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Endovascular retrieval of a CardioMEMS heart failure system

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ABSTRACT

As the creation and utilization of new implantable devices increases, so does the need for interventionalists to devise unique retrieval mechanisms. This report describes the first endovascular retrieval of a CardioMEMS heart failure monitoring device. A 20-mm gooseneck snare was utilized in conjunction with a 9-French sheath and Envoy catheter for retrieval. The patient suffered no immediate postprocedural complications but died 5 days after the procedure from multiorgan failure secondary to sepsis.

Introduction

The number and spectrum of implantable devices has increased dramatically over the past several decades. Along with the continued technologic revolution in biomedical engineering, comes the additional risk of malposition, colonization, and infection. As the number and variety of implantable devices increases, advances in device retrieval are mandatory. Since the first description of endovascular retrieval of an intracardiac steel fragment, interventional radiologists and vascular surgeons have remained cornerstones in cases of endovascular device retrieval.

There have since been numerous reports describing techniques for removing malpositioned or infected intracardiac devices, inferior vena cava filters, wire and catheter fragments, stents, and embolization coils [1,2]. The following case describes the first known endovascular retrieval of a CardioMEMS heart failure monitoring device.

Case report

Institutional review board approval was not required for the preparation of this report. A 54-year-old woman with history of prior atrial septal defect status post closure, hypertension, peripheral artery disease, ischemic cardiomyopathy, and heart failure presented with sepsis. Blood cultures demonstrated fungemia with *Candida tropicalis*. She was found to have a 14-mm metallic foreign body of unknown origin projecting over her left pulmonary artery on chest radiograph (Fig. 1), which

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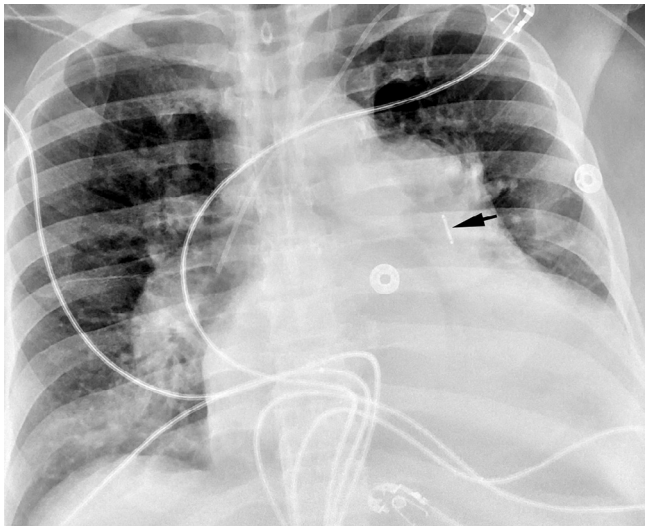

Fig. 1 – Chest radiograph. Arrow pointing to the implantable device projecting over a left-sided pulmonary artery branch.

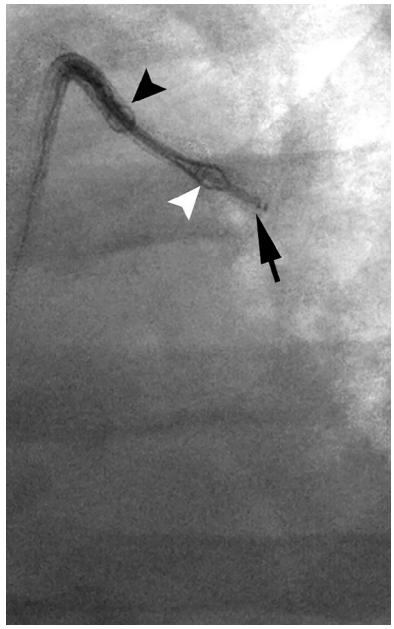

Fig. 2 – Intraprocedural fluoroscopic image shows a 20-mm gooseneck snare (white arrowhead) deployed from the Envoy catheter (black arrowhead) and in firm grasp of the device (arrow).

was re-demonstrated on computed tomography of the chest. This implant was thought to be a nidus for infection. A consult was placed for removal.

Left pulmonary arteriography showed enlarged pulmonary arteries, consistent with hypertension, as well as the foreign body within the left lower lobe pulmonary artery. Attempts were made to retrieve the foreign body using 15-mm and 20-mm gooseneck snares (Medtronic, Minneapolis, MN) and an 18-30 mm Ensnare (Merit Medical, South Jordan, UT); however, all were unsuccessful. It appeared as if the foreign body was embedded within the pulmonary artery wall.

Subsequently, a 9-French sheath and a 6-French Envoy guiding catheter (DePuy Synthes, West Chester, PA) were advanced into the left pulmonary artery. A 20-mm gooseneck snare (Medtronic) was then used to successfully grasp the device (Fig. 2). The foreign body, however, could not be withdrawn into the 6- or 9-French sheaths (Fig. 3). Therefore, the foreign body, Envoy catheter, and 9-French sheath were removed in unison through the femoral vein. Upon retrieval, the device was noted to be a CardioMEMS heart failure monitoring device (Fig. 4). No immediate complications occurred. Culture of the device yielded *C tropicalis*. The patient died 5 days after the procedure from fungal septicemia and multiorgan failure.

Discussion

The CardioMEMS heart failure system is the first and only Food and Drug Administration–approved pulmonary artery pressure monitoring heart failure device [3–5]. The device is deployed into the distal pulmonary artery where it continuously monitors pulmonary artery pressures and sends data from the implant to an external device wirelessly [3–5]. Data are transmitted to an online portal where the health-care provider or patient may monitor pulmonary artery pressures. The CardioMEMS heart failure device has been shown to improve exercise capacity and quality of life in heart failure patients and reduce heart failure admissions by 37% [3–5].

C tropicalis, an ever increasingly pertinent organism with relation to implantable devices, was the culprit organism for

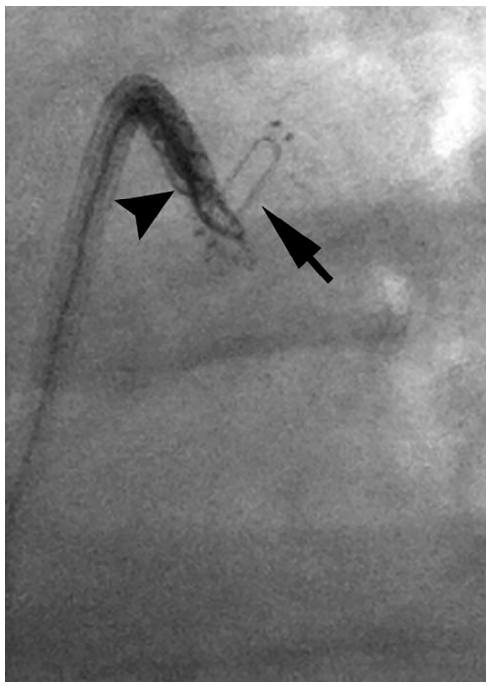

Fig. 3 – Intraprocedural fluoroscopic image of attempted retraction of device into sheath. A 20-mm gooseneck snare (black arrowhead) is unable to pull the device (black arrow) into the sheath.

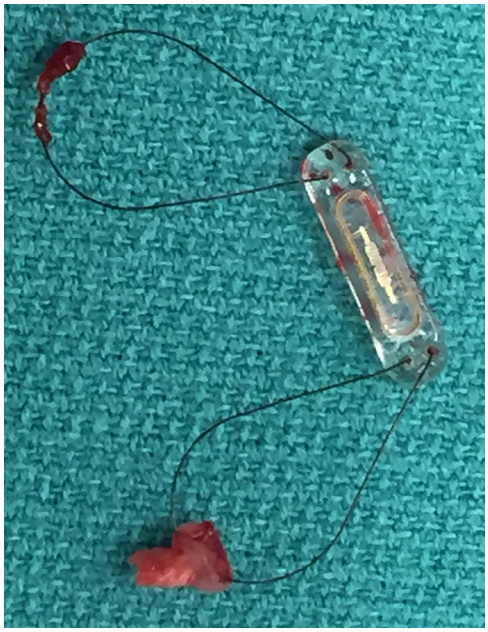

Fig. 4 – The CardioMEMS device after retrieval. The device is noted to have two nonradiopaque stabilizing hydrophilic loop wires. These wires were incorporated into the pulmonary artery branch wall.

device colonization, sepsis, and eventual death in our patient. Infections from this organism have steadily increased on a global scale, now identified as the most prevalent pathogenic yeast of the *Candida*-non-*albicans* group [6]. Implicated in this increase, usage of intracardiac prosthetic devices carries with it up to a 3% infection risk and biofilm formation with *Candida* species [7]. The propensity of this organism to organize into biofilms coupled with its growing resistance to fluconazole [6,7] makes device retrieval the cornerstone treatment among a list of dwindling options in this patient population.

Device implantation, typically performed by interventional cardiologists, may provide clues to determine the optimal methodology for removal. Regarding placement, first, venous access is obtained through the right common femoral vein with an 8-French sheath which is subsequently upsized to a 12-French sheath. A modified APC or balloon catheter is then advanced through the heart to the left pulmonary artery and pressures are obtained. Ideal sensor placement is within the inferior or lateral branch of the left pulmonary artery, with a lumen measuring 7-15 mm in diameter. A left-sided approach is more commonly utilized as right-sided placement of the implant may limit signal strength for interrogation. After 4-8 mL of dilute contrast is injected to visualize a target location for deployment, a 0.018-inch wire is advanced to a distal portion of the pulmonary vessel. After heparinized saline is applied to the two hydrophilic nonradiopaque stabilizing loop wires, the device is loaded into a delivery catheter over a 12-French sheath. Once the device is advanced to the desired location, the tether release system is withdrawn. The delivery catheter is then removed under fluoroscopic guidance. A balloon wedge or Swan-Ganz catheter is then used to measure pressure and calibrate the newly implanted device [5].

Removal challenges in this case include the unknown nature of the device at the time of retrieval and the anatomy of the device itself. Device removal was hindered due to the presence of two stabilizing loop wires, which are nonradiopaque and may incorporate into the pulmonary artery wall. Identification of the device before the procedure and positioning a larger snare distal to the device with retraction of the snare over the distal stabilizing wire may aid in retrieval success. These described maneuvers may also be helpful for other implantable objects such as inferior vena cava filters and fractured catheters. This case illustrates that a 9-French sheath is insufficient to retract the device before removal. Further cases of device retrieval may attempt using a long 12-French sheath or larger as is used in device implantation. Given the luminal caliber of the left and right pulmonary arteries and the device dimensions, however, it may not be possible nor clinically sound to sheath the device before removal. In that case, removal of the CardioMEMS device in unison with the Envoy catheter and vascular sheath may be the best option.

Conclusion

Although additional studies are needed, this report suggests that the CardioMEMS heart failure device may be successfully retrieved endovascularly. This case report emphasizes the importance of device identification, snare sizing and maneuvering, and simultaneous removal of all components in the terminal step for successful retrieval of the CardioMEMS heart failure monitoring device.

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