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CASE REPORT

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Transcatheter removal of a briefly penetrated inferior vena cava filter in an open abdomen: a case report

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Abstract

Background The likelihood of inferior vena cava filter penetration increases with prolonged implantation. Despite the generally low risk associated with an ALN inferior vena cava filter (ALN IMPLANTS CHIRURGICAUX, Ghisonaccia, France), we present a case in which penetration occurred 43 days after implantation. At present, no consensus is available on the standardized approach for filter removal in such cases. In this report, we describe a secure and reliable method involving surgical access to the abdomen and transcatheter filter removal while directly observing the inferior vena cava.

Case presentation A 72-year-old Japanese male patient presented to our institution with complaints of pain and subsequent edema in his left lower limb. Contrast-enhanced computed tomography (CT) revealed thrombi spanning from the left common iliac vein to the external iliac vein, as well as in the right pulmonary artery and inferior vena cava. Upon admission, we promptly inserted an ALN inferior vena cava filter and initiated anticoagulation therapy. Follow-up contrast-enhanced CT performed on day 13 after filter implantation demonstrated disappearance of thrombi in the pulmonary artery and inferior vena cava, and the patient was discharged on day 14 following implantation. However, due to the presence of a residual thrombus in the left common iliac vein, we decided against removing the inferior vena cava filter at that time. Contrast-enhanced CT performed on day 43 after implantation revealed signs suggestive of filter penetration with extension into the abdominal aorta, necessitating immediate filter removal. To address this, we performed transcatheter removal of the filter through open abdominal surgery.

Conclusions An ALN inferior vena cava filter, initially considered to pose a low risk of penetration, unexpectedly exhibited penetration during the brief indwelling period. Although a definitive consensus concerning the optimal removal approach for such cases remains elusive, our experience indicates that transcatheter removal via laparotomy represents a secure and reliable method.

Keywords Filter, Inferior vena cava, Venous thromboembolism, Transcatheter removal, Open abdominal surgery

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Background

Inferior vena cava (IVC) filters are widely used for managing venous thromboembolism, although their implantation can lead to complications such as filter strut fractures, filter migration/embolization, and penetration [1]. The incidence of filter penetration varies depending on the filter type, with an ALN IVC filter generally regarded as safe, supported by limited reports on penetration [2, 3]. Prolonged indwelling periods are a known risk factor for penetration [4], and the risk of fracture escalates when the indwelling period exceeds 408 days, potentially resulting in symptomatic penetration [5]. In this study, we report a case of a patient who remained asymptomatic despite IVC filter penetration after a relatively short indwelling period of 43 days. Managing asymptomatic penetration of the IVC filter and determining an appropriate approach for filter removal remain subjects of uncertainty. To prioritize safety and certainty, we carefully ensured that the IVC filter did not encroach on the surrounding organs during an open abdominal procedure and subsequently performed transcatheter removal. Following removal, we confirmed the integrity of the IVC and surrounding organs by closing the abdomen. To the best of our knowledge, this is the first reported case of transcatheter removal of an IVC filter following laparotomy in the medical literature.

Case presentation

A 72-year-old Japanese male patient, functionally independent in daily living, had a medical history of rheumatoid arthritis and dyslipidemia. He was currently prescribed prednisone 5 mg/day and atorvastatin 10 mg/day. The patient reported experiencing pain in his left lower limb the day before presenting to the hospital. The patient experienced mild pain during ambulation. On the day of the visit, he sought medical attention due to edema in the affected limb but had no complaints of dyspnea.

Investigation

During the examination, the patient's vital signs were as follows: blood pressure, 140/60 mmHg; pulse rate, 109 beats/min; respiratory rate, 18 breaths/min; and oxygen saturation 96% (room air). Physical examination revealed no abnormal heart or respiratory sounds. Notably, the patient exhibited indurated edema in the left lower leg extending from the thigh to the anterior tibia. Blood tests revealed an elevated D-dimer level (Table 1).

Differential diagnosis

Given the sudden onset of unilateral leg edema, deep vein thrombosis was suspected. Contrast-enhanced computed tomography (CT) confirmed the presence of thrombi in the right pulmonary artery, IVC, left common iliac vein, and external iliac vein (Fig. 1). Consequently, a diagnosis of venous thromboembolism was established.

Outcome and follow-up

Using contrast-enhanced CT, thrombi were not only identified in the left common iliac to the external iliac vein but also in the IVC. Thrombus in the IVC was free-floating (Fig. 2), necessitating placement of an ALN IVC filter (ALN IMPLANTS CHIRURGICAUX,

Table 1 Laboratory findings upon the initial visit

Parameter	Recorded value	Standard value
White blood cell count (/μL)	9600	3300–8600
Hemoglobin (g/dL)	15.8	11.5–15.0
Platelet count (/μL)	16.3×10^4	$15–35 \times 10^4$
C-reactive protein (mg/dL)	0.95	≤ 0.14
Aspartate aminotransferase (U/L)	26	13–30
Alanine aminotransferase (U/L)	19	7–23
Lactase dehydrogenase (U/L)	303	124–222
Blood urea nitrogen (mg/dL)	27.3	8–20
Creatinine (mg/dL)	1.18	0.46–0.79
Sodium (mEq/L)	134	138–145
Potassium (mEq/L)	4.8	3.6–4.8
Chloride (mEq/L)	102	101–108
Total cholesterol (mg/dL)	244	142–248
Triglyceride (mg/dL)	94	30–117
High-density lipoprotein cholesterol (mg/dL)	116	48–103
Low-density lipoprotein cholesterol (mg/dL)	109	65–163
Hemoglobin A1c (%)	6.2	4.9–6.0
D-dimer (μg/mL)	10.7	< 1.0

Fig. 1 CT scan. CT scan showing thrombi in the right pulmonary artery (**a**), thrombi in the inferior vena cava (**b**), and thrombi in the left common iliac vein (**c**). CT, computed tomography

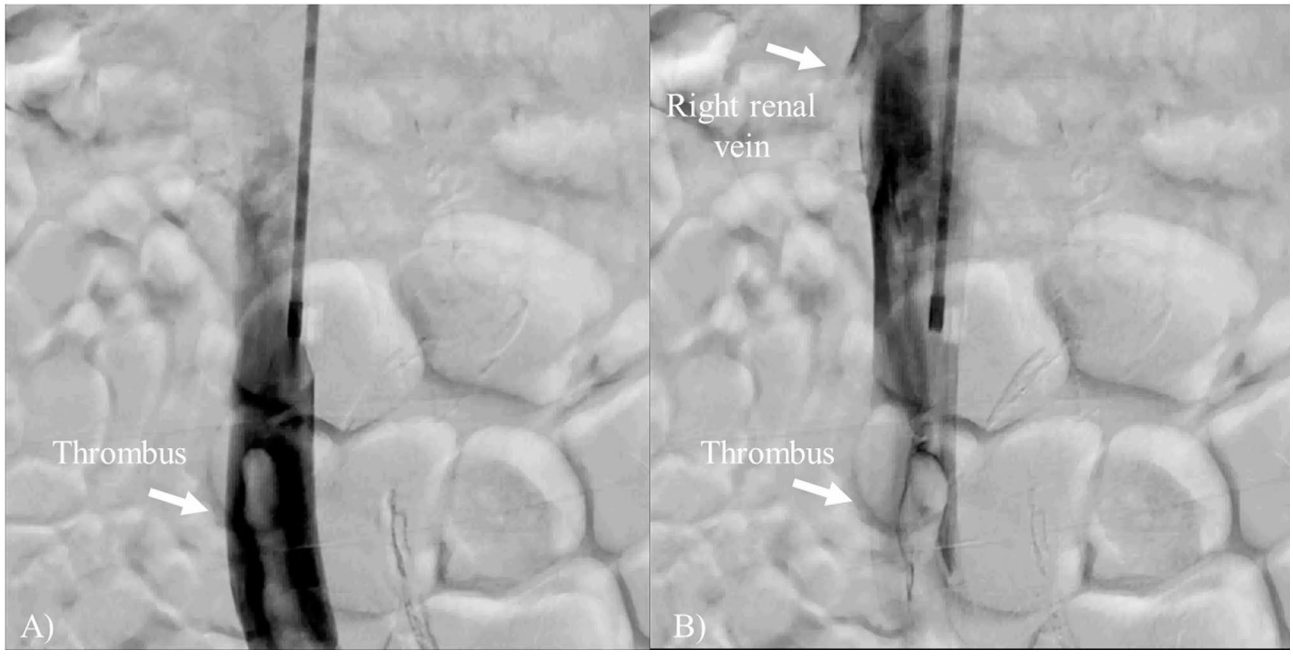

Fig. 2 CT scan of the IVC showing a large floating thrombus. **a** and **b** are continuous images of the same shooting. A large and floating thrombus is detected below the renal vein. IVC, inferior vena cava; CT, computed tomography

Ghisonaccia, France). The implantation procedure was performed through the internal jugular vein on the day of admission. Additionally, the patient received urokinase, starting at a dose of 240,000 units for 3 days, followed by a reduction to 120,000 units for 7 days, in combination with warfarin therapy. The activated partial thromboplastin time and prothrombin time-international normalized ratio were adjusted to 1.5–2 times and 2.0–2.5, respectively. Subsequent contrast-enhanced CT scans on days 7 and 13 after filter implantation revealed regression and eventual disappearance of the thrombus in the pulmonary artery and IVC. This improvement led to the patient's discharge on day 14 after implantation. Despite regression of the thrombus in the left common iliac vein, the decision was made not to remove the IVC filter due to concerns about possible thrombus release and consequent recurrent pulmonary thromboembolism. On day 43 after implantation, we performed a CT scan to validate residual thrombus, revealing filter penetration (Fig. 3). Remarkably, the patient remained asymptomatic; however, given the proximity of the filter leg to the abdominal aorta, concerns arose regarding potential aortic penetration. Consequently, the decision was made to remove the filter. On day 58 after implantation, the filter was removed transcatheterically, and this procedure was conducted with direct observation of the abdominal region to monitor for bleeding. Under general anesthesia, a midline incision was made in the abdomen to expose the IVC. Adhesion of fatty tissue was observed around the IVC and penetrated filter strut. After removal of these adhesions, a total of six perforations were observed in the legs of the IVC filter (Fig. 4). Further, although the filter was expected to be in contact with the aorta, CT indicated that, upon opening the abdomen, it did not extend to the

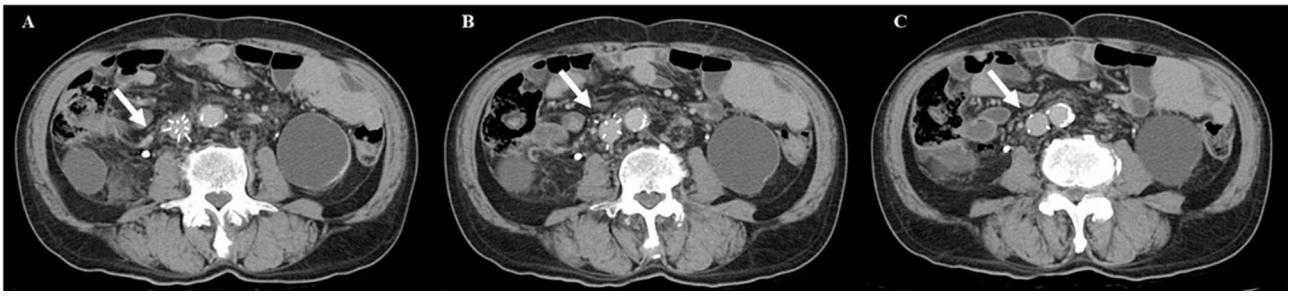

Fig. 3 CT scan CT scan showing that the filter has penetrated the caval wall (**a**, **b**) and that the IVC filter strut has made slight contact with the abdominal aorta (**c**). IVC, inferior vena cava; CT, computed tomography

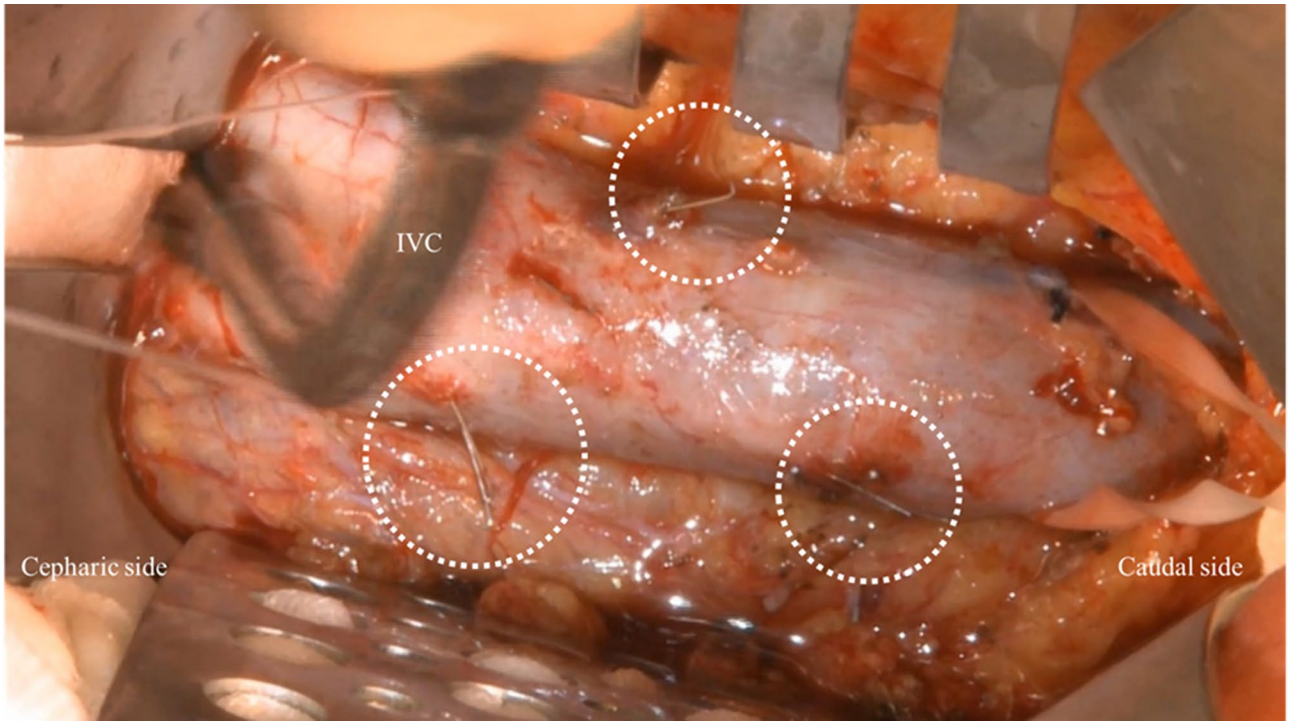

Fig. 4 Filter strut penetration. A total of six perforations are observed in the legs of the IVC filter, with no extension to the abdominal aorta. IVC, inferior vena cava

abdominal aorta. The perforating leg was subsequently excised, and the filter was removed transcatheterically using the jugular vein approach. After an inspection confirmed no damage to the IVC and surrounding organs, the abdomen was closed to ensure the absence of bleeding. The procedure lasted for 3 h and 10 min and was collaboratively undertaken by a cardiologist and a cardiovascular surgeon. The patient experienced a favorable postoperative course and was discharged from the hospital on day 7 after the procedure.

Discussion and conclusions

First and second novelty

Penetration of an IVC filter is a significant complication, and its risk typically increases with prolonged implantation periods [4]. However, penetration can also manifest after a relatively brief implantation period, as evidenced in this particular case (43 days). Managing asymptomatic IVC penetration is challenging, and research has demonstrated that failure to remove the filter may lead to worsening penetration over time [6]. Therefore, it is essential to remove the filter, which can be achieved through either transcatheterical or surgical methods. In this case, the transcatheter removal approach involved opening the abdomen and directly observing the IVC to extract the filter. This method is deemed both secure and dependable, as it allows for verification that the IVC filter does not ensnare neighboring organs. Furthermore, it provides an opportunity for immediate surgical intervention in the event of IVC and damaged organ bleeding.

Significance of the first and second novelty

Penetration of an IVC filter is a notable and concerning complication that warrants careful consideration. According to the defined criteria for penetration (a filter leg extending > 3 mm beyond the IVC), the reported frequency of penetration is approximately 19% [6]. The incidence of penetration varies depending on the shape and type of filter, with conical filters displaying a significantly higher occurrence of penetration than non-conical filters [6]. However, among conical filters, the ALN IVC filter used in the current case is recognized for its lower frequency of penetration compared with other filters [7]. An ALN filter is designed with six short anchorage struts and three long centering struts, which rely on the self-expanding force from the anchorage struts rather than the anchoring force to the IVC wall, thereby reducing the risk of penetration [8]. Usually, the risk of penetration increases with prolonged filter implantation periods [4, 5]. However, as demonstrated in this case, penetration can occur even after a relatively short implantation period of 43 days, emphasizing the need for vigilant management. Several risk factors contribute to penetration, including tilting of > 15° [6], migration [7], diameter of the IVC [9], distance between the IVC and abdominal aorta [10], and Valsalva maneuver [11]. When the IVC diameter is < 24.2 mm, it becomes more susceptible to penetration [1]. In our case, since the IVC diameter measured 17.2 mm, the risk of penetration may have been heightened. Conversely, the ALN IVC filter has been observed to migrate when the IVC diameter exceeds 28 mm [9], thereby increasing the risk of penetration. As a result, both large and small IVC diameters pose risks, prompting the need for further studies to establish an appropriate ratio between IVC diameter and filter size [4]. A previous case report has highlighted that Valsalva maneuver reduces the cross-sectional area of the IVC by 60%, increases IVC pressure five-fold, and elevates the risk of filter penetration; however, this was not applicable in our case [11]. When implanting an IVC filter, practitioners should always be mindful of potential complications, and early removal should be considered.

In the present case, the patient remained asymptomatic despite evidence of filter perforation. The appearance of symptoms due to penetration varies depending on the site and extent of penetration, as well as the involvement of surrounding organs near the IVC [6]. Among cases of penetration, approximately 8% exhibit symptoms, with pain being the most commonly reported subjective symptom and the duodenum being the organ most frequently involved [6]. In symptomatic cases, immediate filter removal is recommended [12]. However, managing cases such as the present one, where the patient remains asymptomatic despite imaging evidence of penetration, is challenging, and uncertainty remains regarding the patient's asymptomatic status during follow-up [6]. Previous studies have indicated that the degree of penetration tends to worsen with time and increases with prolonged retention of the filter [6]. Given the apparent contact of the filter leg with the abdominal aorta in this case, we opted for filter removal due to concerns about potential aortic injury over time if the filter was not removed.

Reports indicate that 39% of perforated filters are removed transcatheterically, whereas 4% are removed surgically [6]. In this specific case, due to the filter leg's apparent extension into the abdominal aorta, we opted to perform laparotomy to ensure immediate repair in the event of aortic injury and to assess potential damage to the IVC wall following filter removal. Although laparotomy allows for direct visualization of the involved organs and the IVC wall, ensuring safety and reliability, it is a highly invasive procedure that may present challenges for older patients or those with underlying conditions. The lack of clear consensus regarding the preferred filter penetration removal method adds to the complexity of such cases. A study examining the classification of penetration degree and its association with complications following transcatheter removal reported safe extraction of even grade 2 (filter leg entirely outside the IVC, appearing as a "halo" in the retroperitoneal fat) and grade 3 (involving organs surrounding the IVC) penetrations without significant complications [13]. However, this study included Recovery filters (35.9%), G2 filters (46.9%), Gunter Tulip filters (12.5%), and OptEase filters (4.7%), but not ALN IVC filters [12]. In another case report involving six of nine legs with ALN IVC filter penetration, two legs perforated the duodenum, and one perforated the descending aorta. An ALN filter, with its leg measuring 0.3 mm thick (thinner than a 27-gauge needle, 0.4 mm), is considered unlikely to cause significant damage to the IVC or descending aorta. Therefore, in the case of an ALN filter perforation, transcatheter removal may not result in complications. In such cases, attempting transcatheter filter removal is not difficult; however, the safety of transcatheter withdrawal in cases where the ALN filter has penetrated to grade 2 or 3 has not been established. Given the potential risk of damage to the aorta due to filter struts, as indicated on CT, as well as the possibility of uncontrolled bleeding from the IVC, safety was the first priority in our case; therefore, we used combination treatment. Upon opening the abdomen, the penetrated filter struts were adhered to the fatty tissue surrounding the IVC, posing challenges for catheter removal. Even if catheter removal were feasible, a high possibility of complication (such as bleeding) exists.

While it is technically possible to remove the filter by incising the IVC, this carries the inherent risk of bleeding, even with subsequent repair; therefore, we opted for transcatheter approach for filter removal.

Reference to clinical utility

Penetration of an IVC filter is a common complication, with its risk typically increasing with prolonged implantation periods [4]. However, it is important to note that even short-term implantation may result in penetration, thus emphasizing the need for early consideration of filter removal. In this case, the IVC filter should have been removed promptly after confirming disappearance of the floating IVC thrombus. Once filter penetration is detected, prompt removal becomes imperative.

For cases wherein an ALN filter penetrates the IVC, no consensus is currently available on the optimal removal approach. While transcatheter removal is feasible, safety cannot be guaranteed. Our hybrid system, which combines transcatheter removal with an open abdomen approach, offers a very safe extraction method. The advantage of this hybrid system lies in its ability to provide direct observation of any damage to organs surrounding the IVC and to promptly address any instances of bleeding or malfunction, thus allowing for immediate access to the affected area enhances safety and allows for swift intervention if complications arise.

In conclusion, the ALN IVC filter, recognized for its relative safety, displayed early penetration in our case. In cases of penetration of the IVC filter, the transcatheter removal approach in an open abdomen proved to be a secure and dependable method.

Abbreviations

IVC Inferior vena cava
CT Computed tomography

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12872-025-05062-3.

Supplementary Material 1

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Not applicable.

Author contributions

MN managed the case and wrote and revised the manuscript. NY, HU, KT and TK assisted in the preparation and revision of the manuscript. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work. All authors take full responsibility for the integrity of the study and final manuscript. All authors have read and approved the final manuscript.

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Data availability

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

The requirement of ethics approval and consent for this case report was waived by the Ethics Committee of Naha City Hospital due to the retrospective nature of the study.

Consent for publication

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 Journal Editor.

Competing interests

The authors declare no competing interests.

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References

1. Lee JK, So YH, Choi YH, Park SS, Heo EY, Kim DK, et al. Clinical course and predictive factors for complication of inferior vena cava filters. Thromb Res. 2014;133:538–43.
2. Pellerin O, di Primio M, Sanchez O, Meyer G, Sapoval M. Successful retrieval of 29 ALN inferior vena cava filters at a mean of 25.6 months after placement. J Vasc Interv Radiol. 2013;24:284–8.
3. Deso SE, Idakoji IA, Kuo WT. Evidence-based evaluation of inferior vena cava filter complications based on filter type. Semin Intervent Radiol. 2016;33:93–100.
4. Desai TR, Morcos OC, Lind BB, Schindler N, Caprini JA, Hahn D, et al. Complications of indwelling retrievable versus permanent inferior vena cava filters. J Vasc Surg Venous Lymphat Disord. 2014;2:166–73.
5. Kuo WT, Robertson SW, Odegaard JI, Hofmann LV. Complex retrieval of fractured, embedded, and penetrating inferior vena cava filters: a prospective study with histologic and electron microscopic analysis. J Vasc Interv Radiol. 2013;24:622-30.e1 quiz 631.
6. Jia Z, Wu A, Tam M, Spain J, McKinney JM, Wang W. Caval penetration by inferior vena cava filters: a systematic literature review of clinical significance and management. Circulation. 2015;132:944–52.
7. Shimoo S, Koide M. Incomplete opening of an ALN-type inferior vena cava filter due to entanglement of the filter legs resulting in filter migration and inferior vena cava perforation. Radiol Case Rep. 2020;15:1231–4.
8. Pellerin O, Barral FG, Lions C, Novelli L, Beregi JP, Sapoval M. Early and late retrieval of the ALN removable vena cava filter: results from a multicenter study. Cardiovasc Intervent Radiol. 2008;31:889–96.
9. Grewal S, Chamarthy MR, Kalva SP. Complications of inferior vena cava filters. Cardiovasc Diagn Ther. 2016;6:632–41.
10. Kato S, Saito F, Asahina N, Iinuma N, Kamimura D, Nakachi T, et al. A case of acute pulmonary embolism presenting penetration of descending aorta by the ALN IVC filter successfully retrieved via catheter. Heart. 2019;51:440–7. (Available in Japanese only).
11. Laborda A, Kuo WT, Ioakeim I, De Blas I, Malvè M, Lahuerta C, et al. Respiratory-induced haemodynamic changes: a contributing factor to IVC filter penetration. Cardiovasc Intervent Radiol. 2015;38:1192–7.
12. Wang W, Spain J, Tam MD. Acute abdominal pain after retrievable inferior vena cava filter insertion: case report of caval perforation by an option filter. Cardiovasc Intervent Radiol. 2011;34:883–5.
13. Oh JC, Trerotola SO, Dagli M, Shlansky-Goldberg RD, Soulen MC, Itkin M, et al. Removal of retrievable inferior vena cava filters with computed tomography findings indicating tenting or penetration of the inferior vena cava wall. J Vasc Interv Radiol. 2011;22:70–4.

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