Case Report

Successful experiences and feasible techniques of robotic-assisted inferior vena cava filter retrieval after failure of endovascular attempts: a case report

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Background: The mainstay of inferior vena cava (IVC) filter retrieval has been snare techniques. However, caval penetration or filter fracture makes endovascular approaches challenging, which in turn leads to more aggressive attempts, including open surgical procedures. The fact that laparoscopic approaches (especially the da Vinci robotic system) with minimal invasion allow for equivalent long-term outcomes as compared with open procedures is encouraging. To date, few centers have attempted secondary minimal invasive operation after filter retrieval failure. In this study, we presented a case of robot-assisted filter retrieval after failure of snare techniques. The operative time was 55 minutes, which was the shortest time reported in the collected studies thus far.

Case Description: A 27-year-old female was diagnosed with deep vein thrombosis after delivery and placement of an IVC filter. Local surgeons tried endovascular approaches to retrieve the filter, but failed twice. She was then transferred to our hospital and computed tomography venography revealed that the filter struts had protruded outside the cava wall. Based on our previous experiences of robotic surgery with vena cava graft replacement, we decided to perform robotic-assisted filter retrieval. The operation was successful, and the estimated blood loss was less than 50 mL. The patient was discharged 5 days after the operation and presented for reexamination 6 months later. Ultrasound showed that the IVC blood flow was smooth. No complications occurred, and the renal function was nearly normal.

Conclusions: Filter retrieval failure through the endovascular approach is challenging, and occasionally, open surgery is needed as a second attempt. With the advancement of laparoscopic approaches, especially the enhanced ergonomics of the robotic system, aggressive operation can be avoided, and robotic-assisted filter retrieval can offer an alternative for surgeons to manage these issues.

Keywords: Endovascular; filter retrieval; robotic; vena cava; case report

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Introduction

Inferior vena cava (IVC) filter placement is indicated for any contraindication to anticoagulation in the presence of deep vein thrombosis (DVT). Placement is recommended to be less than 3 to 4 months, and the mainstay of standard removal has been via the endovascular approach, mainly snare techniques (1,2). However, complications can occur after IVC filter placement, including malposition, caval penetration, and filter fracture. Any bleeding encountered is extremely difficult to control during endovascular procedures, which indeed requires conversion to open surgery for better caval control (3,4). Recently, robotic surgeries (e.g., the da Vinci SiHD system) have gradually emerged and allowed surgeons to completely control the IVC and reconstruct vessels in a safe and less aggressive fashion (5). The advantages of the robotic platform are enhanced visualization, free manipulation, and comfortable ergonomics during a long operation (6). Our institution had experiences with vena cava graft replacement with a robotic system, which indicated that these techniques could provide an excellent alternative for IVC filter removal when endovascular retrieval fails (6). In this case report, we describe such a case and highlight the unique techniques used during the procedure. The operative time was 55 minutes, which is the shortest time recorded in the related literature thus far (5,7,8). We present the following case in accordance with the CARE reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-22-513/rc).

Highlight box

Key findings:

- Conversion to open surgeries may be avoided after endovascular failure of filter removal.

What is known and what is new?

- The mainstay of endovascular retrieval is snare techniques, but these only have a 73.2% success rate.
- Robotic-assisted filter retrieval is an alternative and acceptable choice for surgeons when faced with the failure of endovascular approaches.

What is the implication and what should change now?

- Computed tomography venography needs to be complemented when complications occur after IVC filter placement. Multidisciplinary discussion and preparation offer better options for both surgeons and patients.

Case presentation

A 27-year-old female underwent placement of a retrievable IVC filter (Cook Celect, Inc., Bloomington, IN, USA) in the local hospital due to left common and external iliac vein thrombosis after delivery. Three months later, she attended our hospital for filter retrieval (Appendix 1). The chest X-ray and the kidney, ureter, and bladder (KUB) X-ray revealed that the filter was located at the L2–L3 level (*Figure 1A*). The endovascular snare technique was performed but failed twice. During the procedure, cavography images revealed hook malposition and strut protrusion outside the cava wall. Therefore, the patient was transferred to our department. Computed tomography venography revealed that the filter was in the infrarenal level and that the struts had perforated 7.5 mm outside the cava wall and were adjacent to the psoas major and diaphragmatic crura (*Figure 1B*,*1C*), which was defined as grade III according to the definition of Durack *et al.* (9). Three-dimensional reconstruction was also conducted to explicitly reveal the malposition and caval penetration of the filter (*Figure 1D*). Based on our previous experiences of robotic surgery with vena cava graft replacement (6), we decided to perform a robotic-assisted filter retrieval. The patient was placed in the left lateral decubitus position, and a 6-port approach was used as we previously described (6). The vena cava was circumferentially dissected from the adjacent tissues and entirely exposed to our sight at the infrarenal level (*Figure 2A*). The lumbar vein was identified and ligated by Hem-o-lok clips (*Figure 2B*). The gonadal vein was carefully divided and protected due to the young age of the patient. Red rubber catheters (8 Fr) were wrapped twice around the caudal IVC and cephalic IVC sequentially and clamped by Hem-o-lok clips (*Figure 2C*). Cavotomy was conducted, and the filter was found to be totally endothelialized (*Figure 2D*). During the filter removal, the hook penetrating the posterior cava wall was confirmed to be outside the IVC (*Figure 2E*). After a wash with heparinized saline, the cava wall was closed with 4-0 Prolene (Ethicon, Somerville, NJ, USA) suture in a running fashion (*Figure 2F*). Cephalic and caudal loops were released sequentially, and the filter was removed through the 12-mm port. The operative time was 55 minutes, with the IVC cinch portion being 18 minutes. The estimated blood loss was less than 50 ml, and no blood transfusion was needed. The patient resumed ambulation and a regular diet on the fourth day postoperatively, and she

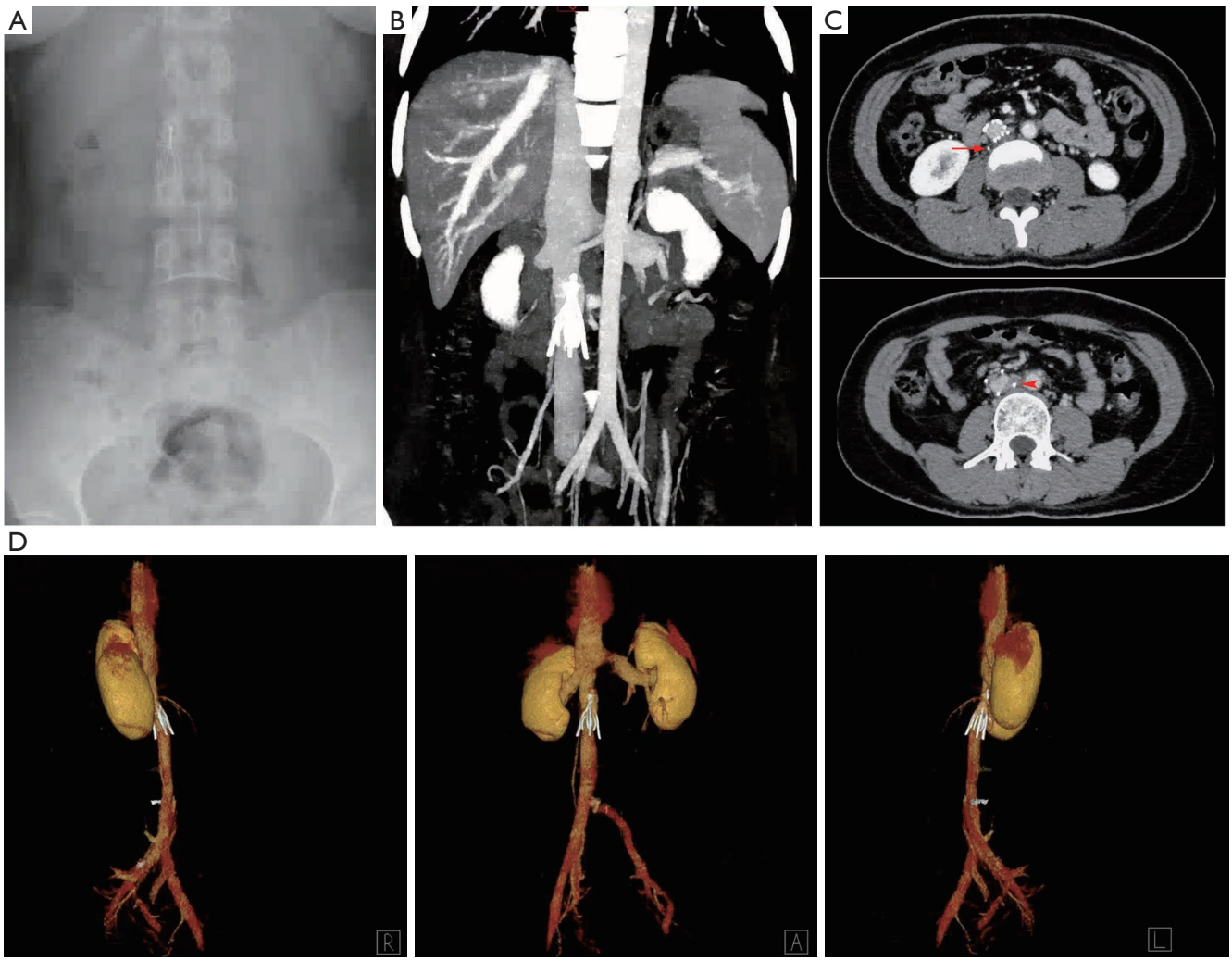

Figure 1 Preoperative images revealed that the filter had protruded outside the cava wall. (A) The chest X-ray and kidney, ureter, bladder (KUB) X-ray revealed that the filter was located at the L2–L3 level. (B) Computed tomography venography revealed that the filter was at the infrarenal level. (C) (upper) The red arrow indicates the struts perforating the cava wall by 7.5 mm. (lower) The short arrow indicates other struts adjacent to the diaphragmatic crura. (D) Three-dimensional reconstruction confirmed the malposition and caval penetration of the filter.

was discharged from hospital on the fifth day after surgery. Rivaroxaban was routinely administered for half a year postoperatively as recommended by vascular surgeons. The patient presented for reexamination 6 months later, and ultrasound showed that the IVC blood flow was smooth. No complications occurred, and the renal function was nearly normal (*Table 1*, Figure S1). All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Discussion

As of the time of writing, there have been few reported cases of filter retrieval with robotic assistance (5,7,8). Compared with the previous studies, our operative time was the

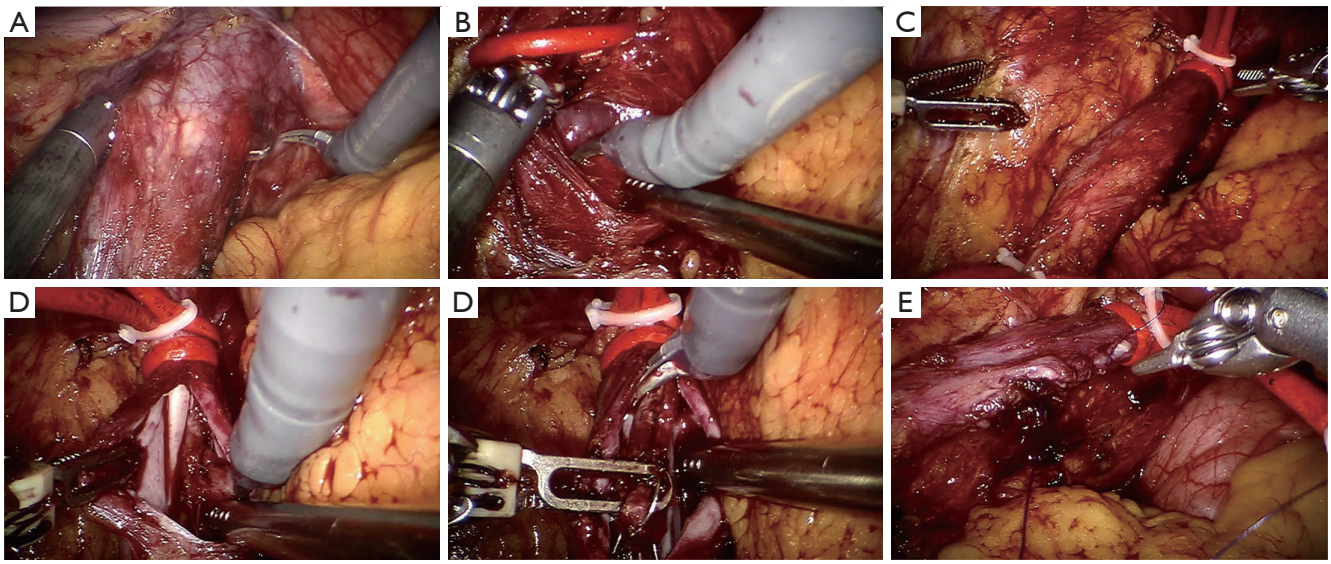

Figure 2 The procedure of robotic-assisted filter retrieval. (A) Exposure of the inferior vena cava, (B) ligation of the lumbar vein, (C) cinching of the vena cava with 8 Fr catheters, (D) cavotomy and exposure of the filter, (E) removal of the endothelialized filter, and (F) closure of cava wall in a running fashion.

Table 1 Perioperative data

Characteristic	Preoperative	Postoperative
Hemoglobin, g/L	118	107
ALT, U/L	10	8
AST, U/L	16	17
Serum creatinine, μmol/L	49.2	40
Serum BUN, mmol/L	4.19	5.04

ALT, alanine transaminase; AST, aspartate transaminase; BUN, blood urea nitrogen.

shortest, and the estimated blood loss was the lowest. Some experiences and techniques could be summarized from our robotic-assisted vascular surgery. First, total circumferential control of the IVC with Rummel tourniquet/8 Fr catheters (twice-wrapped) is necessary. Caudal IVC occlusion should be ensured prior to the cephalic part due to considerations of the venous flow. Second, if necessary, lumbar veins should be ligated before venotomy or cavotomy in cases of uncontrolled bleeding. Gonadal veins, however, should be protected if they do not interfere with the procedure. Third, according to our experiences, there is no need to control both renal veins due to the infrarenal level of the filter release even though we completely expose these anatomical positions. However, if the filter hook is at the renal vein level or above the renal vein, both the right and left renal veins need to be controlled. Fourth, the use of 3 robotic arms is preferred when the patient is obese. ProGrasp forceps may facilitate to the better exposure if surgical sites and facilitate bleeding control with the bipolar forceps.

Conclusions

Robotic-assisted filter retrieval is viable alternative and acceptable choice for surgeons when faced with failure of endovascular approaches. Multidisciplinary discussion and preparation can offer better options for both surgeons and patients.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at https://tau.amegroups.com/article/view/10.21037/tau-22-513/rc

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tau.amegroups.com/article/view/10.21037/tau-22-513/coif). The authors report that the study was supported by the Key Research and Development Plan in China (grant No. 2017YFB1303100), the National Natural Science Foundation of China (grant Nos. 82002704, 81927807, 81874090, and 81972630), and the Individual Innovative Research Funding of Union Hospital (grant No. 2019xhyn124). The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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Appendix 1 Patient perspective

After delivery, I found myself to have lower extremity edema. Local doctors conducted a physical examination and ultrasonography, which indicated that I had left common and external iliac vein thrombosis. Therefore, I took the doctors' advice and undertook inferior vena cava (IVC) filter placement. Three months later, I visited Wuhan Union Hospital for filter removal. The vascular surgeons tried an endovascular approach two times, but this failed. I felt pain and was transferred to the urology department. The urologists asked me to undergo computed tomography venography. The result showed that the struts had perforated 7.5 mm outside the cava wall. The surgeons advised me to undergo robotic-assisted filter retrieval, and I agreed. The operation was successful, and I felt great. No complications occurred postoperatively, and I have returned to normal life.

In summary, after nearly half a year of the disease, I have the following thoughts:

I think the robotic-assisted surgery was amazing, as it could accomplish this complex operation. I am very satisfied with the proactive response of all the hospital staff, with a rapid response to the initial diagnosis and the quality of the different surgeries and treatments available thus far. I would also like to highlight the humane treatment and accessibility when needing any consultation. I will move forward with a positive attitude and follow the advice and treatment of professionals to fight against and defeat this disease.

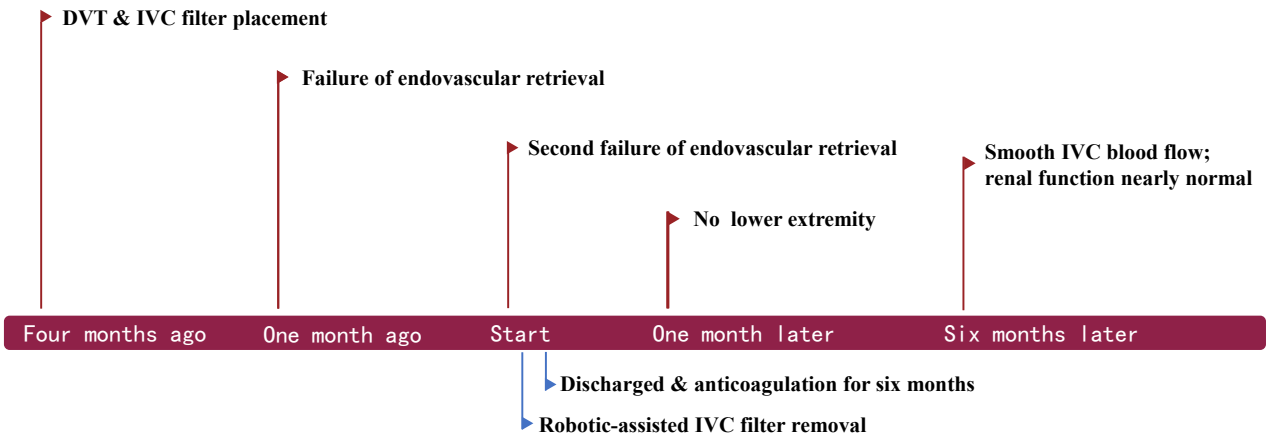

Figure S1 A timeline of the diagnosis and treatment procedures. DVT, deep vein thrombosis; IVC, inferior vena cava.

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