Introduction

It is well accepted that inferior vena cava (IVC) filter placement provides short-term protection from the occurrence of pulmonary embolism in patients with deep venous thrombosis (DVT). However, long-term implantation of these devices can result in serious complications. Thus, in patients with a long life expectancy, avoidance of permanent filter implantation would be ideal when only short-term protection is required.

Retrievable vena cava filter appears to offer a broader range of clinical applications compared with either permanent or temporary vena cava filter. Retrieval of a vena cava filter can be implanted without an attached catheter or guide wire and, if necessary, can be left in place to serve as permanent filter. In other words, whether the filter is used temporarily or permanently can be decided according to the patient’s clinical status after therapy for pulmonary embolism and/or deep venous thrombosis (DVT).

We describe a strategy for removal of a retrievable Gunther tulip vena cava filter (GTF) (Cook, Bjæverskov, Denmark) that was placed in a young woman with pulmonary embolism due to lower extremity DVT. When the pulmonary embolism and DVT almost completely resolved after therapy, we attempted to retrieve using the standard method employing a vascular sheath placed via the transjugular approach in combination with a snare device was impossible. A thrombus occupying the apical hook made it difficult to snare the hook, also one filter leg was incorporated into the inferior vena cava wall. Therefore we modified an existing method to withdraw the filter. As the first step, the filter cone was snared using the snare-over-guide wire loop technique, and the cephalad site of the filter was introduced into the sheath. Then, a 12-French sheath was advanced from the femoral vein and, using a pusher, the distal legs of the filter were pushed, which resulted the filter leg that was incorporated into the inferior vena cava wall became detached. Finally the filter was successfully retrieved.

Key words: embolism, pulmonary, interventional procedures, vena cava, filters

How To Do It

Retrieval of Gunther Tulip Vena Cava Filter with Thrombosed Hook and a Leg Incorporated into the Vena Cava Wall

Takuji Yamagami, MD, Ph.D, Rika Yoshimatsu, MD, Tomohiro Matsumoto, MD, and Tsunehiko Nishimura, MD, Ph.D

A Gunther tulip vena cava filter was implanted in a patient with pulmonary embolism from deep venous thrombosis. The filter became unnecessary after therapy. However, retrieval by the standard method employing a vascular sheath placed via the transjugular approach in combination with a snare device was impossible. A thrombus occupying the apical hook made it difficult to snare the hook, also one filter leg was incorporated into the inferior vena cava wall. Therefore we modified an existing method to withdraw the filter. As the first step, the filter cone was snared using the snare-over-guide wire loop technique, and the cephalad site of the filter was introduced into the sheath. Then, a 12-French sheath was advanced from the femoral vein and, using a pusher, the distal legs of the filter were pushed, which resulted the filter leg that was incorporated into the inferior vena cava wall became detached. Finally the filter was successfully retrieved.
with embolus. Also it was found that there were deep venous thrombi distributing in the left iliac, femoral and popliteal veins that were extended to the inferior vena cava (IVC) at the lower level of the renal vein.

To prevent further deterioration, a GTF was implanted at the suprarenal IVC through the right jugular vein under local anesthesia. Anticoagulation therapy with intravenous heparin followed by warfarin sodium given by mouth was administered. In addition, catheter-directed thrombolysis was performed to DVT.

Twenty-seven days later, enhanced CT showed that the pulmonary embolism and DVT were greatly reduced. The patient also became asymptomatic and retrieval of the GTF was attempted.

At first, the standard method was employed using the GTF retrieval set supplied by the manufacturer (Cook). Devices for retrieval were inserted from the right jugular vein. The details of techniques to retrieve GTF are described elsewhere. However, snaring the hook was impossible despite perseverance. Hence, we attempted to use the snare-over-guide wire loop technique which was firstly described by Kuo et al.

A 4-French angled catheter (Medikit, Tokyo, Japan) was inserted into the retrieval catheter of GTF retrieval set (Cook) to enter inside of the cone from a space between one of the filter legs and an additional wire was to emerge from another space. A 0.035-inch, 150-cm-long hydrophilic guide wire (Terumo, Tokyo, Japan) was inserted into the previously inserted 4-French angled catheter. Then a 90-degree-angled loop (7 mm in diameter) Amplatz gooseneck snare wire (Microvena, White Bear Lake, MN, USA) inserted into a micro-catheter was coaxially advanced from the retrieval catheter, as was the 4-French angled catheter (Medikit). The snare wire captured the distal edge of the hydrophilic guide wire that had been advanced from the 4-French angled catheter (Medikit) through the inside of the cone of GTF (Fig. 1A). The end of the hydrophilic guide wire that snared and looped through the GTF was maintained in the sheath, while both 4-French catheter and snare wire were pulled toward the cephalad site with tension maintained at both ends. The retrieval catheter and outer sheath were then advanced toward the apex of the filter so that the cephalad side of GTF was introduced into the outer sheath.

However, when the distal end of the sheath reached the distal end of the legs of GTF, we felt strong resistance in advancing the sheath over the entire GTF assembly. One of the legs was incorporated into the contacted IVC wall and could not detach (Fig. 1B). Therefore, we withdrew both Amplatz gooseneck snare wire (Microvena) and micro-catheter.

As an alternative, we attempted to use a method that we modified for this case. A 0.035-inch, 260-cm-long, hydrophilic guide wire (Terumo) was newly inserted through the retrieval catheter and advanced to the right iliac vein. Subsequently, a 12-French, 90-cm-long sheath (Medikit) was inserted from the right femoral vein. By selecting the tip, the hydrophilic guide wire was advanced directly into the inside lumen of the 12-French sheath and the distal end of the guide wire was pulled extra-corporeally out of 12 French sheath.

The inner dilator was inserted into 12-French sheath and advanced over the hydrophilic guide wire, which was passed from the right jugular vein and pulled out of the right femoral vein through GTF with tension maintained at both ends. This procedure oriented the distal legs of the GTF toward the pusher and the 12-French sheath lumen. Using the inner dilator, we gently pushed the distal edge of the legs several times and the incorporated leg was finally detached. Then 12-French sheath was advanced to cover distal tips of all GTF legs (Fig. 1D). Using inner dilator, distal edge of legs as well as entire GTF assembly were moved into the retrieval catheter and was successfully withdrawn. A thrombus, which was too small to be recognized on pre-removal cavogram, occupied the hook part of the apex of the GTF. This was considered to be the reason we could not initially snare the hook by standard method. Additionally, a small amount of thrombus captured in the cone was observed. A part of tissue from IVC wall was also attached at one of GTF leg.

For all of above-mentioned procedures, written informed consent was obtained from the patient.

**Discussion**

The GTF is a retrievable vena cava filter but also functions as a permanent filter. Ease and high frequency of success in retrieval have been described. Millward et al. reported a high success rate of 98% (52 out of 53 GTFs). According to initial clinical reports of retrieval of GTFs, the maximal period of implantation before successful retrieval was recommended to be no longer than 10–14 days. This period was based on results of animal investigation that showed filter legs were incorporated into the contacted IVC wall due to the reaction of IVC
endothelium and this was accounted for the difficulty in retrieving the device.\(^8\)

Some recently published clinical studies,\(^6, 9, 10\) however, reported successful retrieval of GTF after a longer period of implantation. Millward et al.\(^6\) noted that the maximal period of implantation before successful retrieval was 25 days, Terhaar et al.\(^9\) reported a period of 126 days, and more recently Binkert et al.\(^10\) reported a period of 317 days. However, although retrieval has been successful beyond 10–14 days, the incidence of filter fixation to the caval wall increases after 16 days by animal investigation.\(^8\) Other factors that would make retrieval difficult include tilting of the filter resulting in the hook of the apex becoming attached to the side wall of IVC, failure to snare the hook,\(^11\) and formation of thrombus in the hook of the apex which make snaring impossible.

For such cases in which retrieval of a GTF is difficult by standard retrieval technique with snare device, Kuo et al.\(^7\) described the snare-over-guide wire method, which we used as an alternative in the present case. They successfully employed their technique for 4 consecutive patients in whom snaring the cephalad hook of the filter could not be achieved with the standard method.

In the present case, retrieval by the standard method using only a snare was difficult for two reasons: 1) the hook of the apex was occupied by a small thrombus, 2) the barbed hook of the leg was incorporated into IVC wall due to IVC endothelial reaction. Both of these events might have been caused by the relatively long implantation period, although the period of implantation was within the period previously reported in which GTF was successfully retrieved.\(^9, 10\) To overcome the first problem, we used the snare-over-guide wire method after which the cephalad site of the filter was introduced into sheath.

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**Fig. 1** A 15-year-old woman with pulmonary embolism caused by deep venous thrombus.

A: Roentgenogram shows the first half of the snare-over guide wire technique. A 4-French catheter had been inserted into the retrieval catheter. With the aid of the 4-French catheter whose angled tip was introduced into the filter cone (large arrow), a 0.035-inch 150-cm-long hydrophilic guide wire was directed in a retrograde direction through the interstices of the filter to form a guide-wire loop. The free end of the wire was snared by a 90-degree-angled loop (7 mm in diameter). Amplatz gooseneck snare wire inserted into a micro-catheter that was coaxially advanced from the retrieval catheter, which also held the 4-French angled catheter (arrowhead).

B: Roentgenogram shows that the entire filter assembly was introduced into the sheath with the exception of the distal edge of the legs (arrow).

C: Roentgenogram shows that a 0.035-inch, 260-cm-long, hydrophilic guide wire (arrow) inserted through the retrieval catheter was advanced to the right iliac vein and its tip was pulled extra-corporeally out of the 12-French sheath (arrowhead) inserted from the right femoral vein.

D: Roentgenogram shows that the 12-French sheath was advanced to cover the distal tip of all filter legs (arrow) after detaching the leg from the IVC wall by pushing distal edge with a pusher.
In addressing the second issue, we used a 12-French sheath advanced from the femoral vein and, using a pusher, pushed the distal legs of the filter until the leg that was incorporated into the IVC wall was detached.

REFERENCES


