Inferior vena cava filter migration during the prone position for spinal surgery: a case report

Migration d'un filtre de la veine cave inférieure lors d'une chirurgie de la colonne en position ventrale: une présentation de cas

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Abstract

Purpose Inferior vena cava (IVC) filters have been used as an alternative therapy for patients with a contraindication to anticoagulation. We present a case of an IVC filter migration to the right ventricle occurring while a trauma patient was undergoing spinal surgery in the prone position. The patient provided written consent to describe this case.

Clinical features A 54-yr-old multiple trauma male patient with an unstable fracture of the T6 vertebra and a stable fracture of the T10 vertebra developed a pulmonary embolism secondary to a left common femoral deep vein thrombosis. An IVC filter was placed so that an intravenous unfractionated heparin infusion could be stopped two days before scheduled spinal surgery. Intraoperatively, the patient was placed in the prone position on conventional convex support pads. At the end of the procedure, he developed ventricular trigeminy which lasted three minutes.

During the next 48 hr, the patient developed a fever of 39°C. An echocardiogram was performed to rule out endocarditis, and results showed that the IVC filter had migrated into the right ventricle. After a failed attempt at

percutaneous removal of the filter in the catheterization laboratory, the patient was transferred to the operating room and the IVC filter was extracted through a midline sternotomy under cardiopulmonary bypass.

Conclusions The prone position during surgery can induce anatomic and hemodynamic changes in the IVC. This may contribute to the migration of IVC filters—especially flexible retrievable filters. Careful handling and positioning of patients with IVC filters is recommended to avoid a sudden increase in IVC pressure that may predispose to IVC filter migration.

Résumé

Objectif On utilise les filtres de la veine cave inférieure (VCI) comme traitement alternatif chez les patients lorsque l'anticoagulation est contre-indiquée. Nous présentons un cas de migration du filtre de la VCI dans le ventricule droit survenue alors qu'un patient traumatisé subissait une chirurgie de la colonne en position ventrale. Le patient a consenti par écrit à la publication de ce cas.

Éléments cliniques Un patient polytraumatisé de 54 ans avec une fracture instable de la vertèbre T6 et une fracture stable de la vertèbre T10 a subi une embolie pulmonaire suite à une thrombose veineuse profonde de la veine fémorale commune gauche. Un filtre de VCI a été placé de façon à ce qu'une perfusion intraveineuse d'héparine non fractionnée puisse être interrompue deux jours avant la chirurgie planifiée de la colonne. Pendant l'opération, le patient a été placé en position ventrale sur des coussins de soutien convexe conventionnels. À la fin de l'intervention, il a manifesté un trigémisme ventriculaire d'une durée de trois minutes.

Au cours des 48 h suivantes, le patient a manifesté une fièvre de 39 °C. Une échocardiographie, réalisée afin

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d'exclure une endocardite, démontra que le filtre de la VCI avait migré dans le ventricule droit. Après une tentative infructueuse pour retirer le filtre de façon percutanée dans le laboratoire de cathétérisation, le patient a été transféré en salle d'opération et le filtre de la VCI retiré via une sternotomie médiane sous circulation extracorporelle.

Conclusion *Pendant une chirurgie, la position ventrale peut entraîner des changements anatomiques et hémodynamiques dans la VCI. Cela pourrait favoriser la migration des filtres de la VCI – particulièrement les filtres récupérables souples. Une manipulation et un positionnement minutieux des patients ayant des filtres de la VCI sont recommandés afin d'éviter une augmentation soudaine de la pression dans la VCI qui pourrait favoriser une migration du filtre.*

Venous thromboembolism is a major health problem. Inferior vena cava (IVC) filters have been used either as an alternative therapy for patients with a contraindication to anticoagulation or as adjunctive treatment in patients with continued embolization despite anticoagulation.^{1,2} There appears to be a linear relationship between complication rates related to the filters and time from implantation³; however, filter migration has been reported even within a few days of insertion.^{4,5} The causes of early migration are mostly technical and include improper sizing or inadequate positioning of the device.^{5,6} Changes in IVC pressure may play a role in acute filter migration.^{2,7,8} Prone positioning for spinal surgery can cause sudden changes in IVC size and pressure^{6,9-13} and may be a contributing factor to the migration of a newly inserted IVC filter. This factor may be even more important with the use of more recent devices (e.g., flexible retrievable filters).

We present a case of IVC filter migration to the right ventricle occurring while a trauma patient was undergoing spinal surgery in the prone position. The patient provided written consent to describe this case.

Case presentation

A 54 yr-old male with hypertension and diabetes fell from a height of 12 m and was admitted to a peripheral hospital. Results of a neurologic examination were completely normal; however, a total body computed tomography scan showed the following injuries: a fracture of the right humerus, an unstable fracture of the T6 vertebra, a stable fracture of the T10 vertebra, fractures of the sixth and seventh left ribs, fractures of the fifth and sixth right ribs, bilateral hemothoraces, a right femoral fracture, and a left

ankle fracture. He initially had surgery to correct the fractures of his right arm and leg, but 24 hr following tracheal extubation, his trachea was reintubated owing to respiratory distress. A computed tomography scan showed a thrombotic occlusion of the upper and middle right pulmonary arteries secondary to an embolism of a left common femoral deep vein thrombosis. An intravenous unfractionated heparin infusion was initiated, and the patient was transferred to our tertiary care institution for management of his spinal injuries. He was admitted to the intensive care unit (ICU) in a stable hemodynamic condition with uninterrupted tracheal intubation. Two days before his planned surgery, an OPTEASE® retrievable IVC filter (Cordis Corporation, Fremont, CA, USA) was placed so that the heparin infusion could be stopped preoperatively. In the operating room, the patient was placed uneventfully in the prone position on conventional convex support pads. The mean inspiratory airway pressure was relatively high (20 cm H₂O) before prone positioning and increased to 27 cm H₂O in the prone position. A central line had already been inserted through the patient's left internal jugular vein, and the central venous pressure, recorded only after the patient was turned to the prone position, was 10–13 mmHg throughout surgery. The operation consisted of a T6 laminectomy and T4–T12 posterior instrumentation and arthrodesis. At the end of the surgical instrumentation, the patient developed ventricular trigeminy which lasted three minutes, but he remained hemodynamically stable with a blood pressure of 95/55 mmHg and a heart rate of 100 beats·min⁻¹. Arterial blood gas and laboratory tests showed adequate oxygenation with normal hemoglobin and electrolytes. He was treated with fluid replacement with normal saline and a first dose of intravenous magnesium 10 mg. The arrhythmias did not recur. The surgery lasted 180 min, and at the end of the procedure, the patient was placed in the supine position with a central venous pressure of 10 mmHg. He was subsequently transferred to the ICU.

Over the next 48 hr, the patient developed a high-grade fever of 39°C and could not be weaned from the ventilator. The results of blood tests were unremarkable, and the chest *x-ray* was normal. An echocardiogram, performed to rule out endocarditis, showed that the IVC filter had migrated into the right ventricle. Despite being radio-opaque, the IVC filter could not be identified on the plain chest *x-ray*, even retrospectively, due to the superimposed image of the heart (Fig. 1). The patient was taken to the catheterization laboratory where an attempt was made to retrieve the filter percutaneously. The device was clearly seen on radioscopy and captured with a snare (Fig. 2); however, an attempt at its removal led to cardiac arrest—the struts of the filter could not be freed from the tricuspid valve apparatus, which led to a tear in the valve and sudden ventricular

Fig. 1 Chest x-ray of the patient: the filter is not seen in the chest due to the increased density of the heart silhouette

Fig. 3 Severe tricuspid regurgitation following the failed retrieval attempt (transthoracic echocardiography)

Fig. 2 A) Radioscopic image taken in the catheterization laboratory showing the filter in the right ventricle. The snare, introduced percutaneously through the femoral vein, is seen in the right atrium ready to retrieve the filter. B) The filter is snared

fibrillation. The patient was immediately and successfully defibrillated. An echocardiogram showed severe tricuspid regurgitation (Fig. 3), and the patient was immediately rushed to the operating room and placed onto cardiopulmonary bypass *via* a midline sternotomy. The anterior leaflet of the tricuspid valve had been avulsed from the tricuspid annulus. The filter was carefully removed, and the leaflet was sutured back to the annulus with reinforced stitches. A size 32 tricuspid ring was then inserted. The patient tolerated the procedure well, had an uneventful recovery, and was discharged from the ICU to the ward two days postoperatively on an intravenous unfractionated heparin infusion. He was doing well six months after hospital discharge.

Discussion

The use of IVC filters for the prevention of pulmonary thromboembolism (PE) has increased dramatically during the last two decades due to the introduction of retrievable filters that can be taken out once the transient high risk of PE has resolved.¹ Hence, the indications for IVC filters have shifted from prevention in patients with deep vein thrombosis (with contraindication to anticoagulation) to prophylaxis in the setting of severe trauma or before major surgery.^{1,2} In 1999, 49,000 filters were inserted in the United States, only 19% of which were used for prophylactic indications.¹⁴ This number increased to 167,000 within less than ten years and reached 259,000

in 2012. Now, more than 50% of IVC filters are inserted for prophylactic indications.^{1,14} This indication has been recently challenged, however, and a randomized study showed that anticoagulation alone is equally protective with and without the addition of an IVC filter.¹⁵ The rate of complications relating to IVC filters has steadily increased over time, not only due to the larger number of filters used but also due to the widespread use of retrievable devices.^{1,3,14} The unique physical characteristics of the manufacturing materials in the new retrievable devices are a double-edged sword. Made of lighter alloys, they are radially compressible and axially flexible. These properties are considered responsible for the higher incidence of device migration.² According to the Manufacturer and User Facility Device Experience (MAUDE) database published by the Food and Drug Administration, during 2009–2012, 86% of all IVC filter complications were related to retrievable devices.^{1,14} Migration occurred in 13.4% of all cases, ranging from 0–24% according to the type and the manufacturer, and 78% of the migrating devices were retrievable filters.¹⁴ The highest migration rate (24%) was observed with the OPTASE device, which is the device used in our patient.¹⁴

Proper sizing of the filter is critical to avoid migration and relies on the precise measurement of the IVC diameter with a pre-insertion cavogram.² Nevertheless, the IVC is a dynamic compliant vessel subject to many physiologic variables that may affect its anatomy and hemodynamics. Caval size in the catheterization laboratory does not preclude later changes in IVC diameter under different physiological conditions, and the compliant nature of the IVC may itself be a risk factor for filter migration.⁸ Laparoscopic bariatric surgery best illustrates the dynamic nature of the vena cava—the vessel being under constant stress from fluid resuscitation and pneumoperitoneum—and acute migration of IVC filters has been reported during surgery.² Migrations have also been reported during cardiopulmonary resuscitation, which is another good example. In this instance, the circulatory collapse during arrest directly affects the size of the IVC which takes its maximal diameter as a result of aggressive fluid replacement, pump failure, and positive pressure ventilation.⁸ Prone positioning of patients in the operating room may also acutely modify the pressure in the IVC and contribute to a change in its diameter.^{9–13} Placing patients in the prone position is ubiquitous during lumbar spinal surgery, but prone positions vary according to the available operating facilities and the support padding and frames used. A positioning frame that allows the patient's abdominal viscera to hang freely while the patient is in a prone position significantly reduces IVC pressure, whereas prone positioning on a conventional pad increases IVC pressure by 50%.¹¹ The cumulative negative impact of prone positioning and anesthesia on cardiac output has been

reported.^{10,13} In this case, our patient was positioned on a conventional convex pad, which may have acutely increased the intra-abdominal and IVC pressure. In addition to prone positioning, IVC morphology and hemodynamics are also affected by positive pressure ventilation. In a study of 101 patients scheduled for percutaneous removal of an IVC filter, Laborda *et al.* found a fivefold increase in IVC pressure during Valsalva maneuvers, and the three-dimensional computational models of the patients showed significant IVC deformation around the filter.⁷ Thus, the cumulative effects of prone positioning with abdominal compression along with positive pressure ventilation may have contributed significantly to the device migration in our patient. In some cases, when surgical maneuvers are in close proximity with the IVC, they may play a significant role in filter dislodgement and migration. In this case, however, the posterior instrumentation was performed on the thoracic vertebrae above the level of the device, which was situated below the renal arteries facing the lumbar spine.

Device migration to the heart chambers is a serious complication with a potentially fatal outcome. In a review of all filter migrations during 1998–2008, Janjua *et al.* reported 25 cases of devices migrating up to the heart or the pulmonary arteries.² Three patients (12%) died from cardiac complications, and surgical removal of the filter was necessary in eight patients (32%). In another older review (1996) of 22 filter migrations to the heart, James *et al.* reported one death (4.5%) and one patient presenting with cardiopulmonary collapse due to significant arrhythmias.¹⁶ Finally, Izutani *et al.* reported 12 cases of IVC filter migration to the heart in 2004.¹⁷ There were no reported deaths; however, half of the patients presented with potentially life-threatening complications, including cardiogenic shock, arrhythmias, and acute myocardial infarction.

The only indication of the possible time of intraoperative migration in our patient was the occurrence of arrhythmias during surgery. Arrhythmias may have been triggered by other causes, such as fat, air, or particulate matter embolism during instrumentation. This possibility may be considered a limitation of this case report. In our view, however, an asymptomatic migration from the IVC to the right atrium and then through the tricuspid valve into the right ventricle in a continuously monitored patient in the ICU is less likely to happen without atrial or ventricular arrhythmias.

In conclusion, patients with IVC filters should be handled carefully in the operating room with an increased awareness about the risks related to a sudden increase in pressure in the IVC. Care should be taken when placing the patient in the prone position by using proper frames that allow for less abdominal compression and avoidance of high positive ventilation pressures. New atrial or

ventricular arrhythmias should immediately raise the suspicion of embolization of the device into the heart chambers.

Conflicts of interest None declared.

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