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CLINICAL REPORT

Fatal pulmonary embolism following spinal surgery in a patient with permanent inferior vena cava filter placement

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Abstract It has been proven that the use of an inferior vena cava filter (IVCF) is effective in decreasing the incidence of pulmonary embolism (PE) in high-risk spinal surgery patients. A case of fatal PE after spinal surgery in a 78-year-old woman who had a history of pulmonary hypertension due to peripheral PE treated with a permanent IVCF and anticoagulant therapy for 3 years is reported. The patient had experienced an episode of recurrent PE during the withdrawal of anticoagulants, but she had uneventfully undergone two orthopedic surgeries with a preoperative unfractionated heparin infusion instead of oral warfarin. Three months after the second operation, she underwent posterior lumbar spinal fusion. The following morning, she suddenly complained of chest discomfort and dyspnea with SpO_2 78 %. An electrocardiogram showed a right bundle branch block. Then, 30 min later, she suddenly lost consciousness, and her carotid pulse was not palpable. The patient died 2 h and 30 min after onset. Acute PE probably occurred because of a massive thrombus above the IVCF. This case suggests that the efficacy of long- term use of a permanent IVCF is limited in cases when anticoagulants must be withdrawn, such as for orthopedic surgery.

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Introduction

Deep vein thrombosis (DVT) and pulmonary embolism (PE) are well known thromboembolic complications that occur in patients undergoing spinal surgery. PE is recognized as the most common life-threatening condition a patient risks after spinal reconstructive surgery [1].

Perioperative inferior vena cava filter (IVCF) placement is known to be effective in reducing the risk of PE in patients with risk factors such as a history of PE or a contraindication to anticoagulant therapy because of surgical procedures [1–3]. A case of fatal PE following spinal surgery in a patient with a permanent IVCF is reported.

Case report

A 78-year-old, 152-cm, 64-kg female was scheduled to undergo posterior lumbar spinal fusion. She had a history of PE at the age of 75 years, treated with placement of a permanent IVCF (Greenfield vena cava filter; Boston Scientific, Natick, MA, USA) and anticoagulant therapy with warfarin (controlled with PT-INR 2.0). In the following year, during interruption of anticoagulant therapy because of the need for a nerve root block, she was diagnosed to have recurrent PE presenting as exertional dyspnea and DVT of lower extremity veins. Congenital factors such as protein C deficiency, protein S deficiency, and antithrombin deficiency were not detected. She had undergone knee arthroplasty and lumbar laminectomy uneventfully. Since PE was diagnosed, the patient received a continuous

infusion of unfractionated heparin (UFH) instead of warfarin before the operation, and the UFH infusion was resumed after the operation.

Three months after the lumbar laminectomy, the patient was scheduled for posterior lumbar spinal fusion because of worsening scoliosis. The D-dimer (cut off value <1.0 μg/mL) was elevated to 6.48 after the laminectomy and decreased to 1.90 before the operation. The patient received UFH infusion for 4 days until 5 h before the operation. The results of preoperative echocardiography showed no right ventricular dilation, and ultrasonography of the lower extremities showed no floating emboli. Computed tomography showed IVCF placement at the level of L1–2, just below the renal veins and tilting at an angle of 15° from the axial midline, with the tip of the IVCF touching the vascular wall (Fig. 1). Transforaminal lumbar interbody fusion was

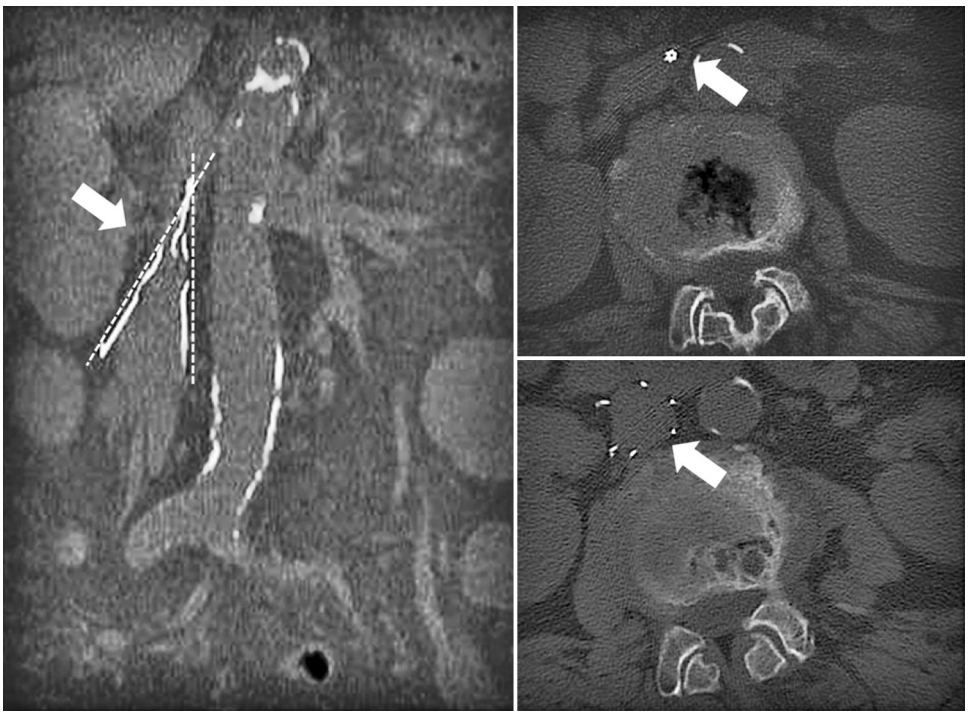

Fig. 1 The *frontal* and *horizontal section* images of computerized tomography (CT) show the inferior vena cava filter (IVCF) tilting at an angle of 15° from the axial midline and the tip of the IVCF touching the vascular wall

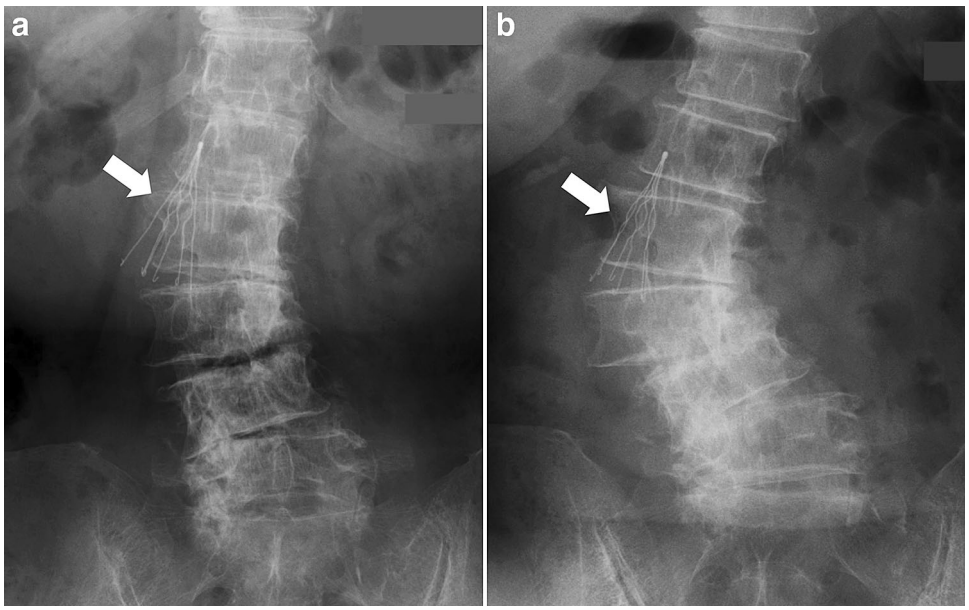

Fig. 2 The lumbar spine diagnostic radiographs taken before lumbar spinal fusion (**a**) and after posterior lumbar spinal fusion (**b**) show no change in the location of the inferior vena cava filter (IVCF)

performed uneventfully; the durations of surgery and anesthesia were 445 and 570 min, respectively. Intraoperative blood loss and urine volume were 2,521 g and 1,060 mL, respectively. Packed red blood cells of 1,680 mL and fresh frozen plasma of 480 mL were transfused. Intraoperative radiographs taken before lumbar laminectomy and after posterior lumbar spinal fusion showed no change in the location of the IVCF (Fig. 2a, b). Following the routine procedure, postoperative CT was not scheduled. The orthopedists planned to restart anticoagulant therapy the following morning after evaluating the patient's bleeding status.

At 8:00 AM the following morning, at breakfast, the patient suddenly complained of chest discomfort. At 8:20, the SpO_2 dropped to 78 %, and she developed peripheral coldness and sweating; the ECG showed right bundle branch block. The attending orthopedists administered 100 % O_2 at 10 L/min and UFH of 5,000 IU. The SpO_2 remained at 80 %, with a heart rate of 130 beats/min. The orthopedists took her to the CT room to diagnose PE, but at 8:30 AM, before the CT was performed, her condition deteriorated. She lost consciousness; her heart rate dropped to 40 beats/min, and her carotid pulse was not palpable. Cardiopulmonary resuscitation (CPR) was initiated. Her trachea was intubated, and she was moved to the emergency room. At 8:40, echocardiography showed no tamponade, no right ventricular dilation, and no thrombosis in the right ventricle, but she had pulseless electrical activity (PEA). SpO_2 recovered to 95–100 % with 100 % O_2. It was thought that PE had occurred at breakfast when the first symptoms of chest discomfort and dyspnea appeared, and the PE was relieved during CPR, but fatal heart failure remained. It was concluded that it was too late to consider percutaneous cardiopulmonary support (PCPS) given her age, and treatment of heart failure by CPR and drugs was the preferable first-line therapy. A femoral vein was cannulated as an emergency measure during cardiac compression. During CPR, the ECG showed persistent PEA, and echocardiography indicated ventricular standstill. She died 2 h and 30 min after the onset of dyspnea. Her relatives refused further examinations, such as an autopsy or autopsy imaging, to establish the cause of death.

Discussion

This patient had undergone three orthopedic surgeries over 2 years following IVCF placement, but fatal postoperative complications developed with the last surgery. It was not possible to confirm the cause of death without autopsy, but massive PE subsequent to IVCF-related central vein thrombosis was the most likely cause of her sudden death based on her medical history and clinical symptoms [4].

The incidence of PE has been reported to vary from 0 % [5] to 13.1 % [6] in reconstructive spinal surgery. The use of IVCF has been proven effective in decreasing the incidence of PE in patients with DVT undergoing high-risk spinal surgery [1, 6–8]. However, it is known that permanent IVCF increases DVT risk in the long term, so it is necessary to continue anticoagulant therapy with IVCF. Though fatal PE is rare after IVCF placement, symptomatic PE was reported to occur in 3.4 %, and death in 0.58 %, of patients with IVCF [9]. In the present case, a "massive" thrombosis is thought to have caused embolism of the main trunk of the pulmonary artery because of the sudden fatal deterioration. Certain factors might accelerate the generation of a massive thrombus above the IVCF causing fatal PE.

The first such factors are the long-term use and tilting of the permanent IVCF. In the present case, about 3 years had passed since placement of the IVCF. The PREPIC trial [9] demonstrated that, after 2 years, the initial beneficial effect of filters was counterbalanced by a significant increase in recurrent DVT, which could be related to thrombosis at the filter site. The trial suggested the need for long-term anticoagulant therapy after placement of a permanent filter. Hajduk et al. [10] reported that long-term anticoagulant therapy with oral warfarin at therapeutic dosages following initial venous thromboembolism in patients with IVCF gives an acceptable prognosis when it is not contraindicated. Thus, use of a permanent IVCF needs anticoagulant therapy for a better prognosis with respect to DVT and PE recurrence. In fact, in the present case, the patient experienced an episode of recurrent PE when the anticoagulant therapy was interrupted 1 year after IVCF placement. This suggests that the administration of an anticoagulant is necessary to prevent PE recurrence.

It is also known that IVCF tilting is related to the capture of thrombi. By design, the Greenfield filter provides maximal clot filtration ability when the apex is centered in the lumen of the IVC [11]. IVCF tilting may result in decreased effectiveness for trapping thrombi with critical tilting of >15° from the axial midline [12]. Therefore, impaired clot filtration by IVCF tilting could be associated with recurrent PE. Although IVCF tilting was detected on radiographic examinations in the present case, no thrombosis around the IVCF was detected preoperatively, and thus, it was presumed that the IVCF had functioned effectively with the appropriate anticoagulant therapy. However, in conditions of inadequate anticoagulant therapy, IVCF tilting might not have prevented accumulation of thrombotic material above the filter, permitting the fatal PE incident.

Additional factors that might have increased the risk of PE are the patient's older age (74 years) and longer anesthesia time (570 min). It has been reported that occurrence

of PE was associated with older age (70 years or older) and longer anesthesia time (more than 360 min) [13].

A case of fatal PE after spinal surgery was reported. For the anesthesiologist, an operation such as presented in this case is challenging because the surgery requires the interruption of anticoagulant therapy even in a patient who has episodes of recurrent PE with a permanent IVCF. We conclude that the efficacy of a permanent IVCF is limited, especially without anticoagulant therapy, and perioperative PE remains a potentially fatal problem.

References

1. Ozturk C, Ganiyusufoglu K, Alanay A, Aydogan M, Onat L, Hamzaoglu A. Efficacy of prophylactic placement of inferior vena cava filter in patients undergoing spinal surgery. Spine. 2010;35:1893–6.
2. Kearon C, Kahn SR, Agnelli G, Goldhaber S, Raskob GE, Comerota AJ, American College of Chest Physicians. Antithrombotic therapy for venous thromboembolic disease: American College of Chest Physicians evidence-based clinical practice guidelines (8th edition). Chest. 2008;133:454S–545S.
3. Ishihara K, Hiromatsu S, Shintani Y, Kanaya K, Mikasa K, Aoyagi S. Clinical outcome of perioperative nonpermanent vena cava filter placement in patients with deep venous thrombosis or blood stasis of the vein. Surg Today. 2009;39:764–9.
4. Tapson VF. Acute pulmonary embolism. N Engl J Med. 2008;358:1037–52.
5. Rokito SE, Schwartz MC, Neuwirth MG. Deep vein thrombosis after major reconstructive spinal surgery. Spine. 1996;21:853–8.
6. Rosner MK, Kuklo TR, Tawk R, Moquin R, Ondra SL. Prophylactic placement of an inferior vena cava filter in high-risk patients undergoing spinal reconstruction. Neurosurg Focus. 2004;17:E6.
7. Streiff MB. Vena caval filters: a comprehensive review. Blood. 2000;95:3669–77.
8. Leon L, Rodriguez H, Tawk RG, Ondra SL, Labropoulos N, Morasch MD. The prophylactic use of inferior vena cava filters in patients undergoing high-risk spinal surgery. Ann Vasc Surg. 2005;19:442–7.
9. Decousus H, Leizorovicz A, Parent F, Page Y, Tardy B, Girard P, Laporte S, Faivre R, Charbonnier B, Barral FG, Huet Y, Simonneau G. A clinical trial of vena caval filters in the prevention of pulmonary embolism in patients with proximal deep-vein thrombosis. Prévention du Risque d'Embolie Pulmonaire par Interruption Cave Study Group. N Engl J Med. 1998;338:409–15.
10. Hajduk B, Tomkowski WZ, Malek G, Davidson BL. Vena cava filter occlusion and venous thromboembolism risk in persistently anticoagulated patients: a prospective, observational cohort study. Chest. 2010;137:877–82.
11. Osher PS, Tobin KD. Percutaneous insertion of the Greenfield filter. AJR. 1989;152:933–8.
12. Cipolla J, Weger NS, Sharma R, Schrag SP, Sarani B, Truitt M, Lorenzo M, Sims CA, Kim PK, Torigian D, Temple-Lykens B, Sicoutris CP, Stawicki SP. Complications of vena cava filters: a comprehensive clinical review. OPUS 12 Scientist. 2008;2:11–24.
13. Masuda K, Chikuda H, Yasunaga H, Hara N, Horiguchi H, Matsuda S, Takeshita K, Kawaguchi H, Nakamura K. Factors affecting the occurrence of pulmonary embolism after spinal surgery: data from the national administrative database in Japan. Spine J. 2012;12:1029–34.