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INTERVENTIONAL RADIOLOGY

TECHNICAL NOTE

Percutaneous retrieval of a Mobin-Uddin inferior vena cava filter 42 years following implantation

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ABSTRACT

Inferior vena cava filters (IVCFs) are an established alternative for protection from thromboembolism when anticoagulation fails or is contraindicated. Before the creation of retrievable IVCFs, patients received filters that were permanent or designed without standardized retrieval options. Although these filters were implanted for prolonged protection, chronic vena caval occlusion and post-thrombotic syndrome are potential sequelae. We present a 53-year-old patient with a Mobin-Uddin permanent IVCF placed 42 years prior, complicated by acute iliocaval thrombosis following more than 40 years of filter dwell time. She was successfully treated with thrombolysis, thrombectomy, endobronchial forceps assisted IVCF removal, and iliocaval stent reconstruction.

Pulmonary embolism (PE) is a devastating consequence of venous thromboembolism and contributes to a significant portion of preventable hospital death. Standard medical management of venous thromboembolism includes anticoagulation. Under circumstances where anticoagulant therapy is contraindicated or fails, clinicians have relied upon procedural interventions such as inferior vena cava filters (IVCFs) to block the migration of deadly emboli to the lungs. One of the earliest accounts of IVCF clinical data originated from placement of the umbrella filter by Kazi Mobin-Uddin in 1969 (1).

The Mobin-Uddin (MU) filter was designed to provide lifetime prophylaxis for patients; however, it is not devoid of thrombotic and filter-related postplacement complications. Thrombotic manifestations include acute caval thrombosis, chronic vena cava occlusion, and increased risk of subsequent deep vein thrombosis (DVT), which may further necessitate concurrent anticoagulation. Filter-related complications include penetration into adjacent viscera, migration, fracture, and embolization. The recovery process for retrievable vena cava filters is well documented in medical literature. In comparison, there seems to be a scarcity of insight regarding the removal of permanent inferior vena cava filters (pIVCFs). In this case report, we describe the retrieval tactics implemented in removing a MU filter in a patient who developed acute obstruction 42 years post filter placement.

Technique

The patient was a 53-year-old female with a history of ulcerative colitis status post pancolectomy and ileostomy who had a MU filter placed at age 11 following DVT with PE. There was no history of familial thrombophilia. She was asymptomatic for 42 years until she developed a left lower extremity DVT. This thrombotic event caused severe throbbing pain with swelling, and she was treated urgently at an outside facility with thrombolysis. During this procedure, venography demonstrated extensive occlusion at the iliocaval confluence with the development of numerous venous collaterals. Although thrombolysis alleviated the acute lower extremity DVT, the patient still experienced an array of symptoms secondary to increased occlusion at the vena cava. In particular, the patient experienced significant heaviness and swelling in both legs along with debilitating dyspnea and light-headedness with exertion, which was likely due to occlusion related decrease in venous return with subsequent reduction in cardiac output. The patient worked in an automobile manufacturing plant on the assembly line, and these symptoms considerably limited her quality of life and

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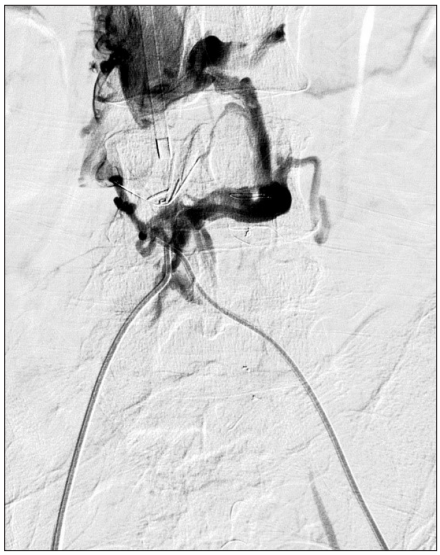

Figure 1. IVC venogram via right jugular catheter positioned in the caudal IVC and bilateral femoral access catheters positioned at the iliac venous confluence showing indwelling MU filter with iliocaval occlusion and pericaval collaterals.

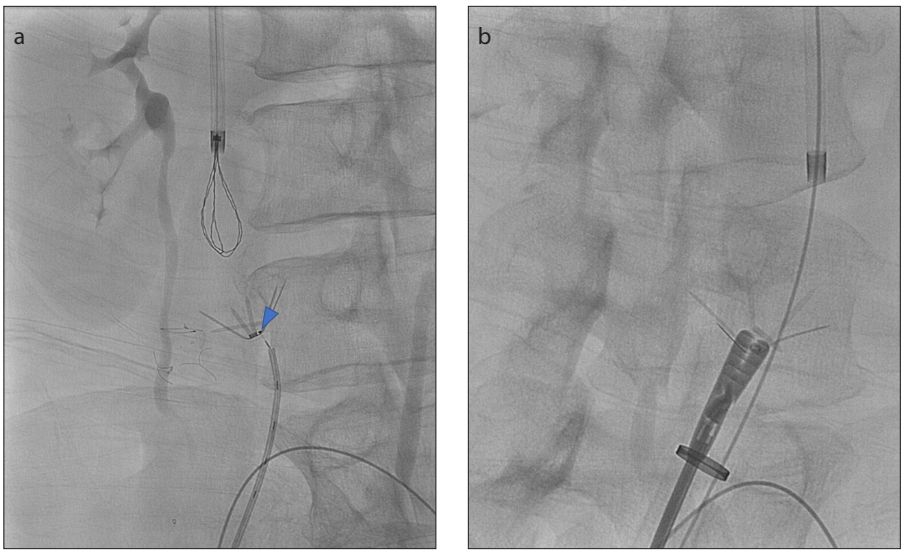

Figure 2. a, b. Panel **(a)** shows radiofrequency wire transversal (*blue arrowhead* marks wire tip) across the filter-associated thrombus and fibrotic tissue with snare device from above for targeting and subsequent thru wire access. Panel **(b)** shows endobronchial forceps withdrawal of filter elements into the 26 F sheath.

capacity to carry out occupational responsibilities. Additionally, she was noncompliant with anticoagulation due to repeated heavy bruising from job-related tasks. IVC stenting with the filter in situ was considered for the patient. However, the construction of the MU filter with multiple small holes within the silastic membrane covering the metallic skeleton to allow for blood flow was felt to likely constrain any stent deployed through the stent struts, and so this method was decided against. Thus, the constellation of clinical symptoms without a viable alternative treatment option warranted removal of the pIVCF and percutaneous iliocaval reconstruction due to filter associated chronic thrombosis of the IVC.

Main points

- Although retrievable vena cava filters remain a mainstay for thromboembolism prophylaxis with anticoagulation contraindication/failure, permanent filters do not have a standardized method of retrieval, and therefore have their own unique technical hurdles.
- We detail the procedural undertakings in the extraction and successful removal of a Kazi Mobin-Uddin permanent umbrella IVC filter that had a 42-year dwell time in a patient who presented with symptoms related to post-thrombotic syndrome.
- The removal process consisted of different technical steps including radiofrequency wire implementation, snare usage for through and through stability, and endobronchial forceps engagement.
- Following a technically successful filter extraction and subsequent iliocaval reconstruction, the patient had complete resolution of her activity-limiting post-thrombotic syndrome.

The procedure was performed under general anesthesia via bilateral common femoral and right internal jugular vein access. 12 F vascular sheaths (Terumo Medical) were placed with sonographic guidance over Glide Advantage guidewires (Terumo Medical) via each access site. Initial iliocaval venography revealed occlusion of the bilateral common iliac veins, left external iliac vein, and the inferior vena cava with extensive bridging collaterals (Fig. 1). After opening the occluded bilateral common iliac vein segments, 12 mm balloon dilation (Mustang, Boston Scientific) was executed for subsequent endobronchial forceps navigation. However, a presumed network of filter associated fibrosis and thrombus precluded filter engagement. Guidewire transversal of the occluded caval segment was also initially unsuccessful despite prolonged attempt and therefore radiofrequency guidewire (PowerWire, Baylis Medical) transversal was performed followed by engagement of the transversing wire from the jugular access with EN Snare (Merit Medical). This process facilitated through and through access for stability (Fig. 2a). Then, with a 14 mm balloon (Atlas, Boston Scientific), the occluded caval segment was dilated, the right femoral sheath was upsized to 26 F (Dry Seal, Cook Medical) and advanced adjacent to the filter. Through this access, large endobronchial forceps were used to free the filter and adherent fibrotic tissue complex from the caval wall. The complex was withdrawn into the sheath and removed in a subtotal manner (Fig. 2b). Three spokes of the filter were located extraluminally and were surrounded by dense fibrosis. The operator chose to leave these elements in situ.

The extensive bridging collaterals and narrow caval flow channel (Fig. 3a) observed on post-procedural venography were addressed through preliminary angioplasty of the stenosis (Fig. 3b) and 14 mm "kissing" iliocaval stent (SMART, Cordis Medical) reconstruction that extended into bilateral common iliac veins and the left external iliac vein. This followed with 14 mm balloon angioplasty of the stented iliocaval segments with subsequent restoration of antegrade flow and resolution of the venous collaterals (Fig. 3c). The patients' lower extremity symptoms resolved at a 1-week post-procedural evaluation. The patient returned 8 days later with recurrent right lower extremity pain and work-up revealed recurrent right iliac vein occlusion. AngioJet (Boston Scientific) power pulse thrombolysis with 6 mg tPA was followed by AngioJet thrombectomy for flow and luminal restoration. The right external iliac vein stent was extended caudally without any postprocedural complications. Regular clinical and cross-sectional imaging

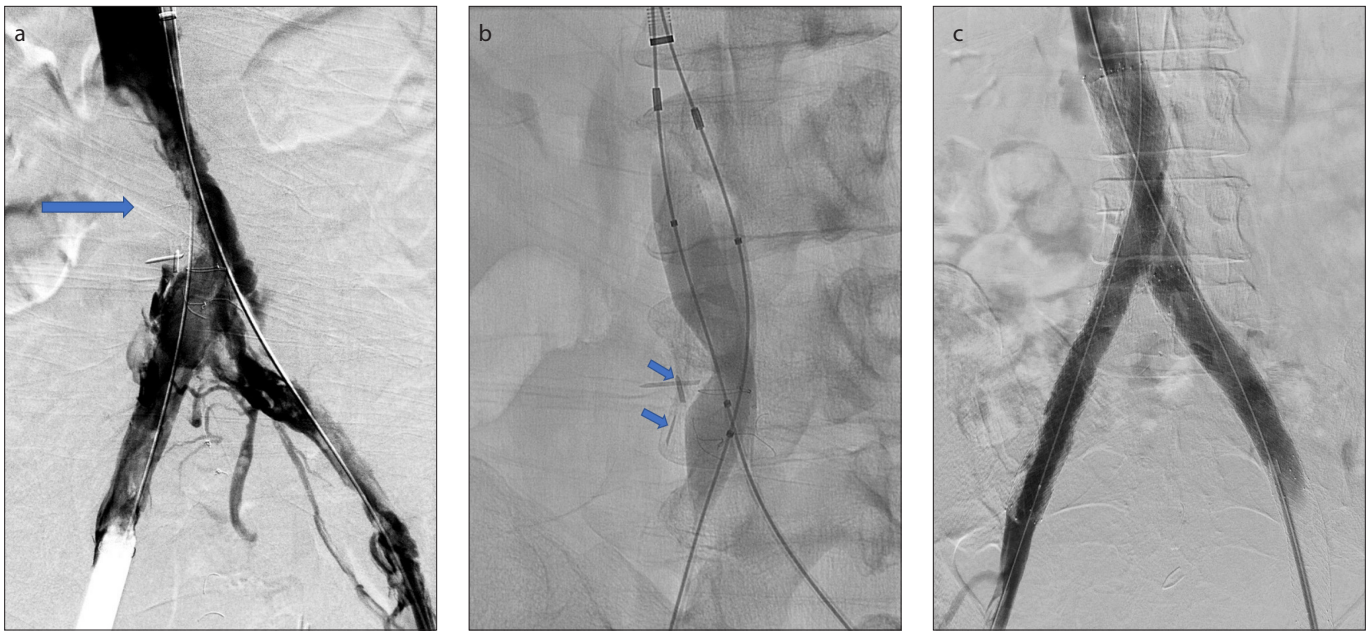

Figure 3. a–c. Post extraction venogram **(a)** illustrates flow marked narrowing *(blue arrow)* of the IVC with substantial flow channel irregularity. Panel **(b)** shows subsequent caval kissing angioplasty with three filter strut fragments *(blue arrows)* seen adjacent to the flow channel. Panel **(c)** shows catheter-based venogram following iliocaval reconstruction with "kissing" stent configuration with restoration of a patent caval lumen without irregularity and with the absence of previously noted venous collaterals.

follow up at 2 years shows continued patency of the reconstruction. The patient currently remains asymptomatic with normalized exercise tolerance and absence of lower extremity symptoms.

Discussion

The MU Filter (Edwards Laboratories) consists of a silicone umbrella design with 6 stainless steel alloy spokes protruding out from a center core (2). The umbrella filter is designed with and without sieves to maintain vessel patency or to induce complete occlusion. The fenestrated umbrella filter has either 48 holes of 1.5 mm in diameter or 18 holes of 3 mm in diameter (2). MU filter related complications, such as penetration into adjacent viscera, caval thrombosis, filter migration, and decreased IVC patency have all been reported in the literature (3–5).

An investigative study that pooled together assorted MU filter clinical data and performed hemodynamic experiments reported that the umbrella filter may inherently be thrombogenic, as it contributes to the distortion of blood streams by causing turbulence, flow reversal, and stasis (6). Although caval occlusion may be secondary to intrinsic filter thrombogenicity, it also occurs in the setting of IVC filter entrapment of large emboli that further impedes blood flow. Other factors including underlying patient hypercoagulability and malignancy should also be considered in the context of IVC occlusion. Overall, *in vivo* clinical investigations and experimental flow studies give insight to how high rates of post placement thrombosis ultimately contributed to discontinuation of the MU filter in 1986.

Protracted dwell times for IVC filters increase the likelihood that clinical manifestations of filter-related complications arise, including post-thrombotic syndrome (PTS). A systemic review that investigated the frequency of signs/symptoms of PTS in patients who received IVC filters for primary/secondary PE prevention found that 42.9% of patients suffered from lower extremity edema and 12% of patients suffered from trophic dermatological changes (e.g., venous ulcers) at a mean of 4.5 years post filter placement (7). After a prolonged dwell time of 42 years following MU filter placement, our patient started to experience symptoms secondary to iliocaval thrombosis that necessitated immediate removal of the umbrella filter and iliocaval reconstruction for clinical relief. This further shows the potential for successful removal of any IVCF type no matter the dwell time, as well as the longevity of the filters themselves. Although there have been many studies that describe the recovery process of similar permanent conical IVCFs including the Simon Nitinol (Bard Peripheral Vascular) and Kimray Greenfield (Cook Medical) filters, we have not been able to identify a case report that discusses percutaneous retrieval of a MU filter, especially one with such a long dwell time.

The extraction of pIVCFs is a multifactorial process that is contingent on intricate preoperative planning and intraoperative modifications to increase the likelihood of procedural success. There is no standard protocol for the removal of pIVCFs and clinicians may rely upon individualized integration of advanced retrievable filter removal techniques (e.g., forceps-assisted dissection, laser sheath photoablation, dual access ensnarement) to address the technicalities associated with permanent filter removal (8).

In conclusion, the clinical manifestations that arise secondary to extensive dwell times of pIVCFs are multifarious. Although the removal of pIVCFs deviates from their original indication of providing lifetime prophylaxis from venous thromboembolism, the recanalization of a filter-induced chronically occluded IVC may provide symptomatic benefit for some patients as illustrated by this case report.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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