The Use of Paired Optionally Retrievable Günther Tulip Filters in Trauma Patients with Anatomical Variants

Nghia-Jack Vo, M.D.,¹ Karen W. Wieseler, M.D.,¹ Thomas R. Burdick, M.D.,¹ Gaurav K. Goswami, M.D.,¹ Sandeep S. Vaidya, M.D.,¹ and R. Torrance Andrews, M.D.¹

ABSTRACT

Inferior vena cava (IVC) filtration is commonly performed to protect against pulmonary embolism in acutely injured patients with contraindications for anticoagulation therapy. Increasingly, optionally retrievable IVC filters are utilized, particularly in younger patients with longer life expectancies. There are well-described anatomical variants that preclude the typical infrarenal deployment of IVC filters. We describe three cases in which trauma patients with congenital anomalies required temporary prophylaxis with IVC filters. One patient had a duplication of the IVC requiring filter deployment in each IVC limb. The second patient had a low inserting accessory left renal vein, and a third patient had a megacava. Both of these patients required filter deployment in each common iliac vein. In each case, a pair of optionally retrievable Günther Tulip filters was deployed and subsequently retrieved.

KEYWORDS: Inferior vena cava, filter, anatomical variant

Objectives: Upon completion of this article, the reader should be familiar with the benefits and risks of inferior vena cava filtration, know the indications for placement of optionally retrievable inferior vena cava filters, be knowledgeable about common anatomical variations of the inferior vena cava, and recognize possible challenges in filter retrieval.

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Venous thromboembolism is a significant potential source of morbidity and mortality in patients with diminished mobility, with a reported incidence as high as 58%.¹ Prophylactic therapies include systemic anticoagulation and the use of sequential compression devices on the legs. Anticoagulation is also used in the active treatment of thrombosis that has already developed.

However, in certain instances anticoagulation is contraindicated and the use of external mechanical devices for prophylaxis is infeasible or impractical, particularly in patients with lower extremity injuries or external fixation devices.² Inferior vena cava (IVC) filtration is increasingly considered a viable option for prophylaxis against pulmonary embolism (PE) in such cases. Although IVC

¹Department of Radiology, Section of Vascular and Interventional Radiology, University of Washington and Harborview Medical Center, Seattle, Washington.

Address for correspondence and reprint requests: Nghia-Jack Vo, M.D., Department of Radiology, Section of Vascular and Interventional Radiology, University of Washington, 1959 N.E. Pacific, Seattle, WA 98195.

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filters clearly provide short-term value, permanent indwelling filters have potential long-term consequences that must be considered, particularly in younger patients with longer life expectancies.³ It is for this reason that optionally retrievable filters have become commonplace. They offer short-term protection against pulmonary embolism yet can be retrieved at a later time when the risk of PE or the contraindications for anticoagulation therapy have passed.

Ideally, an IVC filter is placed in the infrarenal vena cava with its tip approximating the renal venous inflow. However, this may be inappropriate in patients with certain anatomical variants, including very large vena cava (megacava), duplications of the infrarenal IVC moiety, and low-lying accessory renal veins, that if below the site of filter deployment could provide a collateral pathway for emboli. We describe three cases in which trauma patients with congenital anomalies only required temporary prophylaxis with vena cava filters. One patient had a duplication of the IVC requiring filter deployment in each IVC limb. A second patient had a low inserting accessory left renal vein, and the third had a megacava, both requiring filter deployment in each common femoral vein. In each case, a pair of optionally retrievable Günther Tulip filters (Cook, Bloomington, IN) was deployed and subsequently retrieved.

CASE REPORTS

Patient 1

The first case involved a 42-year-old man who presented with multiple traumatic injuries, including pelvic fractures and vertebral fractures with associated spinal cord contusions. He was found by duplex imaging to have developed infrageniculate deep vein thrombosis (DVT). Immediate anticoagulation was contraindicated by his injuries, so prophylactic optionally retrievable filter placement was requested. A cavagram performed in preparation for IVC filter placement demonstrated the presence of a duplicated infrarenal IVC (Fig. 1). To provide bilateral prophylaxis against PE, paired Günther Tulip filters were deployed, with one in each IVC moiety (Fig. 2). Both filters were deployed via a single right internal jugular vein approach. Seven days following filter deployment, and after the delayed initiation of anticoagulation, both filters were successfully retrieved, again via a right internal jugular vein approach. Each filter was captured using a 15-mm trilobe snare (EnSnare; InterV, Dartmouth, MA) through a 9F sheath. We initially encountered some difficulty in directing the snare into the left moiety to engage the retrieval hook of the filter, but we were successful in doing so with the use of a Judkins left coronary guiding catheter (Fig. 3). Once

Figure 1 Venography before inferior vena cava (IVC) filter deployment demonstrates presence of duplicated IVC. (A) Selection of left common iliac vein with catheter crossing communicating iliac vein demonstrates both left IVC (LIVC) and right IVC moieties, components consistent with duplicated IVC. (B) Selective digitally subtracted venogram of LIVC moiety demonstrates left renal vein communicating with the common suprarenal IVC.

Figure 2 Spot image following deployment of retrievable Günther Tulip filters in each inferior vena cava moiety.

the filter had been engaged, the capture sheath was easily advanced over it.

Patient 2

The second case involved a 24-year-old man who presented with multiple pelvic fractures and lower extremity injuries requiring internal fixation. The patient required numerous blood products for resuscitation and developed significant coagulopathy. On hospital day 2 the patient had an episode of acute oxygen desaturation that was clinically concerning for pulmonary embolism. He was not then a candidate for anticoagulation or sequential compression devices, and therefore temporary filter protection was requested. The initial cavagram demonstrated a large accessory left renal vein inserting 2 cm cranial to the confluence of the common iliac veins (Fig. 4). It was believed that placing a filter above the vein would leave a potential collateral avenue for PE, but there was insufficient space in which to place an IVC filter caudal to this vein. As a result, paired optionally retrievable Günther Tulip filters were deployed, with one device in each common iliac vein (Fig. 5). The patient's condition subsequently stabilized enough to allow anticoagulation, and 5 days after filter deployment both were

successfully retrieved via a right internal jugular vein approach using a 15-mm trilobe snare (EnSnare) and a 9F sheath.

Patient 3

The third case involved a 48-year-old woman who presented with an acute equestrian injury and extensive open wounds involving her thigh and lower extremities. On initial presentation, she required arterial embolization of multiple intercostal arteries to control bleeding that had caused a large flank hematoma with an associated abrupt drop in her hematocrit value. During the hospital course she had developed a right external iliac vein DVT and was not a candidate for anticoagulation therapy due to associated injuries. As a result, a request was made for temporary filter protection. Vascular access was obtained from the left common femoral vein, with the intent of placing a single optionally retrievable filter in the typical infrarenal position, and a cavagram was performed using a 5F marking pigtail catheter. This demonstrated a large IVC (megacava) that measured 30 mm in diameter (Fig. 6). There are no optionally retrievable IVC filters approved for use in patients with a megacava anatomical variant. As a result, a Günther Tulip filter was deployed in the left common iliac vein. Subsequently, access was obtained via the right internal jugular vein and a second Günther Tulip filter deployed in the right common iliac vein. Sixty-seven days following the placement of the optionally retrievable filters, the patient's wounds had adequately healed, and in the interval she was initiated on and achieved therapeutic anticoagulation levels on warfarin. Follow-up duplex evaluations had shown resolution of the right external iliac vein DVT. This offered the opportunity to retrieve the filters (Fig. 7). Both filters were successfully retrieved via a right internal jugular vein approach using a 15-mm gooseneck snare and a 9F sheath after initial venograms demonstrated no significant residual thrombus burden with the filters, with particular attention on the right. Of note were some challenges in retrieving both filters due to angulation of each hook in close proximity to the venous wall. The right iliac filter required the use of a 10-mm-diameter angioplasty balloon to help separate the apex of the filter away from the venous wall, which then allowed for relatively simple engagement of the retrieval hook. Subsequently, the sheath was easily advanced over the filter and removed without incident. The left common iliac vein filter required the snare to be advanced over a wire in a monorail fashion, which then again allowed for the retrieval hook to be easily engaged with the snare. The sheath then again easily advanced over the filter to allow removal.

Figure 3 Retrieval of paired inferior vena cava (IVC) filters (Günther Tulip retrievable filters) 7 days after initial deployment in trauma patient with duplicated IVC via typical right internal jugular vein approach. (A) Venogram before filter retrieval demonstrates absence of caval thrombosis. (B) Hook of left IVC filter captured with 15-mm trilobe snare. Capture of the hook facilitated with use of Judkins left coronary guiding catheter. Capture sheaths were easily advanced over each filter after engagement.

DISCUSSION

Venous thromboembolism is a significant source of morbidity and mortality in trauma patients and others who are immobilized for long periods, and it is reported to occur in up to 58% of this population in the absence of prophylaxis.⁴ Although the risk of subsequent PE is lower, the potential result of such an event can be catastrophic. Patients with multiple pelvic fractures and/or spinal cord injuries, as in the cases presented, are among the group of trauma patients with the greatest risk for development of DVT and PE.⁵ Although the typical strategy for at-risk patients is to use some form of DVT prophylaxis such as anticoagulation or sequential compression devices, some patients have injuries that preclude these standard DVT prophylactic measures. Trauma and postsurgical patients are prone to bleeding with anticoagulation, and mechanical devices are often impractical or frankly contraindicated in patients with lower extremity injuries or those that require external fixation devices.²

In a patient who is at risk for DVT with subsequent pulmonary embolism, and who is not a candidate for typical prophylactic measures, the deployment of an IVC filter has become a common, if not universally accepted, alternative. Although IVC interruption with a filter does not prevent development of DVT, it reduces the risk of clinically significant PE.

Filter-related complications are uncommon, but their incidence increases with longer dwell times. As a result, some authors have advocated against the use of filters, especially in younger patients.⁴ Linsenmaier argues that the known potential complications of permanent IVC filters should preclude their routine prophylactic use, and that optionally retrievable filters should instead be considered for all young patients and those with an otherwise normal life expectancy.⁶

Optionally retrievable filters are an alternative to permanent IVC filters for patients in whom the anticipated period of risk for PE or contraindication to anticoagulation is likely of short and specific duration.⁶ In such cases, they serve as an effective bridge until other prophylactic measures can be initiated or resumed.⁴ Retrievable filters offer the benefit of protection against PE during the early immediate injury and perioperative periods when risk is highest while avoiding the potential long-term sequelae of filters that remain in place permanently.¹ Optionally retrievable filters differ from earlier remotely tethered “temporary” filters in that eventual removal of the latter was mandatory. Although designed for removal, optionally retrievable filters can be left in place permanently if the clinical situation warrants. Their availability and an increasing volume of efficacy and safety data have made

Figure 4 Venography via right internal jugular vein approach demonstrates low insertion of left renal vein precluding typical infrarenal inferior vena cava filter deployment in patient with multiple injuries following recent trauma. (A) Contrast injection into the left common iliac vein for venography shows a contour irregularity (arrow), suggesting presence of large accessory renal vein ~2 cm from iliac vein confluence. (B) Selective catheterization of this structure with venography confirms presence of congenitally anomalous left renal vein.

this class of filter an increasingly attractive and viable option.

In addition to having a need for short-term protection against the risk of PE, the three patients described were further complicated by having congenital anomalies that precluded the typical infrarenal deployment position for an IVC filter.⁷ As a result, paired filters were required for sufficient protection against PE. Such an approach using permanent filters has been well documented in the past, but we could not find prior descriptions of paired optionally retrievable filters deployed and subsequently retrieved in an individual patient.

Duplication of the IVC is an uncommon but well-recognized anatomical variation, with a reported incidence of 2.2 to 2.8%.^{8,9} It represents persistence of both right and left caudal supracardinal veins.¹⁰ Normally, the left supracardinal vein will regress in week 6 of gestation and only persist as a component forming the left common iliac vein. Failure of normal regression results in the persistent communication between the left common iliac vein and the left renal vein.⁸ Typically, the right IVC moiety is larger than the left and continues to carry a significant portion of venous outflow from the left leg and pelvis. However, in some cases, the entire

volume of blood flow from the left leg and pelvis drains exclusively through a large-caliber left IVC that terminates in the left renal vein. In our case, the IVC components were comparable in caliber.

Duplication of the IVC is typically asymptomatic but becomes clinically important during IVC filter deployment.⁸ Filtration of only one route is ineffective due to the potential for thrombus to embolize through the contralateral moiety.¹¹ IVC interruption options in patients with duplicated IVC are multiple, and previous descriptions include permanent filter placement in each IVC limb, deployment of a single filter in the suprarenal vena cava (which is unpaired), placement of a filter in the right IVC at the normal infrarenal location with concurrent embolization of the duplicated left moiety, and placement of a filter in the right IVC system with concurrent embolization of the point of communication with the duplicated segment.⁸ We elected to deploy a retrievable Günther Tulip filter in each IVC limb to protect against potential thrombus migration through the duplicated left IVC route. Each filter was successfully retrieved 7 days following deployment without complications via a typical right internal jugular approach.

Figure 5 (A) Venogram through deployment sheath confirms placement of paired Günther Tulip filters in each common iliac vein in patient with history of pelvic trauma and congenital anomaly of left renal vein. (B,C) Both filters successfully retrieved 5 days later via typical right internal jugular vein approach using 15-mm trilobe snare.

Figure 6 Cavagram performed using 5F marking pigtail catheter demonstrates large inferior vena cava (megacava) that measured 30 mm in diameter.

The incidence of retroaortic left renal vein (LRV) ranges from 1 to 3%. The retroaortic segment results from persistence of a retroaortic anastomotic channel and a segment of the left supracardinal vein that

connects the left kidney to the IVC.¹⁰ The insertion site of the retroaortic LRV into the IVC varies, and it can occur anywhere from the level of the normal contralateral renal vein insertion to a more caudal location near the confluence of the common iliac veins.

If a duplicated renal vein is large, it can provide a collateral pathway for thromboemboli to bypass a filter located between the two duplicated moieties. Therefore, when a large duplication is identified, the filter is typically placed caudal to the more caudal vessel. However, when the length of the IVC below the entrance of the variant insertion site is very short, one must choose between placing a single filter in the suprarenal vena cava and placing paired filters in the common iliac veins. The latter option has long been a consideration when infrarenal caval deployment of a filter is not feasible.¹² In our patient, the short infrarenal length precluded the deployment of any filter in an infrarenal location. We opted instead to place an optionally retrievable Günther Tulip filter in each common iliac vein. As is typical with our other patients in whom retrievable filters are deployed, we were successful in retrieving these filters 5 days after initial deployment when the contraindications of anticoagulation had passed.

Megacava is a term used to describe a vena cava with a diameter > 28 mm. Prince et al had 3% of their patient population noted to have IVC diameters > 28 mm.¹³ The concern in patients with megacava in which IVC filter placement is considered is the potential risk of filter migration. Several permanent filters are available and approved for use in such cases. However,

Figure 7 (A) Sheath easily advanced over right common iliac vein filter after successful engagement of retrieval hook using a 15-mm gooseneck snare. (B) A 15-mm gooseneck snare advanced in monorail fashion over guidewire to successfully engage retrieval hook of left common iliac vein filter. Sheath was then easily advanced over filter to allow successful retrieval.

no optionally retrievable filters are approved for use in patients with megacava. As a result, in our third case it was opted to deploy a Günther Tulip filter in each common iliac vein.

Potential challenges can be encountered with retrieving filters positioned in the common iliac veins that are deployed in a tilted position, much like those encountered with tilted filters placed in the IVC. Potential problems could arise from two common mechanisms: (1) The tip is in contact with the venous wall and prevents the snare from successfully engaging the retrieval hook, and (2) there is endothelialization or fibrotic tissue adherence over the retrieval hook. The deployment of filters in the common iliac vein without tilting can be significantly more challenging compared with those placed in the IVC, particularly from a jugular approach. Unlike filters deployed in the IVC, the modified technique described by Lopera et al in which back tension can be used to help reduce filter tilting during deployment may not be as useful due to the inherent angled path of the common iliac vessels.¹⁴ This issue further stresses the importance of directing the retrieval hook away from the vessel wall to increase the likelihood for successful engagement of the hook during the retrieval attempts. Additional techniques available to interventional radiologists to engage the retrieval hook include, as we did, the use of a monorail technique in which a snare is advanced over a guidewire that was positioned between the engagement hook and vessel wall. If there is adherence of the filter to the vessel wall, then considerations could be made for balloon angioplasty to aid in the separation of the endothelialized component away from the vessel wall. Although challenges may arise in retrieval with a greater time interval, filters have been reported to be successfully retrieved after as long as 126 days.¹⁵

In each case described, the patient could potentially have been treated with a single IVC filter in a suprarenal location. However, suprarenal filters can lead to renal venous compromise in the event of filter occlusion by thromboemboli. They may also be at increased risk for migration due to respiratory motion and entrapment by guidewires or other implanted devices. Each patient was also a candidate for placement of permanent filters, rather than optionally retrievable devices. The latter were chosen because each patient was relatively young with a long remaining life expectancy and were believed to be at only transient risk for pulmonary emboli. In each case, Günther Tulip filters were used and offered the benefit that allowed for each filter to be successfully retrieved using a single right internal jugular vein approach. In addition, it allowed for the flexibility to deploy from either a jugular or femoral approach. The use of the Günther Tulip

filter is what our interventional laboratory is most familiar with, but the use of alternative manufacturers' optionally retrievable filters would likely offer similar clinical benefits.

CONCLUSION

We have described the deployment and subsequently successful retrieval of paired optionally retrievable Günther Tulip filters in three patients with congenital venous anomalies. This approach should be considered in patients with congenital anomalies that preclude the typical infrarenal deployment of IVC filters and who require only short-term prophylactic protection.

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