

May 2016 Imaging Case of the Month

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Clinical History: A 58-year-old man with hypertension presents for a routine health examination. As part of his routine evaluation, frontal and lateral chest radiography (Figure 1) was performed.

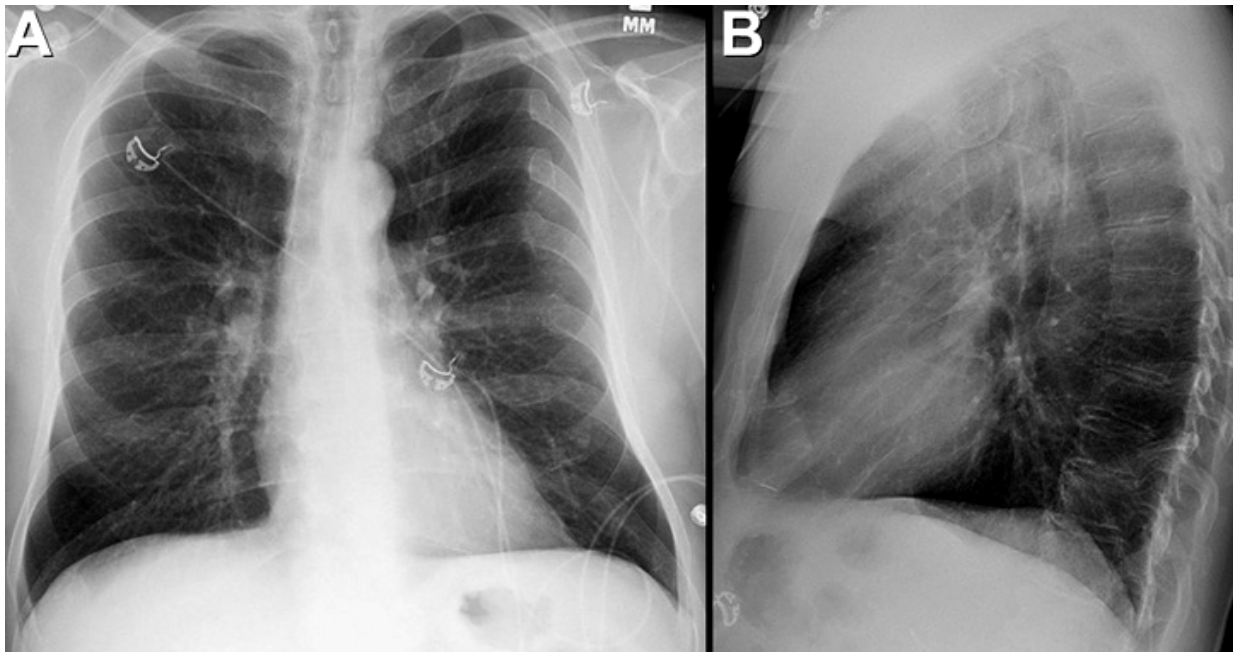


Figure 1. Frontal and lateral chest radiography.

Which of the following statements regarding the chest radiograph is **most accurate**?

1. The frontal chest radiograph shows a small lung nodule
2. The frontal chest radiograph shows a small metallic focus just posterior to the inferior sternum
3. The frontal chest radiograph shows an unusual right-sided mediastinal contour
4. The frontal chest radiograph shows asymmetrically increased attenuation of the left thorax compared with the right
5. The frontal chest radiograph shows normal findings

Correct!

2. The frontal chest radiograph shows a small metallic focus just posterior to the inferior sternum

The frontal chest radiograph shows “nearly” normal findings- the mediastinal contours appear normal, there is no asymmetric attenuation differences affecting the thorax, and no lung nodule is seen. Old left-sided rib fractures are present. However, one potentially significant abnormal finding is present- a small, linear, metallic fragment is seen projecting just posterior to the inferior sternum on the lateral chest radiograph, and can also be seen on the frontal image located at the level of the medial left diaphragm, seen “through” the heart (Figure 2).

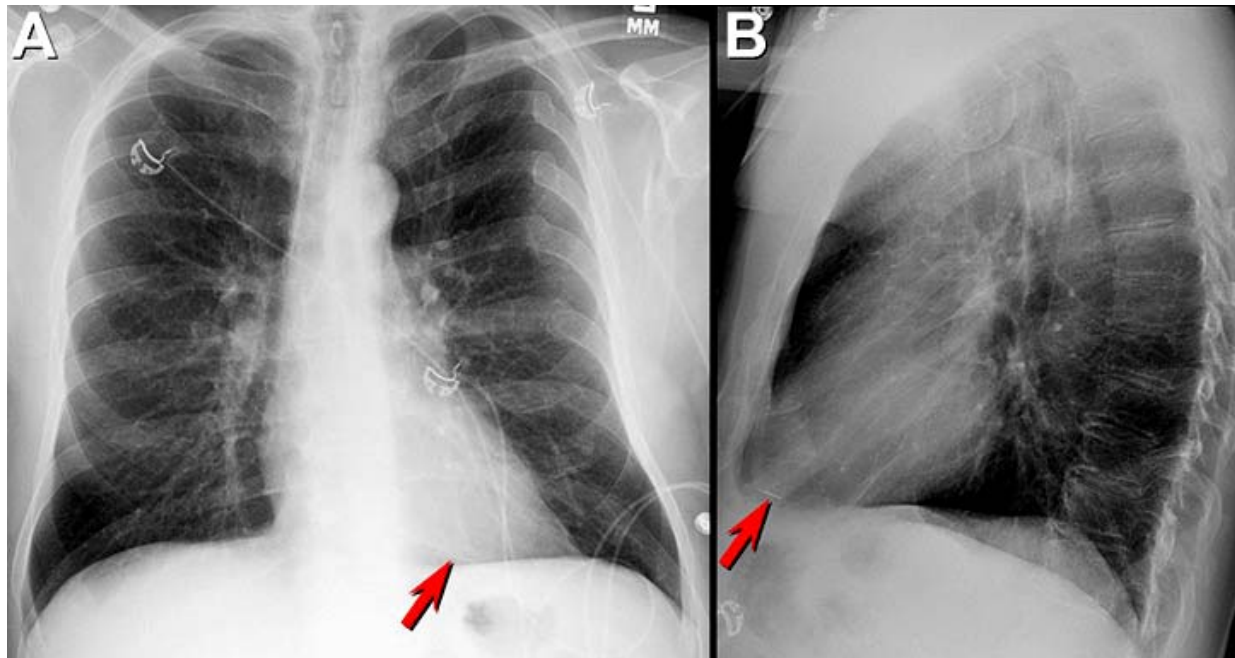


Figure 2. Frontal and lateral chest radiography shows fairly normal findings, but a small, linear, metallic fragment (arrow) is faintly visible in the medial anterior left thorax, projecting in the inferior substernal region on the lateral radiograph, and medially on the frontal image.

Based on the appearance at chest radiography, where is the potential metallic focus **most likely located?**

1. The metallic focus is most likely artefactual, probably reflecting a damaged chest radiographic unit detector element
2. The metallic focus resides in the heart
3. The metallic focus resides in the left costochondral tissues
4. The metallic focus resides in the left lung
5. The metallic focus resides in the thoracic soft tissues

Correct!

2. The metallic focus resides in the heart

The metallic focus projects over the heart and chest wall on the frontal image, just cranial to the diaphragm. On this projection, the metallic focus resides too medially to be located within the left lung since the left lower lobe is located posterior to the heart and the lingula is located lateral to the heart. In other words, the heart's presence in the medial left thorax essentially excludes the left lung's ability to occupy this portion of the thorax; therefore, any object or structure projecting in this region at chest radiography will likely not reside within the lung. On the lateral chest radiograph, the metallic focus projects over the heart and left lung, and resides too posteriorly to be located within the chest wall, either the sternum or medial costochondral junction (the medial portion of which generally roughly resides in the same plane as the sternum on the lateral projection). Combining these two assessments, the heart is the one location for the metallic fragment that is common to both projections, and therefore is the most likely location for this metallic focus.

Which of the following represents an **appropriate step** for the evaluation of this patient?

1. ^{18}F FDG-PET scanning
2. Anterior mediastinotomy
3. Contrast-enhanced thoracic CT
4. Pericardial drain placement
5. Thoracic MRI with contrast enhanced MR angiography

Correct!

3. Contrast-enhanced thoracic CT

Contrast-enhanced CT would be most appropriate to further evaluate the metallic fragment to more precisely localize the fragment and determine its possible etiology and effects on regional anatomy. While a pericardial location for the metallic fragment is possible, and untoward effects on the pericardium due to the fragment cannot be excluded at this point, no chest radiographic features to suggest pericardial effusion are noted. MR examination would not be as efficacious as CT because most metallic fragments are likely be ferromagnetic, and thus will cause a dephasing artifact in the region of the fragment that will obscure both the fragment itself and the anatomy in the immediate vicinity of the fragment. Anterior mediastinotomy would provide visualization of the anterior mediastinum and subaortic space, but there is a significant chance this metallic fragment resides within the heart itself, not the inferior portion of the anterior mediastinum, and thus this procedure would not be appropriate unless further non-invasive localization methods show that the focus resides in a location amenable to visualization at anterior mediastinotomy. ¹⁸F-DG-PET scanning would not play any role in the localization of a metallic fragment.

The patient underwent enhanced thoracic CT (Figure 3) to further characterize the finding at chest radiography.

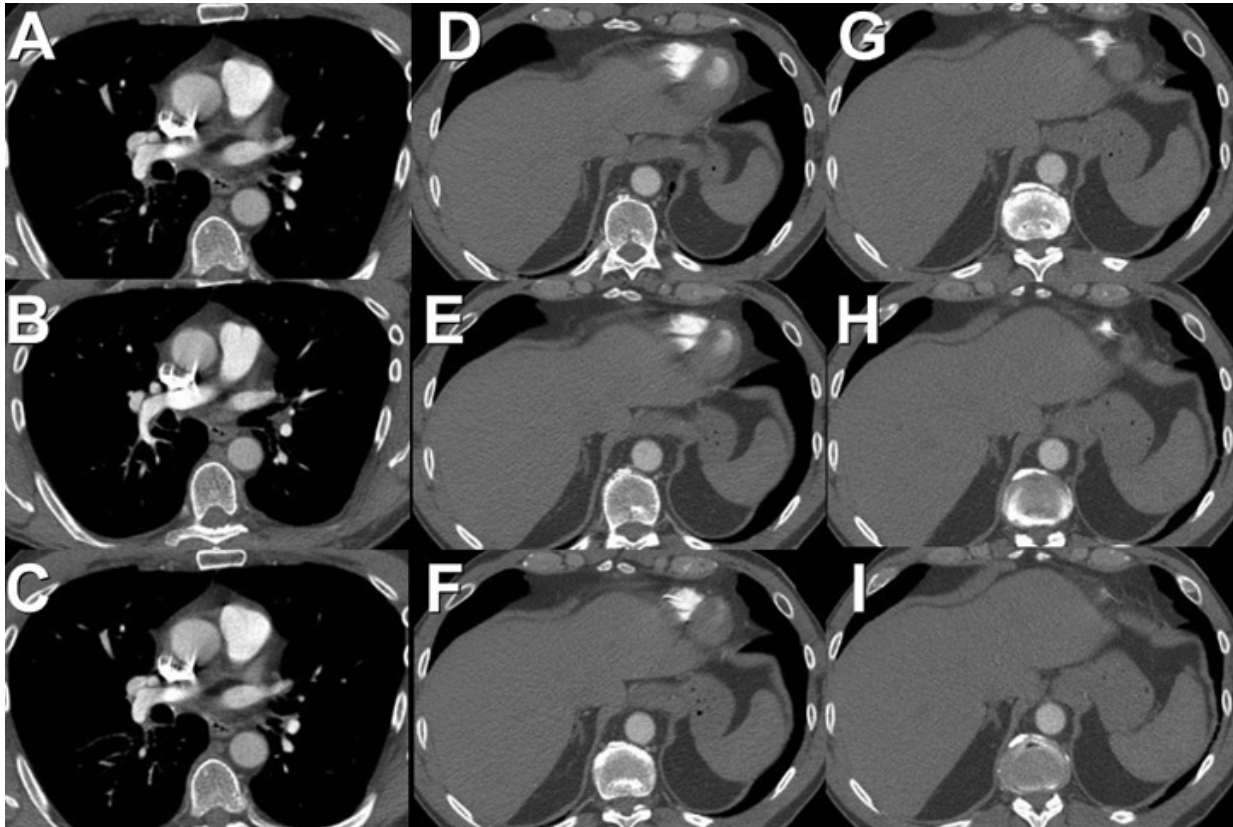


Figure 3. Contrast-enhanced axial thoracic CT.

Which of the following is **correct** regarding the description of the thoracic CT findings?

1. Thoracic CT shows no metallic fragment; the appearance at chest radiography is therefore artefactual
2. Thoracic CT shows the metallic fragment resides in the anterior mediastinum external to the heart
3. Thoracic CT shows the potential metallic fragment actually reflects a linear focus of calcification within the right ventricular chamber
4. Thoracic CT shows the potential metallic fragment is actually pericardial calcification
5. Thoracic CT shows the potential metallic fragment resides within the right ventricular cavity

Correct!

5. Thoracic CT shows the potential metallic fragment resides within the right ventricular cavity

Contrast-enhanced thoracic CT shows a linear metallic fragment within the apical cavity of the right ventricle, possibly even protruding through the very tip of the right ventricular wall, but is primarily intra-cavitary in location [not external to the right ventricular cavity]. The focus is too dense to represent calcification; it could only be metal [the densest substance detected at CT]. The focus resides within the right ventricular cavity itself; the normal pericardium can be seen anteriorly.

Which of the following prior imaging examinations would be **most useful** to review to determine the etiology of the metallic fragment?

1. A previous brain MRI
2. A previous CT of the abdomen and pelvis
3. A previous lumbar spine MRI
4. Echocardiography
5. Older chest radiographs

Correct!

2. A previous CT of the abdomen and pelvis

A CT of the abdomen and pelvis would be the most useful examination, among those listed, to review to determine the etiology of the embolized metallic fragment because a major source for such fragments is fractured inferior vena cava filter struts that subsequently undergo embolization. It is unlikely that brain MRI could suggest a source for a metallic fragment embolization to the heart. Lumbar spine MRI could show the presence of an inferior vena cava filter or other subdiaphragmatic sources of metal, but the metallic nature of filters, as is the case with practically any metallic implant at MRI, will show extensive dephasing artifact that will obscure the metallic structure itself as well as surrounding anatomy. So, the presence of the filter may be noted at lumbar spine MR, but the morphology of the filter- intact and properly positioned versus fractured and improperly positioned- would be far better characterized at CT of the abdomen and pelvis than lumbar spine MR. Furthermore, the field of view of lumbar spine MRI is often restricted- considerably more so than CT of the abdomen and pelvis- and therefore may not demonstrate a subdiaphragmatic source for embolization of a metallic fragment to the heart. Reviewing prior chest radiographs may provide some indication of the time line for the development of the metallic fragment- if enough prior images are available, it may be possible to find a chest radiograph that does not show the metallic fragment and thereby determine a time window when the fragment must have been acquired. However, review of older chest radiographs is unlikely to be capable of showing the etiology of the fragment (although occasionally inferior vena cava filters can be partially seen at chest radiography). Echocardiography could show the fragment in the right ventricle in a manner similar to CT, as well as determine the dynamic impact of the fragment during the cardiac cycle, but it is unlikely echocardiography could reveal the source of the metallic fragment.

Review of the previous CT abdomen and pelvis showed an inferior vena cava filter with an irregular appearance and probable fractured struts (Figure 4), likely the source of the metallic fragment within the right ventricle.

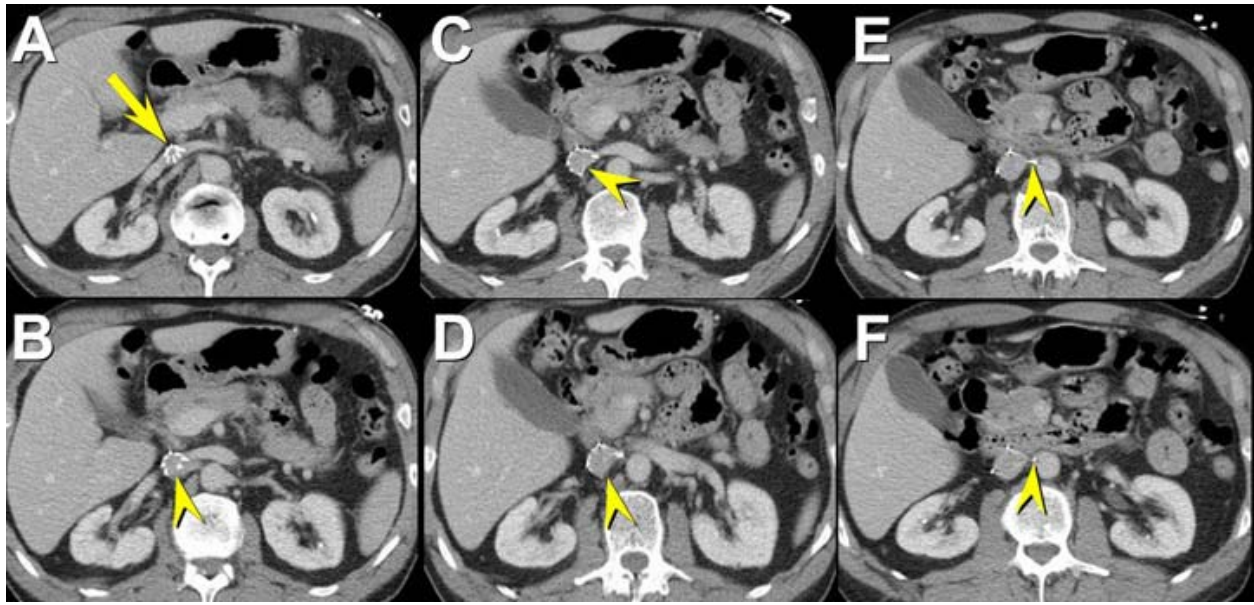


Figure 4. Contrast-enhanced CT of the abdomen and pelvis shows the presence of an inferior vena cava filter (arrow, panel A). Note the asymmetry in the struts posteriorly and medially, with absence of at least one strut between the 4 o'clock and 6 o'clock position (arrowheads, panels B – C). More inferiorly, note how one strut extends medially beyond the confines of the inferior vena cava and appears to pierce the lateral wall of the abdominal aorta (arrowheads, panels E and F).

Based on the data thus far, which of the following represents the **next most appropriate step** for the evaluation of this patient?

1. Attempt percutaneous retrieval
2. Conservative management; monitor the patient but do not intervene
3. Consult interventional radiology for endovascular retrieval
4. Perform fluoroscopic evaluation of the metallic fragment
5. Perform upper endoscopy

Correct!

3. Consult interventional radiology for endovascular retrieval

Consultation with interventional radiology for percutaneous endovascular retrieval of the metallic fragment is the correct choice. Fluoroscopic evaluation of the fragment will show dynamic movement of the fragment during the cardiac cycle and provide localization information, but probably will add little information to what is already known through review of the thoracic and abdominal CT scans. Percutaneous retrieval is not possible given the intracavitary location of the fragment within the right ventricle. Upper endoscopy would play no role in the evaluation or management of this metallic fragment- the fragment is not located anywhere near the esophagus. Conservative management is reasonable, but concerns regarding the potential for this fragment to perforate the right ventricle suggest that removal may be the best course of action.

Interventional radiology was consulted and percutaneous retrieval was attempted. However, during the course of the retrieval procedure, it was noted that the metallic fragment was substantially embedded within the trabeculae of the right ventricle and the retrieval procedure was abandoned as it was determined to be potentially too hazardous. After the attempted percutaneous retrieval procedure, thoracic CT (Figure 5) was performed.

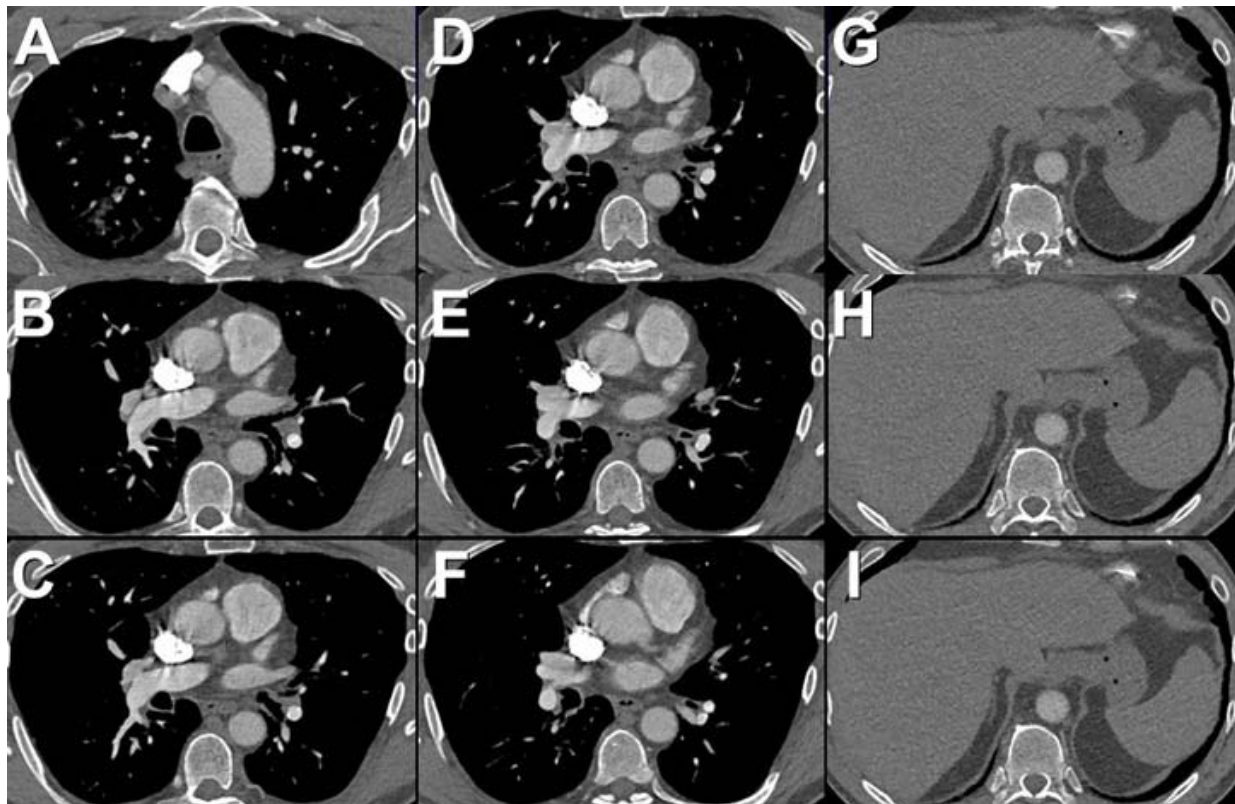


Figure 5. Representative images from the axial contrast-enhanced repeat thoracic CT.

Which of the following is **correct** regarding the description of the thoracic CT findings?

1. The thoracic CT remains unchanged from previous
2. The thoracic CT shows a new intravascular metallic fragment
3. The thoracic CT shows embolization of the metallic fragment in the right ventricle into the pulmonary artery
4. The thoracic CT shows new pericardial effusion, suggesting perforation of the right ventricle by the metallic fragment
5. The thoracic CT shows pulmonary thromboemboli

Correct!

2. The thoracic CT shows a new intravascular metallic fragment

The thoracic CT shows that the metallic fragment within the right ventricular apex is still present and is unchanged. No pulmonary venous thromboemboli are present. The pericardium remains normal; there is no evidence of pericardial effusion to indicate right ventricular wall perforation. However, the examination is not unchanged from previous—there is a new metallic focus within the left lower lobe pulmonary artery (Figure 6, compare Figure 5 to Figure 3).

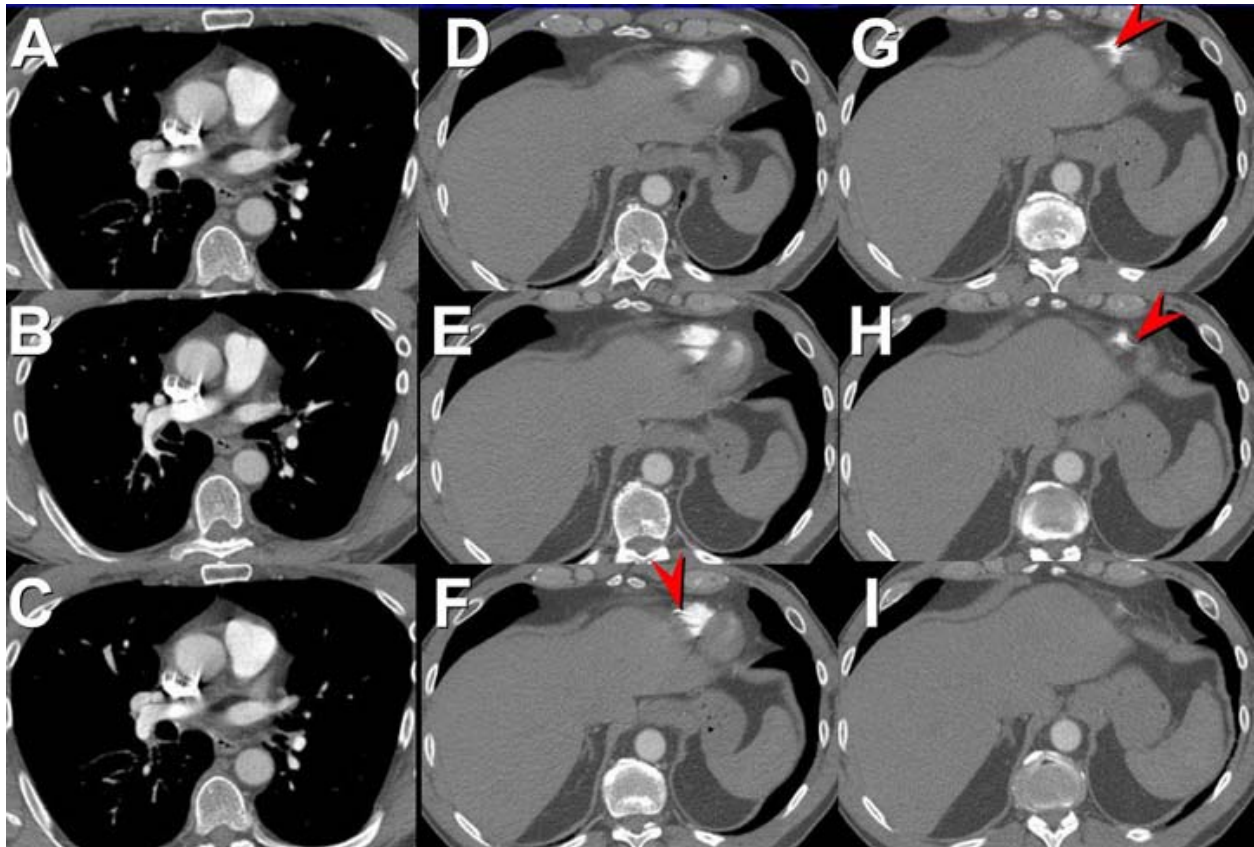


Figure 6. Following the attempted percutaneous retrieval procedure, a new metallic fragment is seen in the left lower lobe pulmonary artery. This metallic focus appears to loop on itself in the artery with two components along the opposite margins of the left lower lobe pulmonary artery, creating the impression of a flexible metallic focus conforming to an upside down “U” shape within the artery. Compare to panels A-C in Figure 2 which shows the left lower lobe pulmonary artery to be patent and free of an intravascular foreign body.

The repeat thoracic CT (Figure 6) shows a new metallic fragment located within the left lower lobe pulmonary artery, representing a fragment of wire or snare related to the attempted percutaneous retrieval of the metallic foreign body in the apex of the right ventricle. Another percutaneous retrieval procedure for the metallic foreign body in the

right ventricle is planned by interventional radiology, but no attempt to remove the right ventricular fragment will be attempted; rather, cardiovascular surgery has been consulted regarding the need for removal for the latter.

Diagnosis: Inferior vena cava filter fracture with migration of fragment into the right ventricle, complicated by pulmonary artery non-thrombotic embolization of an additional metallic fragment related to attempted percutaneous retrieval.

References

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