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Traumatic aortocaval fistula from gunshot wound, complicated by bullet embolization to the right ventricle

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Aortocaval fistulas are most commonly the result of spontaneous rupture or erosion of an abdominal aortic aneurysm into the inferior vena cava (80-90%). The remaining 10-20% of aortocaval fistulas are usually the result of penetrating or iatrogenic trauma from gunshot or stab wounds. We report the case of a 19-year-old male, status post multiple gunshot wounds. To our knowledge, this is the first case report of bullet embolization to the right ventricle from a traumatic aortocaval fistula. We discuss pertinent imaging findings and management of both aortocaval fistulas and bullet emboli.

Case report

A 19-year-old male presented to the county hospital after sustaining gunshot wounds to the left shoulder area and to the posterior left flank. He was transferred to a nearby university hospital for a higher level of care. The transfer note from the county hospital included findings of gunshot injury to the inferior vena cava identified on CT examination of the abdomen.

On arrival to the emergency department at the university hospital, the patient was found to be awake and alert, but complaining of abdominal pain and nausea. Vital signs were within normal limits. Physical examination revealed gunshot entrance sites in the left supraclavicular region and in the left posterior flank. The patient also had diffuse abdominal tenderness to palpation.

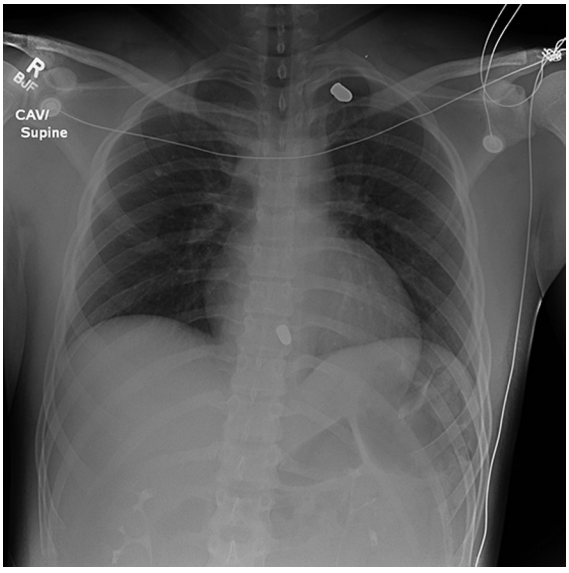

Figure 1. 19-year-old male status post gunshot wounds. Frontal radiograph of the chest demonstrates a bullet superior to the left clavicle, and a bullet in the region of the tricuspid valve.

The chest radiograph showed a bullet superior to the left clavicle, and a bullet in the heart (Fig. 1). The cardiomediastinal silhouette was within normal limits. A trans-thoracic echocardiogram demonstrated a bullet-like foreign body in

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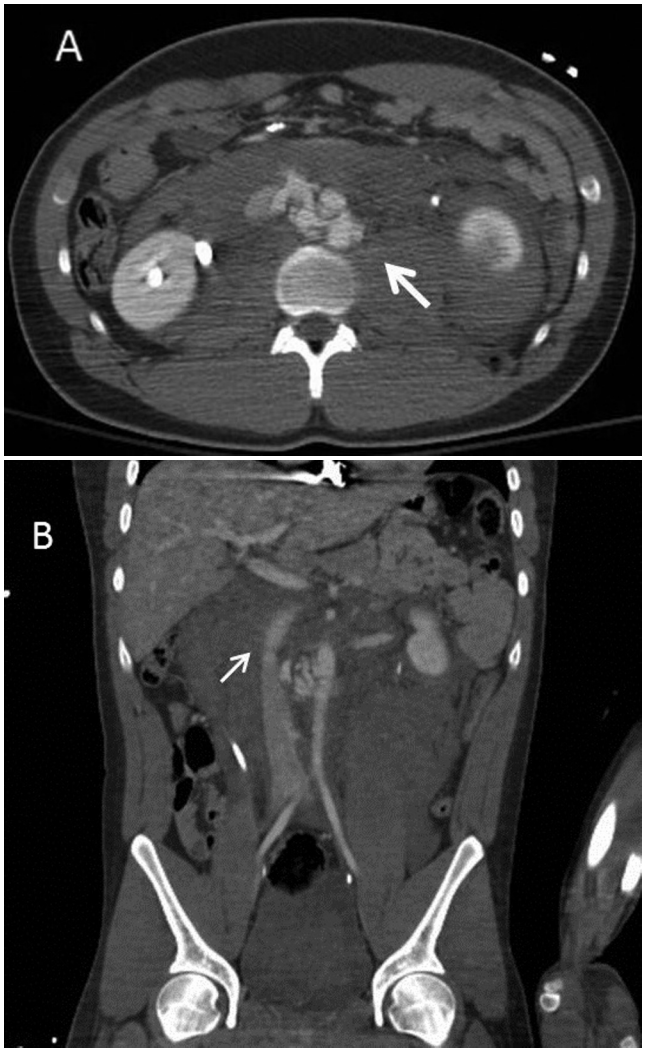

Figure 2. 19-year-old male status post gunshot wounds. A. Axial, contrast-enhanced CT image at the level of L1/L2, below the renal arteries, viewed in soft-tissue windows, demonstrates contrast extravasation between the aorta and inferior vena cava, which is isodense to blood within the aorta. B. Coronal reformatted image. Early contrast opacification of the inferior vena cava is seen immediately superior to the level of hemorrhage.

the right ventricle. CT of the abdomen showed hemorrhage around the infrarenal aorta (Fig. 2). In addition, contrast opacification was seen within the inferior vena cava lumen at the same level as the hemorrhage around the aorta. This was concerning for a traumatic aortocaval fistula.

No bullet entrance site in the patient's chest wall was found during physical examination to explain the bullet in the heart seen on chest radiograph. The CT of the chest was reviewed carefully to identify a possible site of origin of the intra-cardiac bullet, and any possible intra-thoracic injuries. No evidence of an entry wound or subcutaneous emphysema was visualized within the chest wall. There was no evidence of a bullet tract within the lung, pneumothorax, or hemothorax. It was clear that the intra-cardiac bullet did not originate from a penetrating gunshot wound to the chest.

The patient was emergently taken to the operating room, where angiogram and exploratory laparotomy were performed. Angiogram through the right femoral artery demonstrated blush around the infrarenal aorta, immediately followed by contrast opacification of the adjacent inferior vena cava (Fig. 3). These findings were consistent with the aortocaval fistula suggested on CT. Because of the presence of a bullet in the heart, angiogram of the aortic arch and great vessels was performed to identify an entrance site for the bullet. No pseudoaneurysm or extravasation of contrast was found to indicate a bullet entrance site.

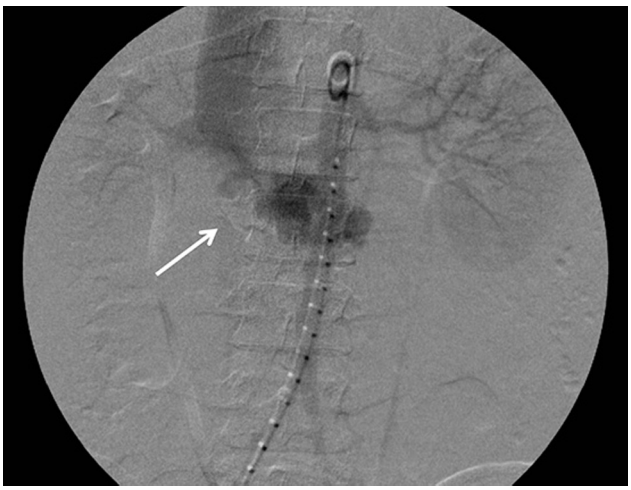

Figure 3. 19-year-old male status post gunshot wounds. Abdominal aortic angiogram demonstrates blush around the infrarenal aorta, immediately followed by contrast opacification of the adjacent inferior vena cava.

Next, exploratory laparotomy confirmed the aortocaval fistula. The aortocaval fistula was repaired with end-to-end anastomosis of the aorta and lateral venorrhaphy of the inferior vena cava. The remainder of the exploratory laparotomy did not show any solid organ or bowel injury.

On a separate day, the patient was taken back to the operating room for removal of the bullet from the right ventricle. Median sternotomy and cardiopulmonary bypass were performed. No bullet entry site into the heart was seen. The right atrium was opened. Next, the right ventricle was examined, and the bullet was found sitting immediately beneath the pulmonary valve, and was extracted.

How had the bullet localized to the right ventricle? The patient had only two bullet entrance sites on physical examination: the left supraclavicular region and the left posterior flank. The bullet that had entered the left supraclavicular region remained in the left supraclavicular soft tissues. A CT scan of the abdomen, angiography, and exploratory

laparotomy confirmed a traumatic aortocaval fistula from the gunshot through the left flank. The angiogram excluded injury to the aortic arch or great vessels to suggest an entrance site into the heart. No bullet entry site on the heart was found during open-heart surgery for retrieval of the bullet. There is only one plausible explanation for the constellation of these findings: the bullet had penetrated the patient's skin in the left flank area, entered the aorta and subsequently the inferior vena cava (forming an aortocaval fistula), and then embolized into the right ventricle.

The patient was discharged approximately two and a half weeks after his admission in stable condition.

Discussion

The most common cause for aortocaval fistulas is the spontaneous rupture or erosion of an abdominal aortic aneurysm into the inferior vena cava (80-90%) (1). The natural history of abdominal aortic aneurysms is gradual enlargement and eventual rupture. Most commonly, rupture occurs into the retroperitoneum. However, abdominal aortic aneurysms may also erode into any structure that is anatomically adjacent to the aorta, including the inferior vena cava, duodenum, ureters, and renal veins.

The remaining 10-20% of aortocaval fistulas are usually the result of penetrating or iatrogenic trauma. Traumatic aortocaval fistulas are most commonly the result of penetrating trauma from gunshot or stab wounds, and less commonly from iatrogenic injury during arterial and cardiac catheterization or lumbar-disk surgery (1).

The classic triad of an aortocaval fistula includes the following: abdominal pain, a pulsatile abdominal mass, and a machinery-like abdominal bruit. A small fistula may be asymptomatic. Large fistulas lead to large-volume left-to-right shunts, which cause increased venous return and the development of lower-limb edema, hepatomegaly, ascites, portal hypertension, and high-output heart failure. Renal failure may also occur due to diminished renal perfusion (2).

Traditionally, aortography has been considered the gold standard for diagnosis of aortocaval fistulas. However, contrast-enhanced CT is a noninvasive alternative to aortography for the accurate diagnosis of aortocaval fistulas. Several findings can be seen on contrast-enhanced CT.

- Early passage of contrast into the inferior vena cava from the aorta may be visualized.
- There may be disappearance of the normal anatomic space, or fatty planes, between the aorta and the vena cava.
- Occasionally, direct visualization of the abnormal communication between the inferior vena cava and the aorta can be seen (3).

CT imaging studies are not only helpful in identifying aortoacaval fistulas; they are also important in planning surgical treatment. If the patient's clinical status is rapidly deteriorating, it may be necessary to start operative repair as soon as possible with only the contrast CT results, and without aortography. Early diagnosis and surgical intervention of aortocaval fistulas significantly improve patient outcome.

Open repair has been the mainstay method for repair of aortocaval fistulas, but it has been reported to have a mortality rate as high as 30% (4). Endovascular repair provides a promising and exciting alternative to the traditional method of open repair. The first reported successful endovascular repair of aortocaval fistula was performed by Beveridge et al in 1998 (5). Since then, endovascular management of aortocaval fistulas has become more common. Endovascular repair causes less physical stress on the patient compared to open repair, and is considered when patients are unlikely to survive open repair (6). After endovascular repair, patients are also more likely to recover earlier and have a shorter hospital stay. Indications for endovascular repair instead of open repair are not currently fully defined. Endovascular repair probably reduces morbidity and mortality; however, because endovascular repair of aortocaval fistulas is a relatively new occurrence, accurate mortality rates are unknown and long-term followup is currently lacking.

Though bullet embolism is an uncommon complication of trauma, it should be suspected if a gunshot entry site is present without an exit site, and if the bullet is not found near the expected trajectory of the gunshot in the patient's body on imaging studies. According to a literature review conducted by Springer et al, there were 296 published cases of bullet emboli through December 2007 (7). Bullet embolization occurs when a bullet enters the vasculature and then moves to a distant site in the circulatory system. When a missile enters the human body, it usually passes through. At other times, however, the missile may lose its kinetic energy after penetrating the vasculature, remain within the lumen of a vessel, and subsequently migrate to a distant site such as the heart, lung, or peripheral vessels (8). In the patient discussed in this case report, the bullet (instead of traveling through the body) embolized to the right ventricle.

If there is suspicion of bullet embolism, a complete radiologic search should be undertaken with emphasis on the peripheral vascular system, heart, and pulmonary system, as embolization to these areas has been previously described. Multiple radiographs are usually initially evaluated to locate the bullet embolus, followed by CT examination to identify bullet tracts, and to determine the extent of organ injury. For an intracardiac bullet embolus, CT is often inadequate for precise localization within the cardiac cavity due to artifact generated by the projectile. Improved localization of the embolus can be obtained by transthoracic or transesophageal echocardiography or fluoroscopy (8).

Bullet embolization can be arterial or venous. Arterial emboli are much more common and account for approximately 80% of all reported cases of bullet embolization (9). Arterial embolization is more likely to be symptomatic than venous embolization, and usually produces symptoms early from peripheral embolization and subsequent limb ischemia. The majority of venous emboli eventually migrate to

the right ventricle or pulmonary arterial tree. Rarely, paradoxical bullet emboli occur. Paradoxical emboli enter the arterial circulation from the venous system, right atrium, or right ventricle, through an intracardiac defect such as a patent foramen ovale or a ventricular septal defect (10).

Because of the relative scarcity of bullet embolization, no management guidelines are universally accepted. Several studies suggest that all intracardiac emboli should be removed. However, most studies suggest that bullet emboli within the right heart should be removed only if certain criteria or other complications do *not* occur; these include bullet fragments that cause valvular dysfunction, abscess formation, pulmonary infarction, erosion into surrounding structures, or arrhythmias. In such cases, right-heart bullet emboli can be carefully followed without therapy (11).

Removal of intracardiac emboli has historically been performed with open surgical procedures. However, advancements in endovascular techniques have permitted more widespread adoption of this technique (12).

To our knowledge, this is the first case report of bullet embolization to the right ventricle from a traumatic aortocaval fistula.

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