Foreign Body Retrieval of a Radiographically Occult Intravenous Catheter from the Pulmonary Circulation, “Old School Techniques” and the End of an Era

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Abstract
Intravascular foreign body retrieval is a procedure within the purview of the interventional radiologist. Foreign body retrieval cases are often the result of an iatrogenic event or so called misadventure. These events may occur in the hospitalized patient or in the outpatient setting and are believed to have increased with the number of complex intravascular interventions being performed.

This case is somewhat novel in that this small foreign body was radiographically occult and so could not be primarily visualized by fluoroscopy. This report describes the successful technique of retrieval used and highlights other options, which are more likely to be utilized in the future.

Keywords: Foreign body retrieval; Venous catheter; Embolization; Interventional Imaging Physics

Introduction
Intravascular foreign body retrieval is a procedure within the purview of the interventional radiologist. Foreign body retrieval cases are often the result of an iatrogenic event or so called misadventure. These events may occur in the hospitalized patient or in the outpatient setting and are believed to have increased with the number of complex intravascular interventions being performed. The presence of a “lost” foreign body within a patient can be extremely upsetting to the patient involved and can compromise the confidence the patient has in the facility and clinical team. Therefore, the ability to retrieve the item has value beyond the obvious clinical implication. The actual clinical implications of a small foreign body embolized to the pulmonary circulation and the management remain controversial. The incidence of the events, the risk of leaving the foreign body in place and the risk of various forms of retrieval are all poorly understood with mostly anecdotal reporting and a few case series available in the medical literature for study [1].

The techniques of interventional endovascular foreign body retrieval have been well described [2]. This case is somewhat novel in that this small foreign body was radiographically occult and so could not be primarily visualized by fluoroscopy. The foreign body was also not occlusive and so would not be easily seen by wide field of view angiography. These characteristics of this specific foreign body required modifications of standard foreign body retrieval techniques to allow successful retrieval.

This report describes the technique of retrieval used and highlights other technical options, which will be likely more often utilized in the future. The report also is contrasted against a very similar contemporary case reported in the thoracic surgical literature in 2016. The comparison case was treated with a surgical technique [3].

Case Presentation
A 71-year-old woman with a history of bilateral shoulder osteoarthritis underwent left shoulder replacement surgery. On post operative day three nursing assessed her right wrist 18-gauge angiocatheter at removal. The catheter had been present in the cephalic vein over the right wrist. The removed catheter shaft was only a few mm long with the body of the angiocatheter missing at the time of removal.

The missing catheter component was reported to the clinical team and an assessment was performed in the region of the insertion site. An evaluation of the soft tissue was performed with a linear high frequency ultrasound transducer. The ultrasound examination of the extremity did not reveal the missing catheter. Subsequently, a non-contrast chest CT was performed demonstrating the catheter to have embolized to the upper lobe of the right lung. The clinical team made a request to the interventional radiology team for foreign body retrieval.

A digital chest radiograph was next performed in an effort to determine if the catheter was adequately radio-dense to facilitate fluoroscopic visualization. Due to the low radio-opacity, the catheter was not discretely identifiable by the digital radiograph.

The patient was counseled that the small foreign body was in a distal intrapulmonary location and was thought unlikely to have any negative health consequences but also that the indications for retrieval of such objects remained controversial [1]. The patient desired an attempt at retrieval; a decision was made to go forward with a reasonable “non heroic attempt” at retrieval.

Fluoroscopy of the chest in the angiography laboratory was first performed. Fluoroscopy did not reveal the catheter due to its very low level of radio-opacity.

Venous access was then gained at the right common femoral vein; a six French bright tip vascular sheath was installed to the infrahepatic cava. An angled 5F pigtail catheter was then advance into the main right pulmonary artery.

The coronal reconstructed imaging for the non-contrast CT was then projected next to the fluoroscopic images on the intra-procedural display monitors. A careful morphologic examination of the CT was compared to the fluoroscopic image. The mediastinal and bronchial shadows were observed and measured against the catheter fragment location on the CT images. Then a six French JR4 guide catheter was advanced to the morphologic and fiduciary measured observed location within the desired right pulmonary artery upper lobe branch. The measurements were performed using the bronchus, trachea and mediastinal shadows as landmarks. Thankfully, the very first hand angiographic injection revealed the foreign body in relief as a filling defect. However, the catheter

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The risks and natural history of embolized small intravascular foreign bodies is unknown. There is literature suggesting that the risks associated with embolized catheters favors removal but this is based on the larger caliber and more easily visualize central venous catheters [1].

Anecdotally, one of the authors of this report had a patient who presented five years after therapy for childhood leukemia with an acute pulmonary infection. The patient had focal pneumonic infiltrate localized around a catheter fragment in the left lower lobe. This catheter was also removed and cultured positive for staphylococcus supporting the concern that embolized foreign bodies can serve as a source of infection.

Discussion of Radiographic density and techniques for visualization and localization of poorly opaque structures: With discovery of the x-ray in 1895 an era of non-invasive anatomic imaging was born [4]. Technical developments over the next 70 years improved the resolution and the ability to differentiate different levels of tissue attenuation in an incremental fashion. Still adequately defining adjacent structures in the tissue required significant differences in radiographic density such as those observed between: soft tissue, bone, metal and air.

The two major properties, which can be modulated to allow for improved tissue differentiation by x-ray or fluoroscopy, are the number of photons and the energy level of the emitted photons. The photon quantity is described as Milliamperage seconds (mAs) with (mA) x length of exposure time (S) = mAs. The kVp is the maximum voltage energy applied to the x-ray tube; the lower kVp provides better contrast as tissues can differentially attenuate more of the photon signal. The typical angiography suite functions with a max kVp in the range of 80 kV with the mid spectrum of the emitted kilo-voltage spectrum around 35 to 40 kVp. The quality of materials near the so-called K edge of an x-ray beam can also increase contrast. This is why surgical appliances are typically made radiopaque with materials that have a K edge near the typical average diagnostic spectrum energy levels, such as iodine at 33 kVp or barium at 37 kVp [5].

X-ray attenuation contrast improved with the advent of computed tomography: Computed tomography was introduced into clinical practice in 1972 with the MARK 1 scanner invented by Hounsfiedl[6]. The ability to deconstruct a three dimensional object into a two dimensional series of image “slices” was immediately recognized as a major achievement with wide clinical applications. However, it was also the ability of computed tomography to improve the differentiation of a wider range of tissue photon attenuation or “density”, which resulted in Hounsfield and Cormack winning the Nobel Prize in 1979 [7].

In many ways the angiography suites of the previous decade are little different from early fluoroscopy labs. Digital techniques such as digital subtraction angiography and “road mapping” make the interface with the data more user friendly but the data available in the lab remained that of the difference in attenuation of relatively similarly attenuating soft tissues thus limiting the available conspicuity between tissues and nonradio-opaque objects. This limitation of visualization existed until the advent of the combined fluoroscopy computed tomography labs and the introduction of cone beam CT.

Today cone beam CT is increasingly being included in new angiography-suite installations. Cone beam CT provides the ability to perform real time cross sectional imaging assessments on the angiographic table. Current common applications for these assessments include interventional oncology such as hepatic Y-90 or TACE cases. Other applications such as neurovascular and interventional pain procedures also benefit greatly from the...
ability to use cross sectional imaging to deconstruct complex three-dimensional anatomy. Still just as the Nobel Prize for CT was in part awarded based on the ability to further differentiate tissue density, the new installations of cone beam CT may find the greatest benefit to be the combination of increased tissue differentiation with the cross sectional information.

“Old School” versus new technology

With the installation of cone beam CT and integrated fusion, the advanced imaging will augment or replace the “mental integration” that experienced interventionalist have long utilized. While this case of foreign body retrieval was successful using “old school” techniques including: “blind selective catheterization” and “in relief imaging”, we can be confident that with the coming era this type of technique will not be needed. Hopefully, surgical interventions such as those described in the comparison case will also become a thing of the past.

More informative imaging will no doubt improve patient care and expedite procedural time. However, even favorable technical evolutions can be disruptive and lead to unintended experiential deficits. With each technical improvement comes a loss of “old school” experience, this loss can also have associated costs to collective capabilities of a facility.

It is likely that the next generation of experience with advancing technology will prevent the acquisition of the “old school” experience. We have seen our surgical colleagues suffer with the loss of experience in open surgery. Specifically the experience in abdominal aortic aneurysm repair and open cholecystectomy has been greatly reduced for the trainee and practitioners. At times this decreased experience has been to the detriment of complex patients needing these now more rarely performed open procedures.

The angiography lab of the future will be a completely different world. Improved technology is good but may limit some of the acquisition of skills possessed by current practitioners. Expertise comes from experience and the experiences change with technology improvements.

Conflict of Interest

Authors declared that they have no conflict of interest to disclose.

References