CASE REPORT

Migration of a fractured inferior vena cava filter strut to the right ventricle of the heart

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SUMMARY

Inferior vena cava (IVC) filters are increasingly used in patients with recurrent venous thromboembolism in whom anticoagulation is contraindicated or intolerable. Migration of fragments is a known complication of IVC filter use. We present a case of a 32-year-old man, who presented with right-sided chest pain believed to be caused by a migrated IVC fragment to the right ventricle. The filter was removed by an endovascular cook forceps with the assistance of intracardiac echocardiography. This case serves as an addition to the existing reports of successful removal of intracardiac fragments via minimally invasive endovascular approach, amid a larger number of intracardiac fragments that have been removed by an open-heart approach.

BACKGROUND

Migration of fragments is a known complication of inferior vena cava (IVC) filter use. Fragments that migrate to the right side of the heart can further lodge in the right atrial and ventricular walls and the pulmonary artery.¹ Right ventricular wall implantation can progress to penetration, haemopericardium, pericardial tamponade and possible death.² Management of an IVC fragment which travels to the right ventricle can be challenging.

CASE PRESENTATION

A 32-year-old otherwise healthy African-American man with a history of provoked pulmonary embolism (PE) and IVC filter placement 5 years previously presented with acute right-sided pleuritic and positional chest pain. The IVC filter was placed for provoked PE that occurred during an admission for multiple gunshot injuries that led to total splenectomy and resection of the tail of the pancreas. Vitals were stable. Physical examination and blood work were unremarkable.

INVESTIGATIONS

Chest X-ray showed two linear metallic foreign bodies that were not present in previous films (figure 1), one appearing within the region of the right atrium at the level of the T10 vertebral body, and the other in the right upper quadrant. X-ray of the abdomen showed fractured segments of the IVC filter and a radiopaque foreign body involving the right deep lateral costophrenic sulcus (figures 2 and 3). CT of the chest confirmed a radiopaque foreign body located within the region of the right atrium and another in right lateral deep

costophrenic sulcus (figure 4). Interestingly, trans-thoracic echocardiogram showed normal left and right chambers with no foreign bodies seen within the heart. Further imaging with coronary CT angiogram (CTA) with three-dimensional cardiac imaging which was done to look for migrated filter fragments in the vasculature showed a broken strut of the IVC filter embedded in the free wall of the right ventricle along its posterior and inferior aspect. Its lateral aspect approached the pericardium laterally, and its medial aspect appeared to be near the endocardium and chordae tendineae (figure 5). CT abdomen without contrast showed the medial most filter strut extending through the IVC wall into the retroperitoneum and lying just anterior to the abdominal aorta. The inferior filter strut was fractured, and its fractured fragment was embedded in the anterior aspect of the L3 vertebral body (figure 6). Between the CT chest and the coronary CTA, in a period of lesser than 12 hours, the fragments appeared to have migrated further into the heart.

Figure 1 Chest X-ray showing two linear metallic foreign bodies, one in the anterior aspect of the heart (horizontal radiopaque line within the centre oval) and the other in the right upper abdomen (parallel to the yellow line). The peripheral piece measures about 3.5 cm which corresponds to the entire length of the primary filter strut.

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Figure 2 X-ray abdomen showing a broken strut (yellow arrow) with its distal piece missing, a second fractured strut with the piece lying just caudal to the inferior vena cava filter (green arrows), an unfractured intact strut and a completely missing fourth strut. Six of the original seven thinner legs are intact, with the seventh missing.

TREATMENT

Despite residing in the myocardium of the heart, no visible complications were noted with the embolised strut, and the patient's chest pain subsided the next day after his admission. The patient was evaluated by an interventional cardiologist, a cardiothoracic surgeon and an interventional radiologist who on careful review of the scans felt that retrieval attempts would be risky due to potential damage to the tricuspid leaflet, chordae tendineae or papillary muscle structures. Both the cardiologist and the cardiothoracic surgeon felt that the fragment lodged in the right ventricle was unlikely to migrate further, and an observational approach was initially elected.

However, his pleuritic chest pain recurred in a few days, and he was referred to a tertiary centre where he underwent IVC filter retrieval with an endovascular forceps. Aside from the known fractured leg at the level of the filter, all the components were removed without additional retained fragments. The fractured filter leg had migrated beyond the confines of the vena cava wall and could not be retrieved via endovascular means. A postretrieval IVC venogram demonstrated extravasation of contrast into soft tissues of the retroperitoneum and an intraluminal thrombus at the level of the filter. Balloon tamponade with an 18mm balloon and a mechanical thrombectomy were performed, and a follow-up IVC cavogram demonstrated no evidence of extravasation or intraluminal thrombus. General surgery consultation was obtained for removal of the IVC filter

Figure 3 Coronal view X-ray of the abdomen showing a radiopaque foreign body involving the right deep lateral costophrenic sulcus. The green arrow indicates the two pieces of a fractured strut.

strut in his right hepatic lobe, but removal was not recommended as the patient was asymptomatic. The intracardiac IVC strut was removed by interventional radiology through an endovascular approach with the assistance of intracardiac echocardiography. A small Cook endovascular forceps was used to remove the entire filter fragment in one piece.

Figure 4 CT chest showing a radiopaque foreign body in the region of the right atrioventricular junction. The green arrow indicates a radiopaque filter fragment in the right lateral deep costophrenic sulcus, seen on chest CT.

Figure 5 CT angiogram of the chest showing a metallic linear structure (green arrows) located along the right ventricular free wall anteriorly and the base of the ventricle posteriorly, with possible protrusion through the right ventricular free wall.

OUTCOME AND FOLLOW-UP

Patient did well postoperatively and did not have any complications from the retained intrahepatic fragment to date.

DISCUSSION

It is estimated that the incidence of venous thromboembolism (VTE) in the USA is between 300 000 and 600 000 individuals per year.³ Anticoagulation remains the mainstay of treatment for provoked and unprovoked VTEs. According to the American College of Chest Physicians 2012 guidelines, IVC filters are only indicated for acute proximal deep vein thrombosis (DVT) or acute PE when anticoagulation is contraindicated.^{4 5} Food and Drug Administration recommends timely removal of filters as soon as they are no longer required for protection as longer indwelling time translates into a higher IVC filter fracture rate.⁶

Figure 6 CT abdomen without contrast showing the medial most primary filter strut (3) extending through the inferior vena cava wall into the retroperitoneum and lying just anterior to the aorta. Inferior filter strut (2) is seen embedded in the L3 vertebral body and encased by bony excrescences which also encase one or possibly two secondary struts (thinner legs).

IVC filters are of two types: retrievable and permanent filters. The risk of filter fracture mainly depends on the material and design of the filter and the length of time since implantation.⁷ There are different types of retrievable filters available in the USA which include the BARD recovery filters G1 and G2, Opt Ease (Cordis) and the Gunther Tulip (Cook). Gunther's Tulip filter was introduced in the 1990s and Cook's Celest filters, like the one in our patient, is an improved version of Gunther's Tulip filter and was approved in 2008.

While retrievable filters were designed to reduce the complications, such as increased risk of DVT associated with permanent filters, up to 70% of retrievable filters were never removed.⁸ IVC filter removal should be considered even in patients who have had it for extended periods of time as there is an increase in the frequency of complications associated with an increased filter indwelling time.⁹ Some of the commonly encountered complications include filter migration, embolisation, IVC perforation and strut fracture.^{6 10 11} The process of retrieval itself gets complicated when the filter gets embedded in the caval wall from epithelialisation which renders simple retrieval techniques unsuccessful.^{6 7} Embolisation of fractured filter fragments into the heart is rare. Available literature, including case reports and case series, shows that between 2006 and 2015, there were 37 filter fragments that migrated to the heart in 29 patients.¹² While chest pain has been the most common presentation, the complications from a filter or its fragment's migration to the heart include free wall rupture, cardiac tamponade, dysrhythmias and tricuspid valve involvement causing valve damage and wall perforation.^{13–16}

There have been case reports of endovascular retrieval attempts for removing intact filters that migrated to the heart between 1980 and 2008.¹⁷ It was observed that 69% of these filters were successfully removed, and there were three deaths resulting from ventricular fibrillation arrest,¹⁸ one from filter dislodgement into the pulmonary artery¹⁹ and following ejection of the filter into the right atrium.²⁰ Open-heart approach was thought to be more controlled with lesser risk of damage to internal structures or

Patient's perspective

FDA recommends timely removal of filters as soon as they are no longer required for protection as longer indwelling time translates into a higher IVC filter fracture rate.⁶

Learning points

- ▶ Patients and the physicians should be well informed about the need for prompt removal of retrievable filters as soon as they are no longer required for protection.
- ▶ The complications from a filter or its fragments migration to the heart include intra-cardiac embolisation causing dysrhythmias, tricuspid valve involvement causing valve damage and ventricular wall perforation.
- ▶ Longer than required filter stay heralds complications like caval thrombosis, caval wall perforation, filter fracture and migration to different sites in the body.
- ▶ Although there is no clear consensus regarding the superiority of open surgical approach over endovascular approach, minimally invasive endovascular approach is preferable for struts with a free end that is not completely incorporated into the myocardium and is a reasonable alternative for those patients who are not surgical candidates.

further dislodgement of the fragments.^{21 22} While majority of intracardiac fragments were removed by open-heart approach,¹² a number of IVC fragments in the heart have been removed successfully by endovascular means.^{1 17 23–26} Although literature review has not demonstrated a clear consensus regarding the superiority of one approach over the other, endovascular approach has been deemed a reasonable alternative for patients who are not surgical candidates.²² Also, for struts with a free end, which are not completely incorporated into the myocardium, endovascular approach has been suggested.^{1 27} Our patient had a strut with a free end laterally at the base of the right ventricle (figure 5) which made endovascular approach a reasonable option for him.

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