attached to its potential in reducing mortality, though the rate is low.10)

In situations that limit the dosage of anticoagulation or fibrinolytic agents, for example, in patients with traumatic injury or after surgery, another endovascular therapy should completely replace or should be added to catheter-directed thrombolysis. In some countries, dosage of such drugs is very limited compared with that in western countries. In Japan, for example, dosages of drugs administered for catheter-directed thrombolysis are kept within the dosage permitted by the Japanese government-subsidized health insurance programs and the usage of certain drugs is not permitted. In those programs, use of urokinase is limited to 240000 IU per day and tissue plasminogen activator variants are not permitted, in principle, for therapy of deep venous thrombosis.20) Because of this situation, the effectiveness of catheter-directed thrombolysis must be inferior to that in circumstances in which anticoagulation or fibrinolytic agents can be used in large quantities, as in western countries. Thus, other endovascular therapies such as manual aspiration of thrombus and mechanical thrombectomy must be added in many cases. However, there has been little discussion on the necessity of filter placement during therapies for DVT with interventional radiological procedures other than catheter-directed thrombolysis.20)

In one study of patients on therapies for DVT including systematic anticoagulation therapy in Japan, a clot of trapped thrombus was observed in 83% of 30 retrieved filters that had been implanted optionally during therapy for DVT.32) When an optional inferior vena cava filter was implanted prophylactically during endovascular therapies for DVT in 17 patients, pulmonary embolism was avoided in all; however, in 47.1% (n = 8), a trapped thrombus was observed in the filter on venography performed during endovascular therapies.28) Results of prophylactic implantation of an inferior vena cava filter dur-
ing endovascular therapies for DVT of the lower extremity with a larger number of subjects showed that in 20 (54.1%) of 37 endovascular therapy sessions and in 22 of 66 filters implanted, a trapped clot of thrombus was observed on venography.\(^{29}\) The trapped thrombus filled \(<\frac{1}{4}\) the height of the filter in 2, from \(\geq\frac{1}{4}\) to \(<\frac{1}{2}\) in 6, and \(\geq\frac{1}{2}\) but within the height of the filter in 7. In the remaining 7 of 22 filters, the trapped thrombus occupied greater than the height of the filter. It is possible that if the filters had not been implanted, the thrombus might have moved to the pulmonary artery, causing pulmonary embolism. There is special concern when the captured thrombus is larger than half the height of the filter.

**Challenges in Filter Retrieval When a Large Thrombus Is Trapped in the Filter**

The presence of a large thrombus in a filter at the time of filter removal can be problematic.\(^{33–35}\) Removal of the Gunther tulip vena cava filter (Cook, Bjaeverskov, Denmark), which is one of the optional vena cava filters, is contraindicated by the manufacturer when the thrombus fills more than \(1/4\) of the filter cone.\(^{33}\) Also, in the retrieval of the OptEase filter, another optional vena cava filter, Oliva et al.\(^{35}\) recommended not to attempt filter retrieval if the trapped thrombus is larger than 5 mm in width and/or 20 mm in length. However, in practice, as mentioned above, in certain situations, it is more favorable to remove the filter. Thus, modifying the usual methods for removal of the filter would be helpful in achieving a successful removal. In retrieval of the Gunther tulip vena cava filter, Kinney\(^{34}\) suggested that fibrinolytic therapy could be used to reduce or remove the entrapped clot in preparation for filter removal. In the study of Yamagami et al.,\(^{29}\) in 20 filters, the captured thrombus filled more than \(1/4\) the height of the filter. For these cases, they used a combination of catheter-directed thrombolysis, manual aspiration, and temporary filtering by temporarily positioning another filter at the cephalad side of the filter with the trapped clot to remove the filter safely. During removal of these filters, the pulmonary embolism did not develop or get worse.

**Venous Thromboembolism after Retrieval of Optional Vena Cava Filters**

In addition to reports evaluating the retrievability of optional vena cava filters,\(^{27,28,35,36}\) a follow-up of patients after retrieval with regard to recurrent DVT following removal has been reported.\(^{27,37,38}\) In a report by Millward et al.\(^{27}\) describing a mean follow-up of 103 days, DVT recurred in 1 (2.7%) of 37 patients in whom the filter was removed. Asch et al.\(^{37}\) reported that 1 (4.5%) pulmonary embolism occurred among 22 patients during a post-retrieval clinical follow-up of an average of 223 days with Recovery filters. In a follow-up period of 20.6 months, after retrieval of 72 filters implanted in 67 patients, Yavuz et al.\(^{38}\) observed a recurrent DVT in 2 of the 67 patients. Yamagami et al.\(^{39}\) described the observation of 76 patients after retrieval of optional filters; the rate of recurrent pulmonary embolism was 2.0% and that of DVT was 4.6%. The incidence of recurrent VTE in one study\(^{39}\) was similar to what was reported in other studies, although the follow-up period was much longer and the number of patients was larger.\(^{27,37,38}\) In that series,\(^{39}\) the mean follow-up period after retrieval of the filter was 39.8 ± 22.1 months (range, 6–84 months). Such favorable results might have been obtained because the outpatient care was adequate and long-term, and included monitoring the condition of patients with ultrasound, enhanced CT and blood tests such as D-dimer assays. In that series, risk factors for recurrent VTE after filter removal were also investigated.\(^{39}\) There was a tendency for recurrence of VTE at a higher rate in cases in whom the status of DVT before filter implantation was so severe that endovascular therapies for DVT were required and in whom DVT remained at the time of filter removal. However, the difference between those with and without these risk factors was not statistically significant.

**Conclusion**

In reviewing previous reports,\(^{28–30,32}\) we want to reiterate that, despite the strong controversy as to whether to use filters temporarily in the inferior vena cava during endovascular therapies for deep venous thrombosis, the inferior vena cava filter played an important role in filtering a thrombus released from the lower limb, thereby preventing pulmonary embolism. Thus, use of the optional vena cava filter is recommended during endovascular therapies for deep venous thrombosis. However, long-term follow up to avoid recurrence of venous thromboembolism after retrieval of the filter is necessary.

**References**


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