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Case Report

Coil Migration to Pulmonary Vasculature: Case Report and Review

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Abstract

Coil migration to systemic circulation during coil embolization is a rare and potentially fatal complication. We present a case of asymptomatic coil migration to a pulmonary artery during embolization of accessory veins to salvage an Arteriovenous Fistula (AVF). The patient was managed conservatively and has remained asymptomatic after one and half years of follow up. We also identified the available literature for coil migration to the cardiopulmonary system and conducted a review pertaining to the symptom profile, factors predisposing to migration, management and long term complications.

Introduction

Coil embolization is a minimally invasive and safe procedure for endovascular occlusion. It is widely employed for occlusion of AVF and Arteriovenous Malformations (AVMs). It is frequently used to salvage non-maturing AVF created for Hemodialysis (HD) access by embolizing accessory veins, which is one of the most common causes of early maturation failure of AVF. Although rare, distal migration of coils from target vessels to the cardio-pulmonary system is a known complication and can be potentially fatal. We describe a case of asymptomatic coil migration from accessory veins of AVF to a pulmonary artery.

Case Presentation

A 65 year old male with history of diabetes, hypertension and chronic kidney disease was referred to interventional radiology for a non-maturing AVF which was created 6 months ago for HD access. Physical examination was remarkable for a left forearm AVF with a weak thrill and bilateral pedal edema. Patient underwent a fistulogram, which identified two accessory veins (superior and lateral) and fistula stenosis as etiology of AVF failure (Figure 1). Superior and lateral accessory veins were embolized with two 8mm and two 10 mm tornado coils respectively (Figure 1). Balloon angioplasty was done for stenosis of the AVF. While performing angioplasty, two 10 mm tornado coils were dislodged from lateral accessory vein (Figure 2). Fluoroscopy and Chest x-ray (CXR) showed that the coils had migrated to the right ventricle (Figure 3). Attempts at coil retrieval by using an endovascular snare from the right internal jugular approach were unsuccessful (Figure 4). The patient remained asymptomatic and hemodynamically stable during the whole procedure. Repeat X ray and fluoroscopy the next day showed further migration of the coils in the right pulmonary artery (Figure 5). The patient remained asymptomatic and was discharged with frequent follow up. HD was started after a graft placement and the patient has remained asymptomatic for the last one and half years.

Discussion

An AVF is the preferred long term vascular access for HD due to fewer complications, long term patency and decreased mortality. Failure of an AVF to mature within 4-6 months of creation is classified as early failure of AVF. Stenosis and development of accessory veins are the two most common causes of AVF maturation failure. Coil embolization is a minimally invasive endovascular approach to obliterate accessory veins to salvage a non maturing fistula.

Coils were first used for embolotherapy in 1975 for the treatment of AVMs [1,2]. Coils obliterate the target vessel by providing a surface for clot formation and releasing thrombogenic factors by causing vessel wall damage [3]. The process of thrombosis typically starts within 5 minutes of coil deployment and culminates into an organized thrombus and later leads to neointimal fibrosis. However, host factors such as coagulopathic states and platelet dysfunction can interfere with the process of complete obliteration.

Potential complications of coil embolization include bleeding, infection, post embolization syndrome, vessel perforation and coil migration either to a non target vessel or systemic circulation. Coil migration to systemic circulation is a rare complication and has only been described in 10 individually published case reports (Table 1).

Table 1: Cases of coil migration to cardiovascular system.

Site of embolization	Site of migration	Symptoms	Management	Follow up
Crurel Vein	Right Pulmonary Artery (PA)	Asymptomatic	Conservative	N/A
Lingular AVM	Left Ventricle (LV), Behind posterior mitral leaflet	Asymptomatic (Detected during the procedure)	Median sternotomy with retrieval	N/A
Left internal iliac vein	Lower branch of right PA	Asymptomatic	Conservative	3 months
Right ovarian vein	Right ventricle (RV), Entrapped in tricuspid annulus	Asymptomatic	Conservative	2 years
Left sided pulmonary AVM	LV, Chordae of mitral valve	Asymptomatic Detected during procedure	Retrieval after multiple attempts	N/A
Right sided pulmonary AVF	LV, Chordae of mitral valve	Detected during procedure	Urgent thoracotomy with retrieval	N/A
Right sided pulmonary AVF	LV	Cardiac tamponade 10 days after retrieval	Periprocedural retrieval using catheter forceps via femoral approach	10 months
Patent Ductus Arteriorus	Branch of Left pulmonary artery, latter to segmental branch during retrieval	Detected during the procedure	Retrieval via snare during second attempt	N/A
Superior and Lateral Accessory vein of left brachiocephalic fistula	Right ventricle and latter to Right Pulmonary artery.	Asymptomatic	Failure to retrieve	1.5 years
Left lower lobe AVM	Outflow tract of Right Ventricle	Asymptomatic Detected during procedure	Removed using cordis 8 multipurpose catheter	N/A
Left Gonadal Vein	RV, further migration to Right lower lobe pulmonary artery during extraction attempts from RV	Asymptomatic Detected during the procedure	Retrieved percutaneously using intravascular forceps	N/A

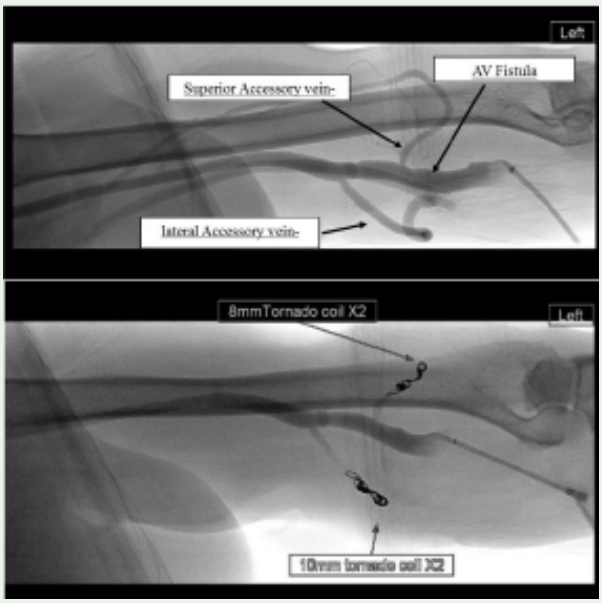

Figure 1: Fistulogram (top) and coil embolization (bottom).

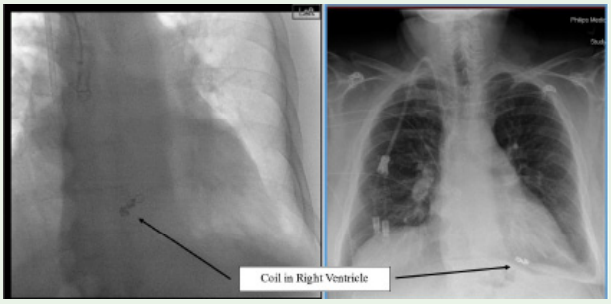

Figure 2: Migration of coil in right ventricle (Right-fluoroscopy, Left- chest X ray)

Systemic displacement of coils can either be a downstream migration within the cardiovascular system during procedures such as embolization of pulmonary AVMs and Patent Ductus Arteriosus (PDA) closure or upstream migration from a distant anatomical site. Distant coils migrate via the inferior vena cava and lodge in the right ventricle and can further migrate into the pulmonary artery.

To the best of our knowledge, no case of upstream migration of coils used to salvage an AVF created for HD access has been reported. In our patient, the coils migrated from the superior and lateral accessory veins to the right ventricle and further into the right pulmonary artery. There have been only four other cases describing upstream migration of coils to the pulmonary artery [4-7] (Table 1).

Coil migration can be an asymptomatic event or can have fatal consequences such as ventricular wall rupture, arrhythmias, pulmonary embolism and myocardial infarction. In the presence of a right-to-left shunt, paradoxical migration is possible leading to stroke and arterial occlusion. Despite these risks, most patients including ours remained characteristically asymptomatic even at long term follow up. During our review of the literature, only one patient developed cardiac tamponade as a consequence of coil migration [8]. During embolization of a pulmonary AVF the coil migrated paradoxically to the left ventricle due to high flow and was detected during the procedure. The coil was retrieved using catheter forceps and cardiac tamponade developed 10 days after the retrieval and was attributed to perforation of the left ventricular wall either by the coil itself or during the retrieval process.

Factors predisposing to migration include the premature deployment of the coil, rapid blood flow and disparity between the size of the coil and the target vessel. The coefficient of friction between the coil and the target vessel is accountable for coil stability; hence selecting the right size of coil is important. For venous embolization, the coil's size has been proposed to be 20% -100% larger than the diameter of the target vessel [9]. Sudden changes in venous caliber, pressure dynamics and rapid blood flow, such as in AVFs and AVMs, can also cause coil displacement.

Various techniques have been proposed to reduce this risk. Detachable coils are being used more often as they can be repositioned or removed if position is not optimal [10]. Segments of gelfoam can

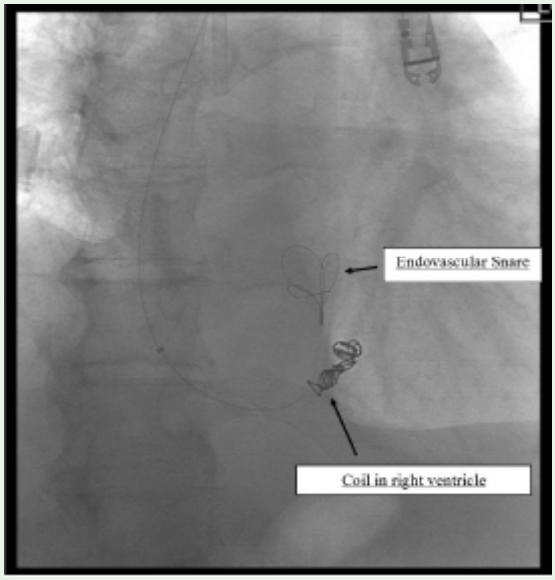

Figure 3: Unsuccessful attempt to extract coil using endovascular snare under fluoroscopy.

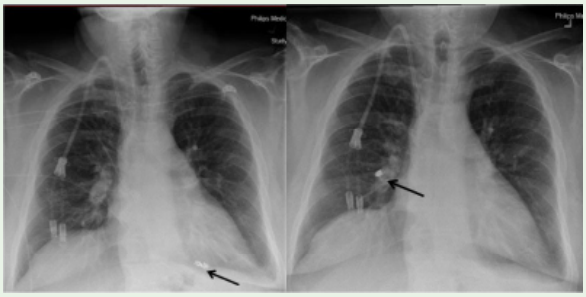

Figure 4: Chest X ray of migration of coil from right ventricle (left) to right pulmonary artery (right).

be interspersed between the coils if multiple coils are being used [11]. A 'reframing' technique has been described for embolization of high flow AVFs in which an interlocking detachable coil is deployed to function as an anchor for microcoils [12]. Wallstent can be used as a permanent barrier to prevent migration of embolic coils during transcatheter embolization [13].

Migrated coils are either directly visualized during the procedure itself or detected during the follow up period. As most of these coils are radio-opaque, X-rays can delineate the general location of the coil, and further imaging such as a Computed Tomography (CT) scan, echocardiography and fluoroscopy are required for precise localization. A CT scan with intravenous contrast is a reliable method for the localization of a coil in the pulmonary artery and peri-valvular area, which can be missed during echocardiography [14].

The management of coil migration in asymptomatic patients remains controversial. Most patients have been managed conservatively and have remained asymptomatic during the follow up period. Coil retrieval was attempted in all cases of coils migrated to ventricles during the embolization of pulmonary AVMs, AVFs

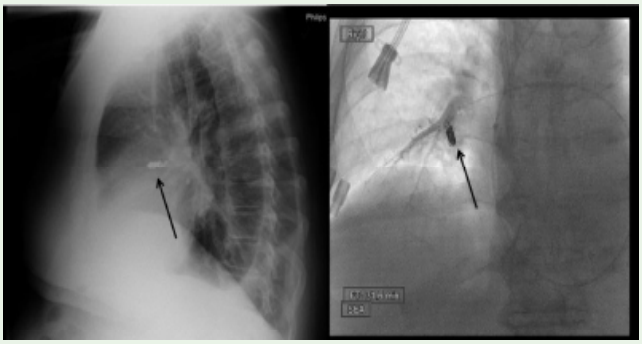

Figure 5: Lateral Chest X ray (left) and fluoroscopy with contrast.

and PDA even in asymptomatic patients. Surgical procedures such as thoracatomy [15] and median sternotomy [14] have been done to retrieve coils. Successful coil retrievals have been done using percutaenous intervention via femoral access and using a trans-septal approach [16]. It should be noted that attempts at coil extraction are not always successful and can sometimes cause complications in an otherwise asymptomatic patient. A coil removal from the left ventricle using catheter forceps lead to a left ventricular wall puncture and cardiac tamponade in one patient [8]. In another case, attempts at retrieval from the tricuspid valve further pushed the coil into the right lower lobe of pulmonary artery [6]. Our review of the literature suggests that coils migrated to the right side of the heart and the pulmonary vasculature can be managed conservatively with watchful observation and long term follow up. Attempts at extraction should be only considered if the patient is symptomatic due to the coil migration or if the coils have migrated to the left ventricle.

Although conservative management is successful in asymptomatic patients, potential long term complications of coil migration have not been addressed in the literature. Presence of a misplaced coil in the cardiovascular system acts as a thrombogenic surface for clot formation. Clot formation either in the right ventricle or the pulmonary artery can lead to pulmonary embolism. A retained coil in the pulmonary artery can trigger remodeling changes and can lead to the development of Chronic Thromboembolic Pulmonary Hypertension (CTEPH). Patients have been followed up for as long as 2 years after the initial event and have remained asymptomatic, although longer follow up would be needed to detect these complications, if they develop. The presence of a coil can be a relative contraindication to MRI, especially if stainless coils are being used. The role of coumadin to prevent pulmonary embolism is also uncertain in these patients [17,18].

In conclusion, coil migration should be recognized as a potential complication of coil embolization, which in most cases is asymptomatic but rarely can cause life threatening complications. A CT scan is a timesaving and accurate imaging modality for precise localization of the migrated coil. We recommend conservative management in asymptomatic patients with diligent follow up to monitor coil location and development of any long term complications. Percutaneous and endovascular approaches should be preferred over open thoracic surgery if attempt at coil retrieval should be made. CTEPH and clot formation are potential long term complications of coil migration and the role of anticoagulation should be evaluated.

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