CASE REPORT

Fracture of a Temporary Inferior Vena Cava Filter
A Case Report

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Summary

Anticoagulation is recommended for the treatment of pulmonary embolism (PE) and deep vein thrombosis (DVT). In some cases, an inferior vena cava (IVC) filter is used to prevent PE. We report the case of a 70-year-old woman who developed non-massive PE and proximal DVT, which were treated using an IVC filter; two filters were placed owing to the fracture of the filters. Few previous reports have discussed IVC fractures and the difficulty in detecting such fractures on computed tomography before retrieval. Based on our experience, we suggest that a temporary IVC filter for DVT treatment should be considered carefully.

Key words: Complication, Treatment of deep vein thrombus, Pulmonary embolism, Prevention

Current guidelines for the treatment of deep vein thrombosis (DVT) include the use of anticoagulants, thrombolytic therapy, surgical thrombectomy, and catheter-directed therapy.1-4 Inferior vena cava (IVC) filters are also used to prevent pulmonary embolism (PE) in patients with contraindications to anticoagulation therapy, although the indications for IVC filters are not defined clearly in current guidelines. Generally, the use of IVC filters is accepted in patients with absolute contraindications to anticoagulation therapy,5 with the filter placement determined on a case-by-case basis.6

Three major types of IVC filters are available, namely, permanent, retrievable, and temporary filters. Permanent filters are used to prevent PE in patients for whom anticoagulation therapy is contraindicated and, therefore, a long-term filter is needed. A retrievable filter is used in patients with the contraindication of anticoagulation therapy that may be resolved in weeks, and so the filter is required only over a finite period and is subsequently retrieved. Temporary filters are intended to be used on a shorter-term basis and retrieved. In Japan, only one type of temporary IVC filter is available, the Neuhaus Protect (NP; Toray Medical Co., Ltd.), which was updated to the Neuhaus Protect SE (SE) filter in May 2017. In terms of construction, temporary filters include not only the filter but also a catheter shaft, which is retrieved from the internal jugular or subclavian vein after filter placement. While using a temporary filter, saline should be administered through the lumen of the catheter to prevent coagulation. The retrieval of a temporary filter is easier than that of a retrievable filter as the shaft is connected to the filter, which obviates the need to use a snare catheter. In this case report, we describe the fracture of a temporary IVC filter used for DVT management, as well as our experience in using temporary IVC filters, including possible complications.

Case Report

A 70-year-old woman with a history of uterine fibroids presented to our hospital because of sustained unconsciousness overnight. She was admitted with a diagnosis of diabetic ketoacidosis (DKA), with a pH, blood glucose level, and an anion gap of 6.74, 800 mg/dL, and 29 mEq/L, respectively. She had no history of diabetes; hence, we investigated the cause of the high blood glucose level using computed tomography (CT). The CT scan revealed a uterine fibroid, 200 mm in diameter, and free air within the abdomen, suggestive of a gastric perforation. Gastric perforation and suppurative peritonitis were treated using emergent laparotomic drainage and omental flap transposition. On day 7 post admission, enhanced CT was performed as a component of the clinical assessment for a persisting fever > 38°C over a period of 5 days. CT imaging revealed bilateral sub-massive PE and DVT of the right iliac and femoral veins, which were not observed at the time of admission (Figure 1). The patient was referred to our department for the treatment of DVT and PE.

Her laboratory data at the time of diagnosis of DVT and PE are shown in Table I. The elevation of the D-dimer level to 92.80 μg/dL was notable. Based on the information and clinical presentation since the time of admission, the cause of DVT was considered to be pro-

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time, which was 30.5 seconds on admission and increased
ated heparin to control the activated partial thromboplastin
ture fibroid. The patient was treated with unfraction-
red bed rest in the intensive care unit or the massive
longed bed rest in the intensive care unit or the massive
uterine fibroid. The patient’s thrombotic risk factors are
shown in Table II, and included a slight decline in free
protein C and S levels; no other significant abnormalities
were identified. The patient was treated with unfrac-
tated heparin to control the activated partial thromboplastin
time, which was 30.5 seconds on admission and increased
t to 50-60 seconds with treatment. As the patient was just
recovering from DKA, as well as septic shock and gastric
perforation, at the time of DVT diagnosis, she was consid-
ered clinically unstable. This meant that a recurrence of
PE would be lethal. Accordingly, we proceeded with the
implantation of a temporary IVC filter, in addition to anti-
coagulation therapy, on the day of diagnosis of PE and
DVT.

Using a sterile technique and ultrasound guidance, a
9-Fr short sheath was placed into the right internal jugular
vein. A guidewire was advanced into the IVC, via the su-
perior vena cava (SVC), with the placement verified using
fluorography. A cavogram was performed to confirm the
absence of abnormalities in the IVC, including thrombus
formation in the proximal IVC. A temporary IVC filter, an
SE type (Toray Medical Co., Ltd.), was placed with the
top of the filter located just below the renal veins (Figure
2A). After placement, saline, at a rate of 40 mL/hour, was
passed through the lumen of the filter.

A uterine fibroid, 200 mm in diameter, which was
suspected to be the cause of DVT, was removed by hys-
terectomy completed on post-admission day 9. On post-
admission day 15, a routine chest radiograph revealed
malpositioning of the IVC filter, with the basket of the fil-
ter having moved into the right atrium. Considering the
presence of a DVT in the right femoral vein, we pro-
cceeded with careful extraction of the filter and sheath un-
der fluorography guidance, monitoring her vital signs,
with preparations for the recurrence of acute PE. No de-
saturation or symptoms were observed during the extract-
ation. After the extraction, we confirmed the fracture of
the basket, with the wires of one proximal edge of the basket
being detached from the shaft (Figure 3). Considering that

Figure 1. Computed tomography images at the time of diagnosis of deep vein thrombosis and pulmonary thrombosis. A: (arrowhead) Thrombi in the left pulmonary artery; B: (arrowhead) thrombi in the right pulmonary artery; C: thrombi in the right external iliac vein. There is a massive uterine fibroid.

Table I. Laboratory Data at the Time of Diagnosis of Deep Vein Thrombosis and Pulmonary Embolism

| Item       | Value          |
|------------|----------------|
| Hb         | 10.6 g/dL      |
| RBC        | 328 \( \times 10^4 \) μL |
| PLT        | 13.0 \( \times 10^4 \) μL |
| AST        | 20 U/L         |
| LD         | 873 U/L        |
| CK         | 64 /μL         |
| BUN        | 32.8 mg/dL     |
| Cre        | 0.34 mg/dL     |
| eGFR       | 138            |
| Na         | 158 mEq/L      |
| K          | 4.3 mEq/L      |
| Cl         | 125 mEq/L      |
| CRP        | 4.12 mg/dL     |
| PT-INR     | 0.99           |
| APTT       | 30.3 seconds   |
| Fbg        | 307 mg/dL      |
| D-dimer    | 92.80 μg/dL    |
| FDP        | 219.9 μg/mL    |
| BNP        | 103.6 μg/mL    |

Hb indicates hemoglobin; RBC, red blood cell; PLT, platelet; AST, aspar-
tate aminotransferase; LD, lactate de-
hydrogenase; CK, creatine kinase;
BUN, blood urea nitrogen; Cre, creati-
nine; Na, sodium; K, potassium; Cl,
chloride; CRP, C-reactive protein; PTI-
NR, prothrombin time-international
normalized ratio; APTT, activated
partial thromboplastin time; Fbg, fi-
brinogen; FDP, fibrin/fibrinogen de-
radiation products; and BNP, brain na-
triuretic peptide.

Table II. Serum Thrombotic Risk Factors

| Variable                  | Value          |
|---------------------------|----------------|
| Heparin-PF4 antibodies    | 0.6 U/mL       |
| Protein C antigen         | 55%            |
| Free protein S antigen    | 57%            |
| Antiphospholipid IgG      | < 8.0 U/mL     |
| Anti-double-strand DNA-IgG| 2.9 IU/mL      |
| Antinuclear antibody      | < 40           |
| Rheumatoid factor IgG     | 0.3            |

PF4 indicates platelet factor 4; IgG, immunoglobulin G; and DNA, deoxyribonucleic acid.
Figure 2. Fluorography at the time of placement and extraction of the inferior vena cava filter. **A:** The first filter was not fractured at the time of placement. **B:** The second filter was intact at the time of placement. **C:** The second filter was fractured before extraction, with the upper end of a filament fractured from the shaft (arrows).

Figure 3. The proximal end of a filter filament detached from the shaft (arrowhead).

The DVT in the right femoral vein persisted despite appropriate anticoagulation and the removal of the uterine fibroid, we planned to place another IVC filter to avoid recurrent PE. Considering that only one type of temporary IVC filter was available for clinical use at the time of this case, as well as reports of failure with extracting retrievable filters, we selected a temporary IVC filter for use in our patient. When placing the second filter, we used the same procedure and confirmed the absence of the fracture using fluorography (Figure 2B). On post-admission day 27, enhanced CT revealed that the PE had dissolved and the DVT had decreased. If DVT had been retained or hemodynamically unstable, we would have considered implanting a retrievable or permanent IVC filter to prevent PE by refractory DVT. However, as the patient was hemodynamically stable, we proceeded with the extraction of the filter. We noticed that the basket had fractured again (Figure 2C) and, thus, we proceeded with careful extraction of the filter under fluorography guidance. For the first month after surgery, the patient received intravenous anticoagulation therapy, as the use of oral anticoagulants was not recommended because of gastric perforation. Following this initial period, Edoxaban (30 mg per day) was prescribed as the oral anticoagulation therapy.

Enhanced CT performed 3 months after discharge showed no evidence of newly occurring PE or DVT. Anticoagulation therapy was discontinued and the patient has remained free of thrombotic events over the 1-year follow-up period. The patient provided informed consent for the presentation of this case.

**Discussion**

An IVC filter is considered a substitute or an additional treatment for DVT and PE, with trials having compared treatment using anticoagulation only to anticoagulation and IVC filters. Decousus, *et al.* reported no significant difference in the mortality rate between anticoagulation therapy alone and anticoagulation therapy with an IVC filter. In their trial, however, Decousus, *et al.* reported a lower rate of PE development in the first 12 days among patients treated with an IVC filter, with a permanent or retrievable filter used in all cases, with no significant increase in major complications other than recurrent thrombotic events being reported.

We identified two previous reports on the fracture of permanent or retrievable IVC filters, with these fractures identified on the three-dimensional reconstruction of radiographs obtained in two projection planes and CT. We retrospectively reviewed the enhanced CT images in our case, obtained before the extraction of the second IVC filter, and identified one image, which showed the possibility that the upper end of the basket wire may have disconnected from the shaft of the filter (Figure 4A). On the other hand, there was no evidence of the IVC filter fracture on CT images obtained for the first IVC filter (Figure 4B). Portable chest radiographs did not reveal the fracture of the filter (Figure 5). In a previous report, three-dimensional CT images were used to detect filter integrity. In our case, we used fluorography guidance to extract the second fractured IVC filter. Imaging should be performed more frequently, particularly if a temporary filter remains in situ for longer than planned. Based on this
information, fluorography or three-dimensional radiographs or CT images would play a role in detecting the fracture of the IVC filter.

In our case, we placed both temporary IVC filters under fluorography guidance, confirming that the filters were not damaged at the time of placement. We did not know the cause of these fractures. Dislocation of the first filter might be one causative factor of the fracture; however, we noted that the second filter fractured without dislocation. Therefore, movement of the filter within the IVC cannot be the only reason of the fracture. Sano, et al.\textsuperscript{10} reported that a fracture of the TrapEase filter, caused by compression against neighboring structures, occurred at a higher rate than a fracture of the Greenfield filter. Regarding the NP and SE filters, the SE more closely resembles the TrapEase in structure, including a wire basket (Figure 4). Regarding the construction of the filter itself, TrapEase and NP/SE have no open-ended wires, while the Greenfield filter has open-ended wires. This difference might suggest the reason for the fragility. Between 2015 and 2019, 65 IVC filters were used in the cardiology department of our hospital, 56 temporary IVC filters, and nine retrievable or permanent filters. The NP filter was used from 2015 to September 2017, and the SE filter used from October 2017 to 2019. On average, NP filters were extracted 14.8 ± 6.6 days after placement, whereas SE filters were extracted 12.1 ± 6.9 days after placement. It is recommended that the SE filter should be removed 10 days after placement. However, in cases where a proximal DVT persisted, we postponed its removal. The following complications developed: one case of catheter infection (SE); two cases of filter dislocation (NP/SE); one case of filter thrombosis (NP); and two cases of filter fracture (both SE). There was no occurrence of symptomatic pulmonary thromboembolism over time from filter placement to extraction. A filter fracture occurred only with the SE filter.

In the case reported herein, the placement period of the first filter was 9 days, with the fracture occurring within the recommended 10-day period. For the second filter, CT imaging was performed on day 12 after placement, with a total placement time of 14 days. We noted that the extraction of the second filter was delayed because of other treatment procedures being performed in the intensive care unit. During this additional period, we performed routine radiograph monitoring, with no evidence of any change around the filter, despite a clear indication that the filters were damaged within the IVC. Miyahara, et al.\textsuperscript{11} previously reported on the fracture of the NP filter. At our institution, we have not experienced fractures of the NP filter. To the best of our knowledge, there is currently no strong evidence about fractures of the SE filter. In our case, both fractured filters were removed successfully, but we were concerned if the disconnected filter filament had penetrated the IVC, right atrium, or SVC wall.

According to previous reports, an IVC filter, in addition to anticoagulation therapy, can be effective in preventing PE in the acute phase.\textsuperscript{7} However, none of these reports addressed the fracture of a temporary IVC filter in the acute period after placement. As radiography and CT imaging are not always useful in revealing the fracture of a filter, the extraction of a temporary IVC must be performed under fluorography guidance, with careful observation if damage to the filter is observed.

We note that our experience was based on the occurrence of only two fractures of a temporary IVC filter in the same patient, which could limit the generalizability of the experience that the fracture is not a common complication in other patients. Additionally, we were unable to identify the cause of these two fractures and, thus, risk

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**Figure 4.** Computed tomography images of the inferior vena cava filters in situ. A: Before the extraction of the second filter, the image shows the suspicious finding of a possible detachment of the filter filament at the proximal end of the filter. B: The distal slice of A. C: Before the extraction of the first filter, there was no observable evidence of a fracture of the filter.

**Figure 5.** Portable chest radiograph taken before the extraction of the second filter.
factors for IVC fractures and mitigating factors could not be identified. Another limitation is that we did not obtain three-dimensional images of the filter fracture.

**Conclusion**

The use of a temporary IVC filter may be an effective preventive treatment for acute proximal DVT. However, the possibility of complications, including filter fractures, within the designated placement period, cannot be overlooked. A fluoroscopic examination is useful in detecting filter fractures before extraction.

**Disclosure**

**Conflicts of interest:** None.

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