

Embedded Inferior Vena Cava Filter Removal: Use of Endobronchial Forceps

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PURPOSE: Removing a retrievable inferior vena cava (IVC) filter can be extremely difficult with the use of standard techniques if the filter is tilted and embedded in the wall of the IVC. The use of rigid endobronchial forceps has been described in case reports to remove embedded IVC filters, and the present report describes the use of this technique to remove a series of tip-embedded IVC filters in two separate institutions.

MATERIALS AND METHODS: The medical records were reviewed of 21 consecutive patients at two institutions who underwent attempted IVC filter removal with rigid endobronchial forceps over a 34-month period. The mean age of patients was 32.4 years (range, 14.1–54.1 y). The patients had the following filters: Recovery ($n = 6$), G2 ($n = 10$), Günther Tulip ($n = 4$), and OptEase ($n = 1$).

RESULTS: Rotational or biplane venography was used to confirm that the filters were tilted and embedded in the wall of the IVC in all 21 patients. Rigid endobronchial forceps were used successfully to remove 20 embedded IVC filters in 21 patients. There was one case of failure to remove an embedded suprarenal G2 filter. There were no major complications.

CONCLUSIONS: Rigid endobronchial forceps may be used as a reliable option for removal of embedded IVC filters.

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Abbreviations: DVT = deep vein thrombosis, IVC = inferior vena cava

RETRIEVABLE inferior vena cava (IVC) filters are designed to be removed if the filter is no longer needed or may be left in place as a permanent device (1,2). Multiple studies have demonstrated that retrievable filters are safe to deploy and can be removed with a high rate of success if caval filtration is no longer deemed neces-

sary (3–5). However, many retrievable filters are not retrieved (6). Reasons for not retrieving an IVC filter include the need for permanent IVC filtration, the duration of required IVC filtration being longer than the filter's window of retrievability, the patient being lost to follow-up, a large amount of clot trapped in the filter, and technically unsuccessful filter removal attempts (2,7).

Currently, there are two retrievable IVC filters approved by the United States Food and Drug Administration: the OptEase filter (Cordis, Miami Lakes, Florida) and the Günther Tulip filter (Cook, Bloomington, Indiana). Both these filters can be retrieved with the use of a snare device. The G2 filter (Bard Peripheral Vascular, Tempe, Arizona) is currently approved by the Food and Drug Administration as a permanent device, but it may be removed on an off-label basis with the use of a 10-F proprietary retrieval de-

vice (Recovery Cone; Bard). Similarly, the predecessor to the G2 filter, the Recovery filter (Bard), was approved as a retrievable filter that could be removed with the Recovery Cone. The Celect filter (Cook) is another approved permanent filter that can be retrieved on an off-label basis with the use of a snare. Although the standard techniques for IVC filter removal are successful in the vast majority of cases, there are instances when filters cannot be removed with standard techniques (4,8). This is an increasing problem and usually occurs as a result of filter tilt, which then causes the tip of the filter to be embedded in the wall of the IVC. Alternative techniques for IVC filter removal have been described, including the use of rigid bronchoscopy forceps (9,10). This article reports the use of the forceps technique to retrieve a variety of tip-embedded filters (Recovery, G2, Günther Tulip filter, and OptEase) at two institutions.

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MATERIALS AND METHODS

Institutional review board approval was granted for this retrospective study. Imaging studies and medical records of patients who underwent IVC filter removal with rigid endobronchial forceps (model 4162; Bryan, Woburn, Massachusetts) at two institutions were reviewed and included in this study. All patients underwent an extensive informed consent process before this procedure, and it was explicitly discussed with the patients that this represented off-label use of the products involved.

Over a 34-month period, 21 patients presented to the interventional radiology divisions of two institutions with IVC filters that could not be removed with standard techniques because the tip of the filter was embedded in the wall of the IVC. This group included 15 female patients and six male patients with a mean age of 32.4 years (range, 14.1–54.1 y). Four of the patients were included in the initial description of this technique (9), and Burke et al (10) subsequently described one of the patients in a case report.

Five of the filters had been initially placed for prophylaxis before bariatric surgery. Filters had been placed in 10 patients who had a history of pulmonary embolism and/or deep vein thrombosis (DVT) with a contraindication to anticoagulation. Five filters had been placed in patients who had a history of trauma with lower-extremity long bone fractures. One patient was homozygous for factor V Leiden and developed recurrent pulmonary emboli despite anticoagulation 1 week after a miscarriage and dilation and curettage.

The filters were removed in 12 patients (57%) because protection from venous thromboembolic disease and pulmonary embolism was no longer needed. In eight of the patients (38%), the filters were referred for removal because the patients were able to tolerate anticoagulation. The one patient with factor V Leiden developed upper abdominal and chest pain more than 3 years after insertion and was found to have a tilted, embedded filter with three legs that had embolized to her heart and lungs before any attempt at filter removal was performed. Nine of the filters had been placed at outside

institutions and were referred to one of the two medical centers after unsuccessful attempts at filter removal with use of standard techniques with the Recovery Cone or a snare. In these patients referred from outside hospitals, initial venography revealed that the tip of the filter was embedded in the IVC, and therefore the initial removal attempt at our institutions was made with the endobronchial forceps. In seven of the patients who were not referred from outside hospitals, initial cavography demonstrated the tip of the filter to be embedded, and the forceps were therefore used as the initial (and only) device to remove the IVC filters. In five of the patients, the endobronchial forceps were used after an initial attempt at removal with standard techniques by the authors failed.

Before attempted IVC filter removal, all patients underwent imaging with lower-extremity Doppler ultrasound (US) of the deep veins or computed tomographic (CT) venography of the IVC with extension to the lower extremities. The US images ($n = 9$) were obtained to evaluate for lower-extremity DVT. The CT venograms ($n = 12$) were obtained to evaluate for DVT and also allowed for evaluation of the IVC and filter before attempted IVC filter removal to look for filter tilt and clot trapped in the filter.

RESULTS

No patient was refused a filter retrieval attempt. The forceps were used to remove 20 IVC filters in 21 patients at two institutions (13 at one institution and eight at the other) that could not be removed with standard techniques. Therefore, on an intent-to-treat basis, the success rate of removal with forceps was 95%. No major complications occurred during the retrievals.

Retrieval attempts of Recovery IVC filters ($n = 6$), G2 filters ($n = 10$), and Günther Tulip filters ($n = 4$) were performed via right internal jugular vein access. Venography of the IVC and filter was performed in all patients. Rotational venography was performed in 12 patients with an injection of 7 mL/sec of nonionic contrast medium (Visipaque; GE Healthcare, London, England) for 12 seconds while the C-arm gantry rotated 120° (Multistar TOP or Artis Axiom d-TA; Siemens, Erlangen,

Germany). In eight patients, the filters were removed with biplane fluoroscopy guidance (Neurostar; Siemens).

When an embedded filter is diagnosed on venography, the key imaging features include an unopacified tissue cap around the tip of the filter or projection of the tip of the filter outside the opacified lumen of the IVC. After detailed venography, a 12- or 14-F, 40 cm sheath (Cook) with an aerostatic valve was placed into the IVC from the right internal jugular vein just superior to the filter. Rigid bronchoscopy forceps were placed through the sheath just superior to the tip of the filter. The forceps can be gently bent to direct the forceps to the tip of the filter. This must be done carefully, as one set of forceps was broken when the tip was bent too aggressively. The forceps were then used to attempt to grasp the tip of the Recovery, G2, or Günther Tulip filter. Because the tip was embedded, the forceps were used to dissect the tip free from tissue around it in six patients. This tissue around tip of the filter was removed by pulling the tissue away from the tip with the teeth of the forceps. After the tissue was dissected free, the filter was moved into a less tilted position, more centered into the IVC. This usually happened spontaneously as soon as the tip was dissected free with the forceps. The centered filter was then removed with bronchial forceps or the Bard Recovery Cone. In 13 patients, after the tissue—which encapsulated the tip of the filter—was dissected away from the filter, the forceps were used to grab the tip of the filter and the filter was pulled directly into the sheath and removed.

In the one case in which the endobronchial forceps were used to remove the OptEase filter, a right femoral approach was used. Rotational venography was performed. A 12-F, 40-cm sheath was then placed from the right common femoral vein into the IVC just inferior to the hook on the OptEase filter. The tissue encapsulating the hook of the OptEase filter was dissected away using the teeth of forceps and the filter was then pulled into the sheath and removed.

Following IVC filter removal a venogram of the IVC was performed in all patients to evaluate for damage to the IVC or residual thrombus. All

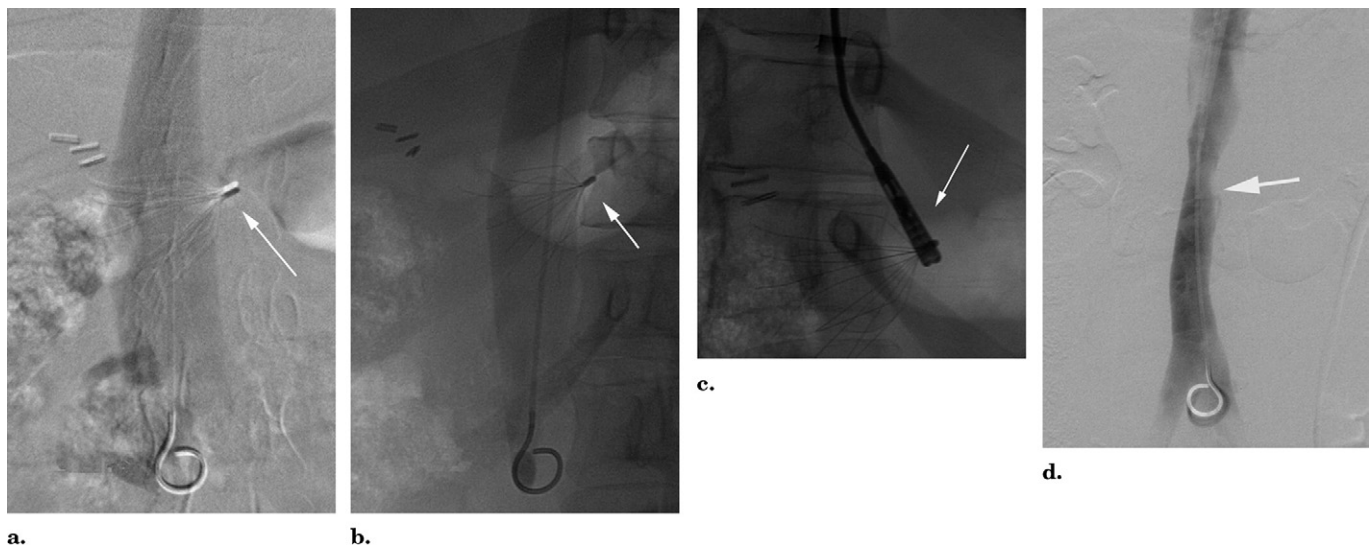


Figure. Subtracted (**a**) and unsubtracted (**b**) IVC images demonstrate the tip of a Recovery filter embedded in the wall of the IVC (white arrows). (**c**) The endobronchial forceps have been used to grasp the tip of the filter (white arrow). (**d**) IVC image after removal reveals mild narrowing of the IVC as a result of spasm and a small defect in the IVC that corresponds to the location of the embedded filter (white arrow).

filters were inspected to ensure that the entire filter was removed.

The average filter dwell time was 296 days (range, 26–1,251 d). Pre-removal imaging with US and CT venography revealed that no patients had lower-extremity DVT. Review of the cavograms before filter removal (**Figure, parts a,b**) revealed that, in 100% of cases, the IVC filters were tilted and the tips of the filters were embedded into the IVC wall. This resulted in a hood of tissue around the tip of the filter. Postremoval venograms (**Figure, part d**) revealed no evidence of contrast agent extravasation in any of the patients. In six patients, a small defect was seen in the wall of the IVC, which corresponded to the previous location of the filter. One of these patients was followed with CT, and at 9 months after filter removal, no caval injury was evident. In this same patient, two of the secondary struts of the Günther Tulip filter were inadvertently partially disrupted; however, the filter was ultimately removed intact. One subsequent patient also had partial disruption of one of the secondary struts of the Günther Tulip filter. Again, this filter was removed intact. None of these patients developed symptoms or had any signs of retroperitoneal hemorrhage. Clinical follow-up in all 20 patients

revealed no evidence of symptomatic recurrent PE or symptomatic caval stenosis or thrombosis after filter removal. Interestingly, the patient with Factor V Leiden was pain-free after the removal of her Recovery filter.

The endobronchial forceps technique failed in one patient (4.8%). A G2 filter had been placed at an outside hospital in the suprarenal IVC in a pregnant woman who developed DVT during her first trimester of pregnancy. After the birth of a healthy baby, the patient presented at the outside hospital for possible filter removal. A plain radiograph of the abdomen revealed that the filter was tilted nearly sideways. The patient was then referred to our center for filter removal. CT venography and rotational venography revealed a severely tilted filter that had its tip embedded in the wall of the IVC. The initial attempt at filter removal was made with the endobronchial forceps. After attempting to remove the filter for 45 minutes, the procedure was stopped. The tip of the filter could not be accessed. In addition, multiple attempts to remove the tissue around the embedded cap of the filter were not successful. The filter was left in place as a permanent device. No complications occurred during the failed attempt at removal.

DISCUSSION

Although permanent IVC filters have an excellent safety profile, late complications from these devices do occur, including an increased risk of DVT, late device fracture, and migration (1,11–13). The recent introduction and subsequent widespread use of retrievable IVC filters offer the hope of providing protection from pulmonary embolism while decreasing the risks of long-term filter complications. This promise of decreased complications will be realized only if the retrievable IVC filters are removed. All currently available retrievable IVC filters can easily be removed in the majority of cases with use of standard techniques (5,14–16). The difficulty of removing an IVC filter can be increased by lengthened dwell time, thrombus in the filter, and tilting of the filter (17,18).

The issue of filter tilt as the cause of retrieval failure as a result of the tip of the filter being embedded in the IVC wall is not uncommon, occurring in as many as 11.7% of attempted filter retrievals (7,19–22). When a filter is unable to be removed with use of standard techniques, it is often left in place as a permanent device. This is not an optimal outcome for many patients, as retrievable filters are placed in a younger group of patients compared with the traditional recipients of IVC

filters. In addition, there are no long-term data available showing a decade-long safety record of the currently available retrievable filters. Many patients do not feel comfortable having an IVC filter in place if it is no longer needed. This is especially true when they were told this was a retrievable device. For these reasons, patients often see removing these filters as a very high priority. However, the risks of any filter removal procedure must be weighed against the risks of leaving the filter in place as a permanent device. There are no data to suggest that retrievable filters are less or more safe than permanent filters when left in place for many years. Some patients do choose to allow the filter to be left in place rather than undergo attempted removal with the forceps.

Alternative techniques to remove a filter that is tilted have been described. Asch (4) described the use of an angled catheter to manipulate a wire toward the side of the filter tilt, which facilitates placement of a Recovery Cone over the filter. However, when the tip of the filter is embedded in the wall of the IVC, this technique will not work. Hagspiel et al (8) described a technique to straighten a tilted filter that involves placing a tip-deflecting wire through the center lumen of the Recovery Cone. The tip-deflecting wire is then placed through the filter struts and traction is applied to the wire to straighten the tilted filter. Kuo et al (23) described a technique for removing a Günther Tulip filter that had become tilted and embedded in the wall of the IVC. This technique involves the establishment of through-and-through guide wire access through filter struts and placement of a snare over the two wire ends. After engaging the filter hook and neck, the snare and sheath can be advanced over the filter and the filter can be removed. This technique was successful in four patients, with no treatment failures. Rubenstein et al (7) described a technique of removing embedded IVC filters by creating a wire loop between the filter legs and pulling the filter into a sheath. This technique was successfully used to remove four Günther Tulip filters and four Recovery filters.

Rigid bronchoscopy forceps were used in the present study to remove 20 IVC filters at two institutions. The pro-

cedures were performed by Certificate of Added Qualifications board-certified interventional radiologists. All filters in the present series were not only tilted, but venograms also showed the tip of each filter to be embedded in the wall of the IVC. Although this technique was successful in all but one patient in whom it was tried and has resulted in no permanent sequelae, it is recognized that this is a fairly aggressive technique. Mention of potential life-threatening complications (eg, filter fracture, filter migration, venous perforation) should be included during the consent process. Minor complications have occurred, including minor defects in the wall of the IVC and partial disruption of the secondary struts of Günther Tulip filters. The fine secondary struts of the Günther Tulip filter can be damaged by the teeth of the bronchoscopic forceps. Therefore, care must be taken to grasp only the hook of the Günther Tulip filter with the bronchoscopic forceps, not the more caudal portion of the filter where the primary and secondary struts coalesce. Endobronchial forceps should be used in the venous system only if it is demonstrated that the filter tip is embedded and cannot be removed with the use of standard techniques. At our institutions, the use of bronchial forceps has become the primary method for filter removal if preprocedural venography reveals that the tip of the filter is embedded in the wall of the IVC. Extended fluoroscopic times and potential complications such as filter fracture and dislodgment can be avoided if futile attempts at filter removal are not performed with a snare or Recovery Cone after an embedded filter is recognized. In addition, because the forceps enable the operator to dissect free the tissue covering the embedded filter, this technique may offer advantages versus other techniques, which may not successfully disrupt the fibrous tissue cap.

As the use of retrievable filters increases, the need for widely adaptable techniques to remove embedded IVC filters will increase. The use of the rigid bronchoscopy forceps allows embedded filters to be removed safely in patients who would otherwise have a tilted filter left in place permanently when it is no longer needed.

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