



Vascular and Interventional Radiology Case Series

Management of failed inferior vena cava filter retrieval for complex cases: A case series

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ABSTRACT

The aim of this report is to describe our experience in managing cases of difficult inferior vena cava (IVC) filter retrieval with emphasis on different advanced retrieval techniques. We report three cases of difficult IVC filter retrieval at our institution. We included three patients age ranging from 42 to 72 years. Two of the cases were presenting with the lower limb deep vein thrombosis and one of the cases had pulmonary embolism and they all had Retrievable Celest Platinum IVC filter (Cook Medical, Bloomington, Ind.) inserted preoperatively. One case was managed conservatively after failing IVC filter retrieval using standard retrieval set, meaning the filter was left in place, one was successfully removed with advanced endovascular retrieval techniques, and one failing advanced endovascular retrieval and finally had it removed with open surgery. We reviewed the risk factors contributing to difficult IVC filter retrieval and discussed the different options for managing these cases including conservative management, endovascular treatment, and open surgery for retrievable type of IVC filter which can be placed permanently. Knowledge of these options will help us better understand conditions, leading to difficult IVC retrieval on insertion, hopefully to minimize the occurrence of these cases, and to better manage cases with difficult IVC filter retrieval to decide the best option for each patient after careful consideration and multidisciplinary discussion with surgeons and patients.

Keywords: Inferior vena cava filter, Inferior vena cava filter retrieval, Inferior vena cava filter removal, Remove Inferior vena cava filter

INTRODUCTION

Venous thromboembolism (VTE) occurs in around 1 in 1000 in the general population and 1 in 100 in high risk group with risk of pulmonary embolism (PE) up to 25% in these patients.^[1] Inferior vena cava (IVC) filter is thus inserted for protection from PE in patients who cannot receive anticoagulation, when there is failure of anticoagulation in the setting of VTE, who are hemodynamically unstable, for massive PE being treated with thrombectomy or thrombolysis, for mobile ilio caval deep vein thrombosis (DVT) and for prophylaxis after major trauma or before surgery, the latter seen in all our three cases.^[2] Two types exist, the permanent type and the retrievable type. We will focus our discussion on retrievable IVC filters below.

Retrieval of IVC filter is indicated as soon as it is no longer clinically indicated, with the U.S. Food and Drug Administration issuing a safety alert in 2014,^[1] when risk of PE is low, when anticipated patient survival >6 months, when the filter can be removed safely, the filter is free of significant clot burden (<25% on venography), and future need of filter is not needed,^[2] as there is significant long-term morbidity associated for long-term indwelling IVC filters. Studies of risk and benefit profile suggest filter removal between 29 and 54 days after insertion.^[1] The

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complications associated with unretrieved IVC filters include caval wall penetration, filter migration, filter fracture, caval thrombosis, and increased risk of DVT.^[1] Most of the cases can be retrieved with standard techniques, but there are circumstances where standard retrieval fail, up to as many as 40–60%,^[1] and advanced techniques are needed occasionally, usually due to abnormal filter position or endothelialization of filter with IVC wall and the longer they have been placed, the more difficult the retrieval may get. Advanced retrieval techniques are defined as anything beyond just using a snare and sheath.^[2] The retrieval rate was reported to be low in the literature, which could be due to poor clinical follow-up.^[3] The timing for safe removal however cannot be universally standardized as it depends on a number of factors including tissue response, caval shape, its orientation at time of retrieval, and expertise in advanced retrieval techniques.^[4]

“Failed IVC filter retrieval” refers to the failure to remove the IVC filter using the standard retrieval set. The most common reason for retrieval failure with standard retrieval set include tilting of the filter, especially when it is more than 15°,^[2] as seen in the cases, we will illustrate below, which may result in embedment of the filter in the IVC wall when the tilt is significant relative to the IVC long axis. When the tilt happens with approximation to the caval wall, blood flow would be disrupted, stagnant flow would cause nearly zero shear stress, and the low shear stress will lead to intimal hyperplasia and also smooth muscle endothelialization.^[3] Other reasons include prolonged indwelling time which is defined as >90 days or >180 days in different literature,^[2] filter migration, filter fracture, and filter perforation.^[3] Prolonged dwell time has been associated with device migration, fracture, penetration into organs, and increased risk of DVT.^[3]

For retrievable IVC filter that cannot be removed with standard techniques, they could be managed conservatively, removed with advanced techniques or surgical removal. Several advanced techniques exist, the aim is to realign the filter in case of tilt or endothelialized hook. Numerous techniques can be employed including the loop-snare technique, the hangman technique and the “fall-back” technique which is modified versions of the loop-snare technique, stiff wire-displacement technique, balloon displacement technique, sandwich technique, and finally dissection using endobronchial forceps and laser sheath.

The aim of this report is to describe our experience in managing difficult IVC filter retrieval in three patients and to discuss the different advanced endovascular retrieval techniques available.

CASE 1

A 72-year-old man with history of gastric adenocarcinoma, peritoneal metastases, and PE had temporary pre-operative IVC

filter insertion in the private sector before radical gastrectomy. The Retrievable Celect Platinum IVC filter (Cook Medical, Bloomington, Ind.) although can be placed permanently, was planned for removal due to complications associated with unretrieved IVC filters including caval wall penetration, filter migration, filter fracture, caval thrombosis, and increased risk of DVT as discussed in the introduction part above.

First attempt at IVC filter retrieval 7 weeks after the insertion failed despite attempts with IVC filter retrieval set (Cook Medical, Bloomington, Ind.) and the use of 7 French (Fr) EN Snare Endovascular Snare System (Merit Medical) despite multiple attempts.

Computed tomography (CT) scan showed the IVC filter closely abutting the anterior wall of the IVC with suspicion of the hook of filter being embedded at the anterior wall of IVC.

With right internal jugular vein puncture, 16Fr 45 cm Performer sheath (Cook Medical, Bloomington, Ind.) was inserted with tip at IVC, 5Fr multiside holes straight catheter (Merit Medical) was put in for venogram. Two loop-wires were made with 5Fr RIM catheter (Cook Medical, Bloomington, Ind.) and 260 cm Terumo J guidewire (Terumo Interventional System) and then snared with 7Fr EN Snare, both ends were brought out from the 16Fr sheath. 7Fr Destination sheath (Terumo Interventional System) was then inserted through one set of loop-wire and engaged the body of filter. Attempted hook capture by double sheath technique while applying tension to loop-wire was not successful. Attempted hook/head capture by 7Fr endomyocardial biopsy forceps (Cordis) also was not successful. The embedded filter hook was finally



Figure 1: A 72-year-old man with history of gastric adenocarcinoma, peritoneal metastases and pulmonary embolism had temporary inferior vena cava filter inserted before radical gastrectomy with difficult filter retrieval which was finally successfully retrieved with loop-snare technique after dissecting the embedded filter hook with the 16Fr sheath, with two loop-wires (arrowheads) and finally snared with 4Fr Goose Neck snare (arrow), as shown in this fluoroscopic image.

dissected out from the IVC wall by 16Fr sheath while applying tension to the two sets of loop-wire, with the support of 7Fr Destination sheath. Hook of the IVC filter was then snared with 4Fr 10 mm Amplatz Goose Neck Snare (Medtronic) and filter was successfully retrieved within the 16Fr sheath, as shown in [Figure 1]. The whole system (16Fr Performer sheath, two set of loop-wire plus 7Fr destination sheath, 4Fr Goose Neck snare plus IVC filter) was removed *en bloc* over 0.035 Amplatz guidewire (Cook Medical, Bloomington, Ind.). A new 16Fr sheath exchanged to IVC with post-procedure venogram and CT showed no extravasation.

CASE 2

A 50-year-old lady presented with the left lower limb DVT with large fibroid planning for total abdominal hysterectomy with bilateral salpingo-oophorectomy had IVC filter inserted preoperatively. Retrievable Celect Platinum IVC filter (Cook Medical, Bloomington, Ind.) was placed at the suprarenal level due to limited landing zone.

Attempted IVC filter retrieval 4 weeks later failed with venogram showing marked lateral tilting of the IVC filter in suprarenal location of IVC, with the hook likely embedded in the wall of the IVC, as shown in [Figure 2], retrieval failed despite multiple attempts with the IVC filter retrieval set (Cook Medical, Bloomington, Ind.). Contrast CT 9 months after filter insertion showed suspicious embedment of IVC filter hook onto the medial wall of the IVC at T11 level. Vascular surgeon's opinion was consulted with endovascular intervention explained being not possible due to high position of IVC filter and delayed removal; option of open



Figure 2: A 50-year-old lady presented with left lower limb deep vein thrombosis with large fibroid had inferior vena cava (IVC) filter inserted preoperatively. Retrievable Celect Platinum IVC filter was placed at the suprarenal level due to limited landing zone. Attempted IVC filter retrieval 4 weeks later failed with venogram showing marked lateral tilting of the IVC filter in supra-renal location of IVC, with the hook likely embedded in the wall of the IVC.

surgery was also not advisable due to suboptimal filter position with high perioperative morbidity and mortality. The patient opted for conservative management after comprehensive discussion with risk of filter dislodgment and erosion understood, which includes leaving the IVC filter in place and continuing anticoagulant (rivaroxaban) treatment.

CASE 3

A 42-year-old lady presented with the left lower limb DVT with large fibroid planning for total laparoscopic abdominal hysterectomy had retrievable Celect Platinum IVC filter (Cook Medical, Bloomington, Ind.) inserted preoperatively.



Figure 3: A 42-year-old lady presented with left lower limb deep vein thrombosis with large fibroid had retrievable Celect Platinum inferior vena cava (IVC) filter inserted preoperatively. Attempted IVC filter retrieval with filter re-alignment done using 12 × 40 mm Mustang angioplasty balloon (arrow) which showed no significant improvement and retrieval was failed.



Figure 4: Complimentary computed tomography showed inferior vena cava penetration by filter with embedment of filter hook and some primary struts (arrow), same patient as in Figure 3.

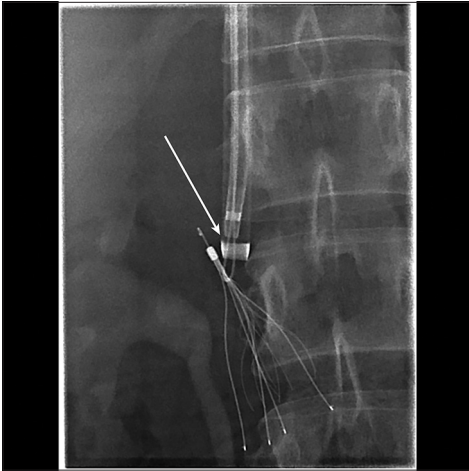


Figure 5: Another attempt a few days later also failed, same patient as in Figure 3. Loop-wire (arrow) was made with 260 cm Terumo J guidewire, 5Fr SHK catheter and 7Fr 17–30 mm EN Snare and tension was applied to try to realign the filter, but embedded filter hook by fibrous cap cannot be dissected out with double sheath technique, as shown in this fluoroscopic image.

Attempted IVC filter retrieval 3 weeks later failed despite multiple attempts with IVC filter retrieval set (Cook Medical, Bloomington, Ind.), Goose Neck Snare (Medtronic), and 7Fr 17–30 mm EN Snare (Merit Medical), attempted filter realignment was done with 12 × 40 mm Mustang angioplasty balloon (Boston Scientific) without significant improvement, as shown in [Figure 3]. Complimentary CT showed IVC penetration by filter with embedment of filter hook and some primary struts, as shown in [Figure 4].

Another attempt a few days later also failed. Loop-wire made with 260 cm Terumo J guidewire, 5Fr SHK catheter (Cook Medical, Bloomington, Ind.), and 7Fr 17–30 mm EN Snare (Merit Medical) and tension applied to try to realign the filter, the embedded filter hook by fibrous cap cannot be dissected out with double sheath technique, as shown in [Figure 5]. The loop-wire was released and another attempt to re-direct the loop-wire on the fibrous cap over the right side of IVC wall by 8.5Fr Destino REACH steerable sheath (Oscor) and Terumo J guidewire was done, another attempted retrieval with combination of loop-snare technique and double sheath technique with loop-wire at another site was also unsuccessful.

The patient was then referred to another institution with inputs from radiologists and surgeons and finally underwent open surgery 1 month later with filter orientation noted to be right anterior oblique with hook impinging on small tributary inferior to right renal vein, surrounding fibrosis and scarring seen. IVC was incised over the filter cap/hook and suture was tied to the filter cap, which was then ran through the end of a 7Fr Arrow sheath, reinforced by an outer 9Fr sheath, and the IVC filter was then removed

completely with tie traction. 4 mm defect at the IVC was then repaired with 5/0 Prolene suture.

DISCUSSION

In this case series, we illustrated three cases highlighting our experience in the management of difficult IVC filter retrieval. One of the cases was managed endovascularly, one surgically and another conservatively after endovascular management were attempted but failed.

A number of advanced endovascular retrieval techniques exist, and some are included in this case series. While by no means an exhaustive list, below include most of the commonly used options available on market. The aim is to realign the filter in case of tilt or endothelialized hook. One technique is the loop-snare technique,^[1-4] also called the sling technique, which involved placing a reverse curve catheter in the IVC below the filter, then direct a guidewire superiorly through the filter legs, just below the filter apex, and a snare is then advanced to grasp the end of the wire and externalize it. Traction at the both ends of the wire can displace the hook away from the IVC wall. Risk of filter derangement exists. A modified technique, called the hangman technique, involves the use of reverse curve catheter and place it adjacent to the filter just below the neck, rather than below the filter. Subsequent removal was then done with snare after the hook was removed from the embedded wall. One other modified technique has been described, called the “fall-back” technique,^[5] where a reverse-curve catheter is not needed, and a large 18Fr sheath is first inserted, then a wire and snare catheter are maneuvered so they pass through the interstices of the filter and the wire is snared below the filter and the resulting “lasso” is pulled up below the collar of the filter, the filter legs are then collapsed, and filter is removed by the 18Fr sheath. A stiff wire-displacement technique is another option where a stiff wire can be used to displace the tilted filter.^[4] There may be a small risk of filter migration, derangement, and fracture with the use of a stiff wire. Another technique involves displacing the embedded with the aid of an angioplasty balloon, the balloon displacement technique, when the above fails.^[1,4] Inflation of the balloon displaces the hook from the IVC wall. It was believed to be associated with a higher rate of filter migration, derangement, and fracture. Single or even dual access can be used for the aforementioned techniques.^[1,4] When single access is not adequate, a second access at the femoral vein can be used, this is called the sandwich technique, which can free the filter by sandwiching it between two sheaths.^[4] More aggressive dissection can also be employed to free the filter from the embedment. Endobronchial forceps^[1-3] can be used to remove the fibrous cap overlying the embedded hook which then was snared. The forceps can be used for dissection and also for subsequent removal of the filter. One has to be cautious with the use

of forceps due to its large curvature which can cause caval distension, caval damage, and patient discomfort.^[3] Another technique for dissection of fibrous tissue that is available is the use of laser sheath, which is particularly useful for cases with prolonged indwelling time.^[2,3] The above-described techniques can be combined.^[2] The choice of the techniques depends on expertise and equipments available, usually starting from least invasive and more straight forward methods and progressing to more complicated techniques when the prior fails.

In case of thrombosis from indwelling IVC filters, stenting across the filter has recently been proposed as an alternative to complex filter retrieval.^[6]

However, complications of IVC filter retrieval can occur with repeated attempts, especially in advanced techniques, they include IVC injury, stenosis, and filter fragmentation and embolization to the heart or pulmonary arteries. Prompt treatment is crucial if these occur with tamponade balloon and stents/stent-grafts available.^[1-4]

Therefore, the use of advanced techniques for filter removal should be balanced against the risks of leaving the filter in place for each patient.

A recent systematic review and meta-analysis suggested that the need for advanced retrieval techniques, but not the actual advanced retrieval technique, is associated with a higher rate of adverse events. The absolute rate of adverse events is still low when it is done by experienced interventionists, therefore balancing the risk and benefit, removal is still considered favorable given the long-term risks associated with indwelling IVC filter. This study, in conclusion, demonstrated that advanced retrieval techniques for IVC filters permit a higher retrieval success rate with low adverse event rates in cases of standard retrieval failure.^[7]

CONCLUSION

Cases of difficult IVC filter retrieval occur when there is increased indwelling time and significant tilting. Knowledge of the different retrieval options available including conservative management, endovascular advanced techniques, and surgical management will help the team arrive at an individualized treatment plan and increase the IVC filter retrieval success rate.

Ethics approval

The study was approved by Hong Kong East Cluster Research Ethics Committee (HKECREC-2023-002).

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Kuyumcu G, Walker TG. Inferior vena cava filter retrievals, standard and novel techniques. *Cardiovasc Diagn Ther* 2016;6:642-50.
2. Quencer KB, Smith TA, Deipolyi A, Mojibian H, Ayyagari R, Latich I, *et al.* Procedural complications of inferior vena cava filter retrieval, an illustrated review. *CVIR Endovascular* 2020;3:23.
3. Desai KR, Pandhi MB, Seedial SM, Errea MF, Salem R, Ryu RK, *et al.* Retrievable IVC filters: Comprehensive review of device-related complications and advanced retrieval techniques. *Radiographics* 2017;37:1236-45.
4. Iliescu B, Haskal ZJ. Advanced techniques for removal of retrievable IVC filters. *Cardiovasc Intervent Radiol* 2012;35:741-50.
5. Foley PJ, Nathan DP, Wang GJ, Woo EY, Stavropoulos SW, Shlansky-Goldberg RD, *et al.* A "fall-back" technique for difficult inferior vena cava filter retrieval. *J Vasc Surg* 2012;56:1629-33.
6. Cherfan P, Zaghoul MS, Abdul-Malak OM, Saadeddin Z, Go C, Hager E, *et al.* Stenting across inferior vena cava filters can be a safe and effective alternative to complex retrieval. *J Vasc Surg Venous Lymphat Disord* 2023;11:302-9.
7. Merritt T, Powell C, Hansmann J. Safety and effectiveness of advanced retrieval techniques for inferior vena cava filters compared with standard retrieval techniques: A systematic review of the literature and meta-analysis. *J Vasc Interv Radiol* 2022;33:564-71.

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