

Venous Non-Iatrogenic Foreign Bodies and Endovascular Retrieval-A Mini-Review

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ABSTRACT

Intravascular foreign body complications continue to increase with the advent of endovascular procedures. These represent both iatrogenic and non-medical foreign bodies, and most commonly present within the venous system. Numerous reports have demonstrated efficacy with an endovascular approach to foreign body retrieval. In this mini-review, we review the literature on venous non-iatrogenic foreign bodies, as well as endovascular strategies for removal.

Keywords: Endovascular retrieval; Foreign body; Venous foreign body; Vascular surgery

INTRODUCTION

Intravascular foreign body complications remain an uncommon but increasingly encountered occurrence. Most foreign body complications are iatrogenic and a result of the increasing number of endovascular procedures performed. However, a small but significant portion of foreign bodies are non-iatrogenic, and present unique diagnostic and therapeutic challenges. A significant proportion of these is found in the venous system, and pose major thrombotic, embolic, and infectious risks [1]. With the advent of endovascular procedures, many of these venous foreign bodies are now removed in a minimally-invasive manner, and various techniques have been described for foreign body retrieval [2]. Although reported cases in the literature focus mainly on the retrieval of medical devices, these techniques can be extrapolated to the removal of various non-iatrogenic foreign bodies as well. In this mini-review, we review non-iatrogenic venous foreign bodies, and describe techniques for retrieval.

VENOUS FOREIGN BODIES

Intravascular foreign bodies present a significant risk of embolic, thrombotic, infectious and bleeding complications. Most intravascular foreign body complications occur within the venous system [2]. These most commonly involve complications resulting from iatrogenic causes such as inferior vena cava (IVC) filters, catheters, and wires [3]. Venous foreign bodies are prone to embolization to the heart, lungs or other sites within the venous system [2,4,5]. Less common causes of venous foreign bodies are

those which are non-iatrogenic, and pose unique considerations. These foreign bodies, which are commonly small in size, may enter the venous system after a traumatic event or penetrate through the gastrointestinal tract.

The most commonly described non-iatrogenic venous foreign bodies in the literature are bullets [4,6]. While intra-arterial bullets are usually symptomatic, the majority of intravenous bullets are asymptomatic, and may present with embolization to a remote site from initial entry. Several case reports have described embolization to distant sites such as the hepatic and internal iliac veins following entry sites within the chest and neck [7,8]. Thus, a high suspicion for embolization must be observed for bullets in close proximity to venous structures. When embolization to the cardiopulmonary system does occur from the venous circulation, it most commonly presents within the right ventricle [6]. Several reports also describe retrograde bullet embolization, which may occur in 15% of patients, and may be a result of positioning and gravity [9,10].

Entry of foreign bodies into the venous system *via* the gastrointestinal tract is also well described, and may be more common among younger patients and those with developmental delay. Although the vast majority of swallowed foreign bodies pass through the gastrointestinal tract uneventfully, surgery may be required in fewer than 1% of cases due to perforation [11]. However, perforation into the venous system represents an incredibly rare occurrence with limited reports in the literature. These usually involve small, sharp objects such as toothpicks and bone fragments, although other objects such as branches have been implicated [12,13]. The

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most common site of perforation is the duodenum, thought to be because of its fixed anatomy [14]. This may result in a duodenocaval fistula, which can present with sepsis, gastrointestinal bleeding, or thrombosis [1,14-16]. However, the variability in presentation and lack of specific findings may make prompt diagnosis difficult [14]. Computed tomography (CT) scans demonstrating thrombus or gas within the IVC in conjunction with an intestinal foreign body may be suggestive of the diagnosis [1]. However, these findings may not always be present. Kim et al described the case of a patient with isolated IVC thrombosis, who was treated with suction thrombectomy, and was incidentally found to have a toothpick which was extracted with the thrombus [16]. Similarly, Rioux et al describe a case of IVC thrombosis with embolization to the right atrium. During retrieval of the right atrial thrombus, a toothpick was incidentally identified [17]. Our group has previously described the entry of a ballpoint pen into the IVC *via* the duodenum [18]. The underlying etiology of the patient's presentation with septic shock was initially unclear until a CT scan identified a ballpoint pen within the IVC. Another report described a patient with the thrombosis of the portal vein and the superior mesenteric vein due to the ingestion of a metal wire and subsequent duodenal perforation [19]. Thus, a high degree of suspicion should be held, especially in patients with mental disabilities who may be more prone to swallowing foreign objects and unable to communicate a proper history.

OVERVIEW OF ENDOVASCULAR TECHNIQUES FOR FOREIGN BODY REMOVAL

The first endovascular retrieval of a venous foreign body was described by Thomas et al in 1964, in which a steel spring was removed from the right atrium and IVC using bronchoscopy forceps *via* the saphenous vein [20]. Since then, numerous reports have described successful removal of intravascular foreign bodies using various instruments. Although open surgical techniques for foreign body extraction can be performed with low rates of morbidity depending on the location, endovascular approaches remain an attractive and less-invasive alternative in many circumstances [21,22]. Wolf et al reported on a 12 year experience with foreign body retrievals, with a minor complication rate of 6%, and no major complications or mortality [23]. The most common devices for removal include endovascular snares, balloon catheters, filters and forceps [24]. Although a listing of the specific techniques is beyond the scope of this review, a proper knowledge of each device's capabilities is key to successful retrieval. Multiple devices may be utilized to remove a foreign object, and more than one retrieval method may often be required [25]. Furthermore, properly planned access is an important aspect of case preparation that cannot be overstated. Multiple access sites may provide multiple traction points and be required to successfully retrieve a foreign body. Most series that describe successful removal of small, non-iatrogenic foreign bodies *via* endovascular approaches utilized snares and filters [6,16,26]. Several series have even reported successful removal of bullets from the heart and pulmonary arteries using various types of snares [6].

Any combination of devices may be required for foreign body retrieval depending on the clinical scenario. In our previously described report on foreign body retrieval within the IVC, we describe a novel approach using laparoscopic forceps in conjunction with a snare [18]. Use of endobronchial forceps for foreign body retrieval

is well-described in the literature for the complex retrieval of IVC filters, although off-label [27]. The typical jaw size of endobronchial forceps range from 2-3 mm, and can be typically introduced through a 12 French sheath. However, in this particular instance, the jaws of the endobronchial forceps were too small for effective grasping of the ballpoint pen. For this larger object, we utilized an atraumatic laparoscopic grasper, which can have jaws ranging from 5-10 mm. This was introduced through a 16 French sheath, and was large enough to grasp the ballpoint pen. Importantly, care must be utilized with any grasper, as inadvertent grasping of the venous wall may result in venous wall injury. Significant force in removing a device from a vessel wall may also result in vessel wall disruption and bleeding. Preparation for such events in the complex retrieval of IVC foreign bodies should be anticipated. As venous circulation is a low-pressure system, many caval defects self-resolve. However, a large compliant balloon may be used for tamponade if a significant injury occurs, and use of stent grafts have been reported in the literature as a bailout maneuver [28]. In our case report, we utilized intraoperative trans-esophageal echocardiography, and cardiac surgery and perfusion were readily available given the proximity of the foreign body to the right atrium. Furthermore, stent graft placement would not have been ideal due to the patient's ongoing sepsis as a result of the foreign body.

DISCUSSION

Endovascular approaches may also be used in a hybrid manner to reduce the morbidity of an open procedure. Salahuddin et al described the case of a bullet which migrated to the right atrium [26]. Using a femoral approach, the bullet was snared from the right atrium and brought down to the common femoral vein access site. An open cutdown over the common femoral vein was then used to retrieve the foreign body, mitigating the need for a median sternotomy and cardiopulmonary bypass.

Generalized recommendations regarding management of intravascular foreign bodies remains difficult, and must be tailored within the specific clinical context. In high-risk patients with significant comorbidities and low risk of embolization and infection, a permanent indwelling status of foreign body may be considered. However, careful follow-up will be warranted in those circumstances.

CONCLUSION

Venous foreign bodies are associated with thrombosis, embolism, and infection, and may have a wide range of presentations. The most common non-iatrogenic foreign bodies are bullets or ingested objects from the gastrointestinal system. Endovascular foreign body retrieval is effective and safe, and may be applied to various forms of retrieval of venous foreign bodies.

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