Bilateral shotgun pellet pulmonary emboli

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ABSTRACT

Intravascular migration of bullets and other foreign bodies is a rare but known complication of penetrating trauma. Missile embolization can represent a diagnostic challenge because it may present in various and unexpected ways. We present the case of a 54-year-old female who sustained shotgun pellet emboli to the pulmonary arteries following a left upper extremity gunshot wound and related vascular surgery. The case illustrates bilateral embolization, and the embolic events occurred following surgery. Embolization should be considered in evaluating patients with gunshot wounds, particularly if there are anomalous symptoms or the projectile is not found in the original, or expected, location. Close attention to the location of the foreign bodies on serial radiographs may reveal the diagnosis of intravascular embolization.

CASE REPORT

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The patient is a 54 year-old female with no past medical history who presented to the emergency room after sustaining a shotgun wound to the left axilla and arm. Upon arrival, the heart rate was 77 beats per minute, the blood pressure was 128/81 mmHg, and the respiratory rate was 18 respirations per minute. The patient was found to have no palpable left radial pulse and no audible Doppler signal in the radial artery using a handheld device.

An anteroposterior chest radiograph was performed and demonstrated numerous shotgun pellets projecting over the left axilla and arm and a solitary pellet projecting over the left heart border, but none projecting over the lungs (Figure 1). A left upper extremity arteriogram was performed and demonstrated transection of the left brachial artery with minimal reconstitution distally (Figures 2 and 3). Left subclavian artery to left brachial artery bypass was performed using a left greater saphenous vein conduit. Occlusion of the axillary vein was noted intraoperatively. On postoperative day 1, diminished left radial artery pulse and audible Doppler signal using a handheld device were noted. The patient was taken back to the operating room where she underwent subclavian artery thrombectomy and vein angioplasty of the outflow anastomosis, which resulted in restoration of good flow in the radial artery.

On postoperative day 2, a repeat anteroposterior chest radiograph demonstrated a cluster of approximately 6 shotgun pellets projecting over the left perihilar region centrally, suggestive of embolization of pellets to the left pulmonary artery (Figure 4). The pellet projecting over the left heart border was no longer visualized.

On postoperative day 6 the patient was taken to the operating room for repair of the left axillary soft tissue defects from the shotgun wound using a left latissimus dorsi myocutaneous pedicle flap. On postoperative day 10, the patient was found to have a cool left hand, no radial pulse, and no radial artery audible Doppler signal using a handheld device. Left axillary artery to radial artery bypass was performed using a polytetrafluoroethylene graft, and radial and ulnar artery thrombectomies were performed. This resulted in restoration of a good radial artery pulse and hand perfusion.

A repeat anteroposterior chest radiograph 2 weeks after admission demonstrated the left sided pellets now projecting more peripherally over the left lung in two discrete groupings. A new pellet now projected over the right mid lung (Figure 5).

Due to clinical concern for pulmonary embolus, computed tomography (CT) examination of the chest with intravenous contrast was subsequently performed and confirmed the presence of bilateral shotgun pellet pulmonary emboli, one within the right middle lobe and approximately 6 within the left upper lobe (Figures 6 and 7). Due to the small size of the pellets and their peripheral location within the pulmonary artery branches, observation was elected instead of removal.

The patient recovered and was discharged home 5 weeks after admission. Due to the extent and severity of her injury, she had residual functional deficit in the left upper extremity. At followup she had recovered partial grasping and some sensation in the left hand. No pulmonary complaints were reported.

DISCUSSION

Intravascular migration of bullets, bullet fragments, pellets, and other foreign bodies is a rare but known complication of penetrating trauma. Missile embolization can represent a diagnostic challenge as it may present in a variety of ways, with manifestations that are unexpected based on the entrance site and presumed trajectory of the bullet.

There are several historical reports of bullet embolization in the literature [1,2,3]. In 1920 Fry, a British pathologist, reported the case of a soldier shot below the left anterior superior iliac spine by a German bullet, which entered the left internal iliac vein and embolized to a left lower lobe pulmonary artery branch where it caused infarction [1].

More recent examples of bullet embolization to the pulmonary artery have also been reported. Agarwal et al. report the case of a bullet that entered from the right internal jugular vein and migrated to the left pulmonary artery [4]. Nehme reports the case of a bullet migrating from the superior sagittal sinus to the left pulmonary artery [5]. Goldman and Carmody report two cases of pulmonary embolism secondary to gunshot wounds to the head, in which the foreign body emboli originated from the cranial venous sinuses [6]. Chen et al. report the case of a gunshot wound to the left flank resulting in bullet fragment embolization to the heart and left pulmonary artery via the inferior vena cava [7].

Most previous reported cases of missile embolization to the pulmonary artery describe a single embolus. Goldman and Carmody report a case in which multiple bullet fragments embolized to a single lobe of one lung, the left upper lobe (lingula) [6]. The present case illustrates bilateral pulmonary embolization, and the embolic events occurred after surgery. Whether the surgical procedure resulted in the embolization, or the embolization would have occurred regardless of operative intervention, cannot be determined.

Foreign body emboli may be classified as arterial, venous, or paradoxical. Arterial emboli often result in ischemia, are symptomatic, and are discovered early. In constrast to arterial emboli, venous emboli are often asymptomatic and may not be recognized until later, if and when they result in vascular injury or obstruction [8]. Missiles may embolize antegrade within the vascular system, such as from peripheral veins to the heart and pulmonary arteries or from the aorta to peripheral arteries. Alternatively they may embolize retrograde against the flow of blood due to gravity, such as from the right heart down the inferior vena cava. Paradoxical embolization is rare, and occurs when the missile embolizes from the venous system to the arterial system through a right-to-left-shunt such as a cardiac septal defect [9].

Overall, missile embolization in the setting of vascular injury is quite rare. Rich et al report missile embolization occurred in 22 of approximately 7,500 (0.3%) of patients in the Vietnam Vascular Registry who sustained vascular trauma in United States military activity in Southeast Asia. Among this group, whole bullet embolization occurred in 14% and fragment embolization occurred in 86%. Arterial embolization was more common, occurring in 82% compared to venous embolization in 18%. 18% of emboli were located in the heart, 18% were located in the pulmonary artery, and 64% were located in systemic arteries [10].

Mattox et al report 28 cases of intravascular bullet emboli. Of these, 36% were from the thoracic or abdominal aorta to a peripheral artery, 25% were from peripheral veins to the pulmonary artery, 18% were from peripheral veins to the heart, 11% were from the heart to a peripheral artery, and 7% were from the heart to the hepatic or renal vein via the inferior vena cava. One case (4%) was paradoxical from the inferior vena cava to the right atrium, then to the left atrium and thereafter into the abdominal aorta. The gender ratio in the series was 3:1 male to female [9].

Missile embolization can present a diagnostic challenge. The clinical presentation is often confusing, with signs and symptoms that do not correspond to those expected based on the missile's apparent course [9]. If the number of entry wounds does not match the number of exit wounds and the missile is not found in the expected location radiographically or surgically, embolization should be considered. If a missile is discovered in an unexpected location based on an observed entry site and expected trajectory, this too should raise suspicion, assuming there has not been a prior history of ballistic injury to account for the finding. Close attention should be given to the location of the foreign bodies on serial radiographs, as this may enable the detection of intravascular embolization. CT can be useful to confirm that the foreign bodies are in fact within the vascular system and determine their exact location.

Risk factors for missile embolization include a history of gunshot wound, other penetrating missile trauma, and vascular injury associated with the trauma. The presence of a right-to-left shunt, such as a cardiac septal defect, is a risk factor for paradoxical embolization.

The differential diagnosis for a bullet pulmonary embolus includes several other entities including pulmonary thromboembolus, a bullet within the lung parenchyma, a bullet within the bronchial tree, and a bullet within the chest wall.

On an anteroposterior radiograph, a bullet within the chest wall may be indistinguishable from a bullet pulmonary embolus, a bullet within the lung parenchyma, or a bullet within the bronchial tree because all may project over the lung. Posteroanterior and lateral chest radiographs will generally be sufficient to identify bullets within the chest wall. In a patient with signs or symptoms of pulmonary embolus, a history of ballistic injury, and risk factors for pulmonary thromboembolus, both bullet pulmonary embolus and pulmonary thromboembolus might be considerations. Since the vast majority of bullets are metallic, the absence of a metallic bullet projecting over the lung on chest x-ray will in general exclude bullet pulmonary embolus. CT will in most cases be able to differentiate between a bullet pulmonary embolus, a bullet within the lung parenchyma, and a bullet within the bronchial tree by depicting the projectile's exact relationship to the relevant anatomic structures.

The management of intravascular missile emboli depends on the clinical situation. If the missile embolus is symptomatic, removal via an endovascular approach may be attempted. In situations where the symptomatic embolus is large or not easily accessible via an endovascular approach, operative removal may be necessary. In general, pulmonary artery missile emboli that are not easily accessible through an endovascular approach can be observed if the patient is asymptomatic [8]. In the present case, the embolized pellets were small and peripherally located within the pulmonary artery branches, therefore observation was elected instead of removal.

TEACHING POINT

A high index of suspicion and close attention to the location of bullets and other missile projectiles on serial radiographic examinations can enable the radiologist to detect intravascular embolization of the objects. CT can be useful to confirm that the missiles in question are in fact within the vascular system, and to exclude other entities in the differential diagnosis including bullets in the lung parenchyma, bullets in the bronchial tree, bullets within the chest wall, and pulmonary thromboembolus.

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FIGURES

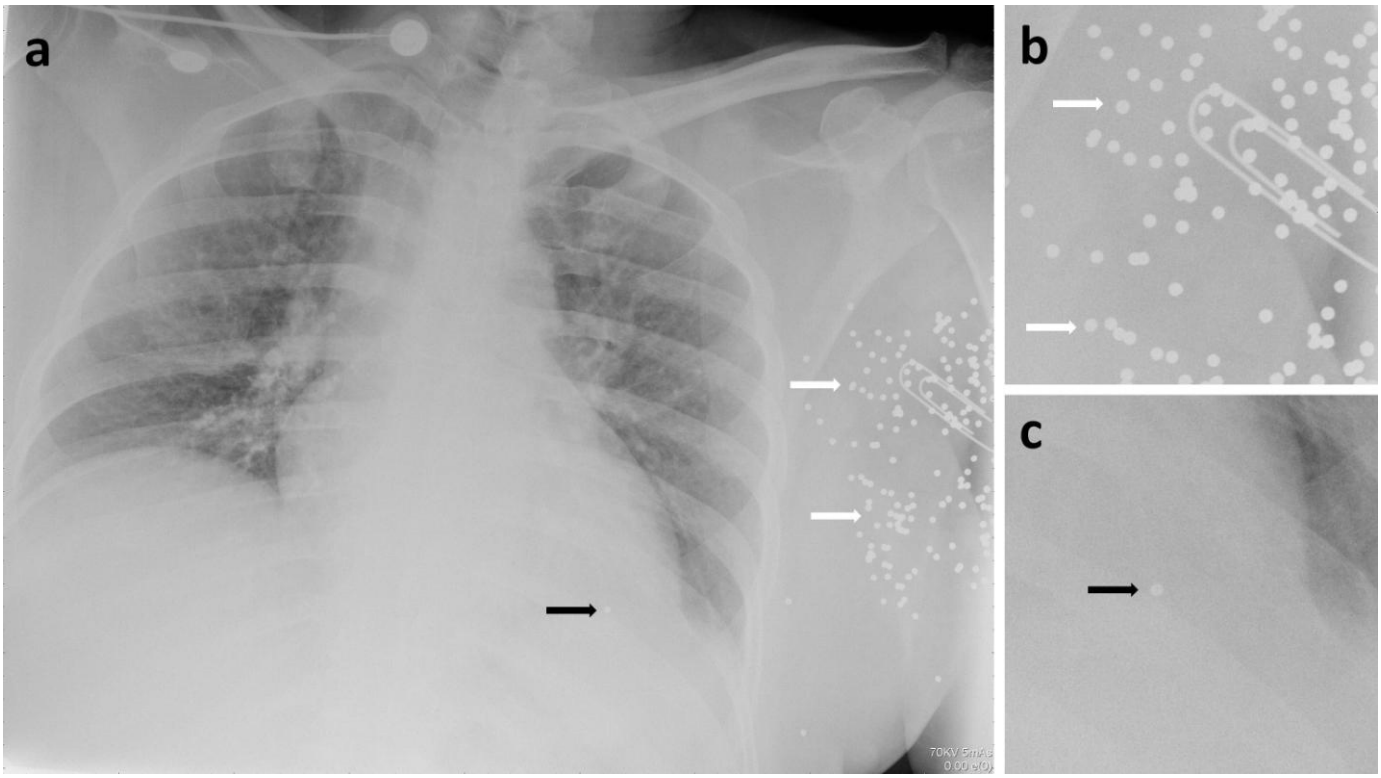

Figure 1: 54-year-old female with bilateral shotgun pellet pulmonary emboli following a left upper extremity shotgun wound. Initial anteroposterior chest radiograph (a) and detail views of the left axillary region (b) and left heart (c) demonstrating numerous shotgun pellets projecting over the left axilla and arm (white arrows in a and b) and one projecting over the left heart (black arrows in a and c), but none projecting over the lungs. A paperclip marks the entry site wound. (Protocol: Anteroposterior portable chest radiograph, 70 kV, 5 mAs).

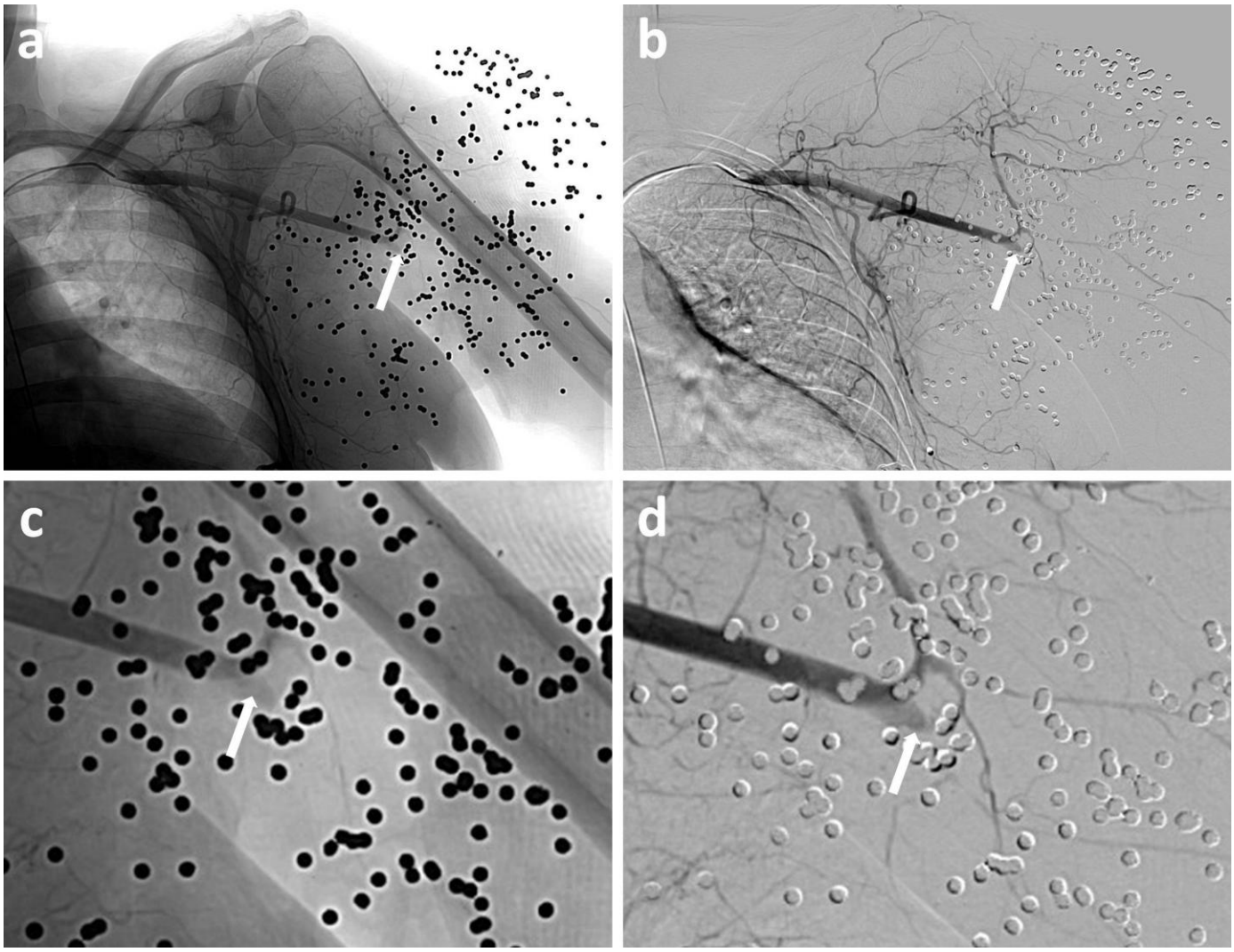

Figure 2: 54-year-old female with bilateral shotgun pellet pulmonary emboli following a left upper extremity shotgun wound. Frontal unsubtracted (a) and digitally subtracted (b) images from a left upper extremity arteriogram via a right common femoral artery approach, and corresponding unsubtracted (c) and digitally subtracted (d) detail views demonstrating abrupt discontinuity of the left brachial artery consistent with transection (white arrows). Numerous shotgun pellets project over the soft tissues of the left axilla and arm. (Siemens Axiom Artis imaging system using automatic exposure control; Visipaque-320 contrast).

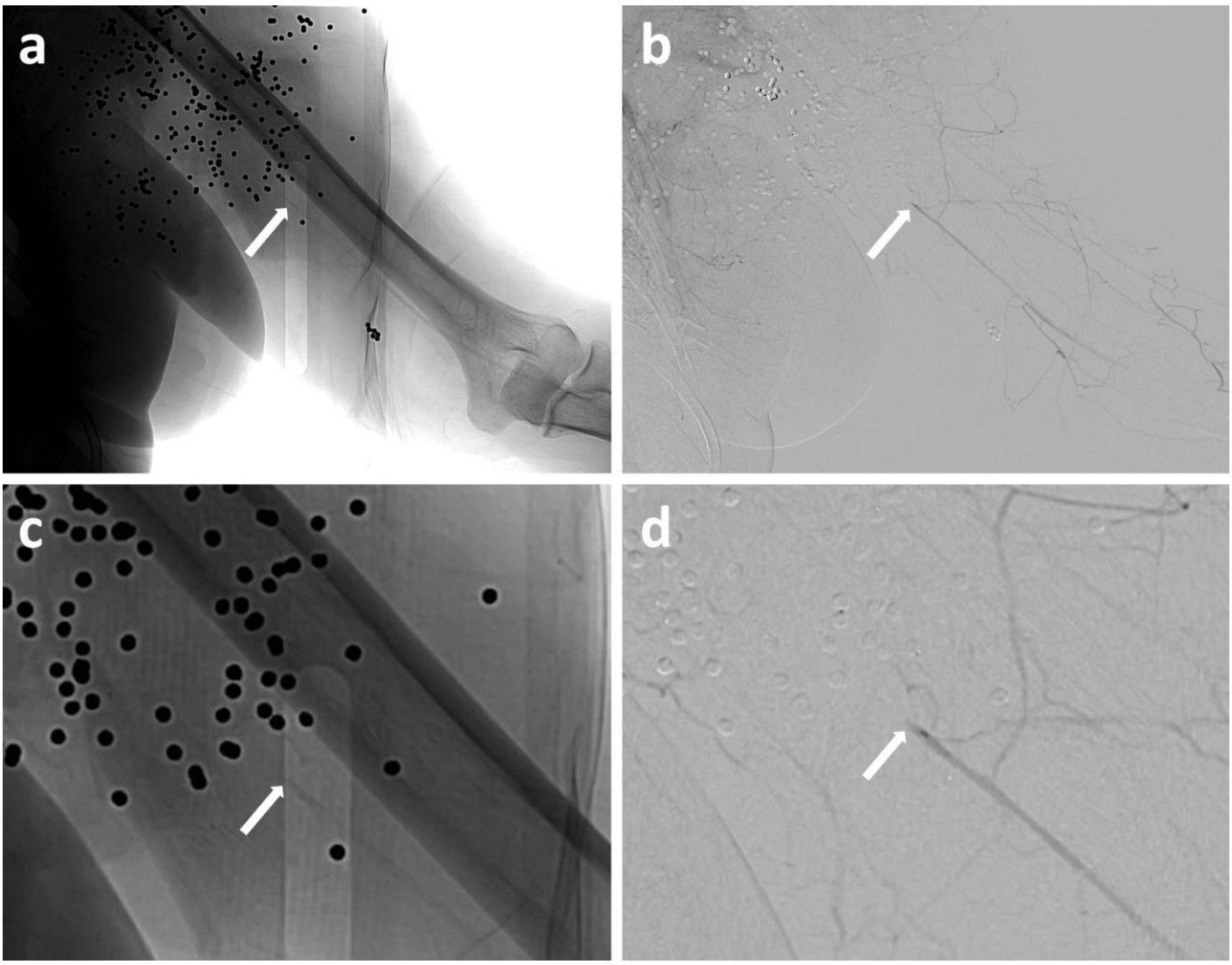

Figure 3: 54-year-old female with bilateral shotgun pellet pulmonary emboli following a left upper extremity shotgun wound. Frontal unsubtracted (a) and digitally subtracted (b) images from a left upper extremity arteriogram via a right common femoral artery approach, and corresponding unsubtracted (c) and digitally subtracted (d) detail views demonstrating demonstrating weak reconstitution of the left brachial artery distally (white arrows). Numerous shotgun pellets project over the soft tissues of the left axilla and arm. (Siemens Axiom Artis imaging system using automatic exposure control; Visipaque-320 contrast).

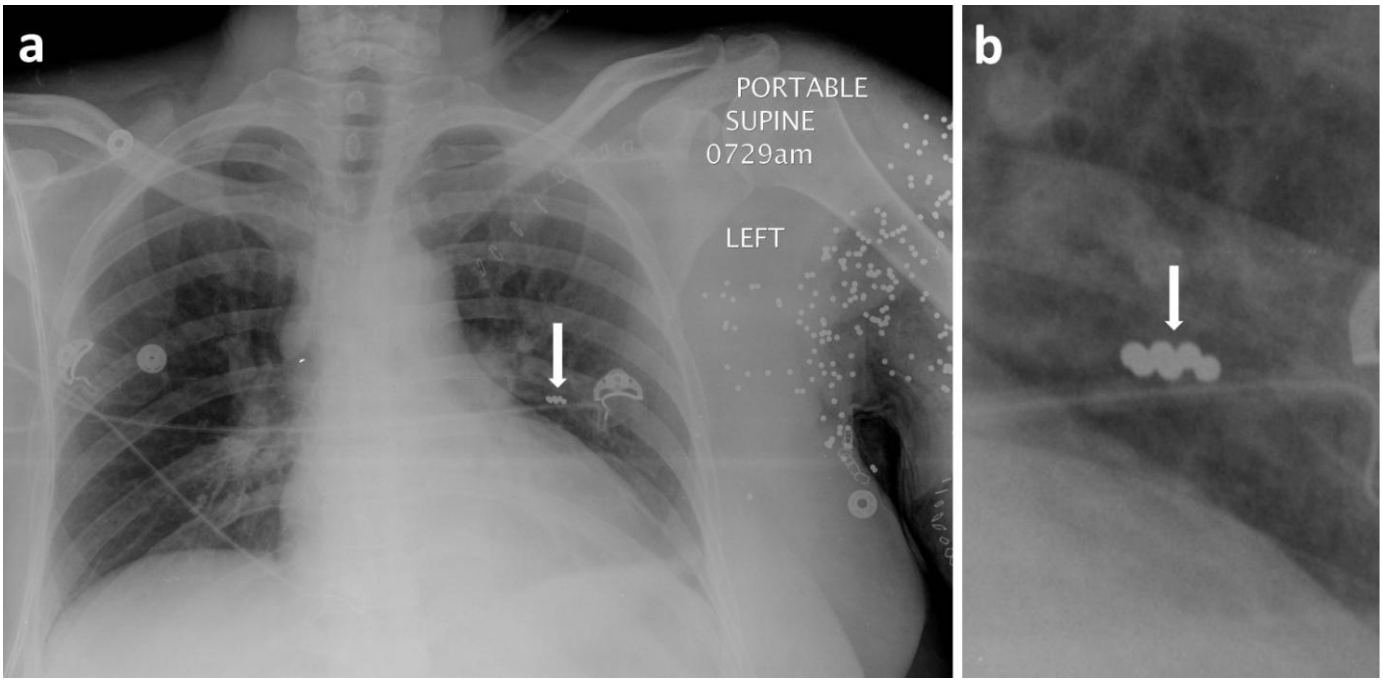

Figure 4: 54-year-old female with bilateral shotgun pellet pulmonary emboli following a left upper extremity shotgun wound. Anteroposterior chest radiograph (a) and detail view of the left lung (b) on postoperative day 2 following left subclavian artery to left brachial artery bypass using a left greater saphenous vein conduit. A cluster of 6 pellets projects over the perihilar region of the left lung (white arrows), suggestive of shotgun pellet embolization to the lung. (Protocol: Anteroposterior portable chest radiograph, 70 kV, 5 mAs).

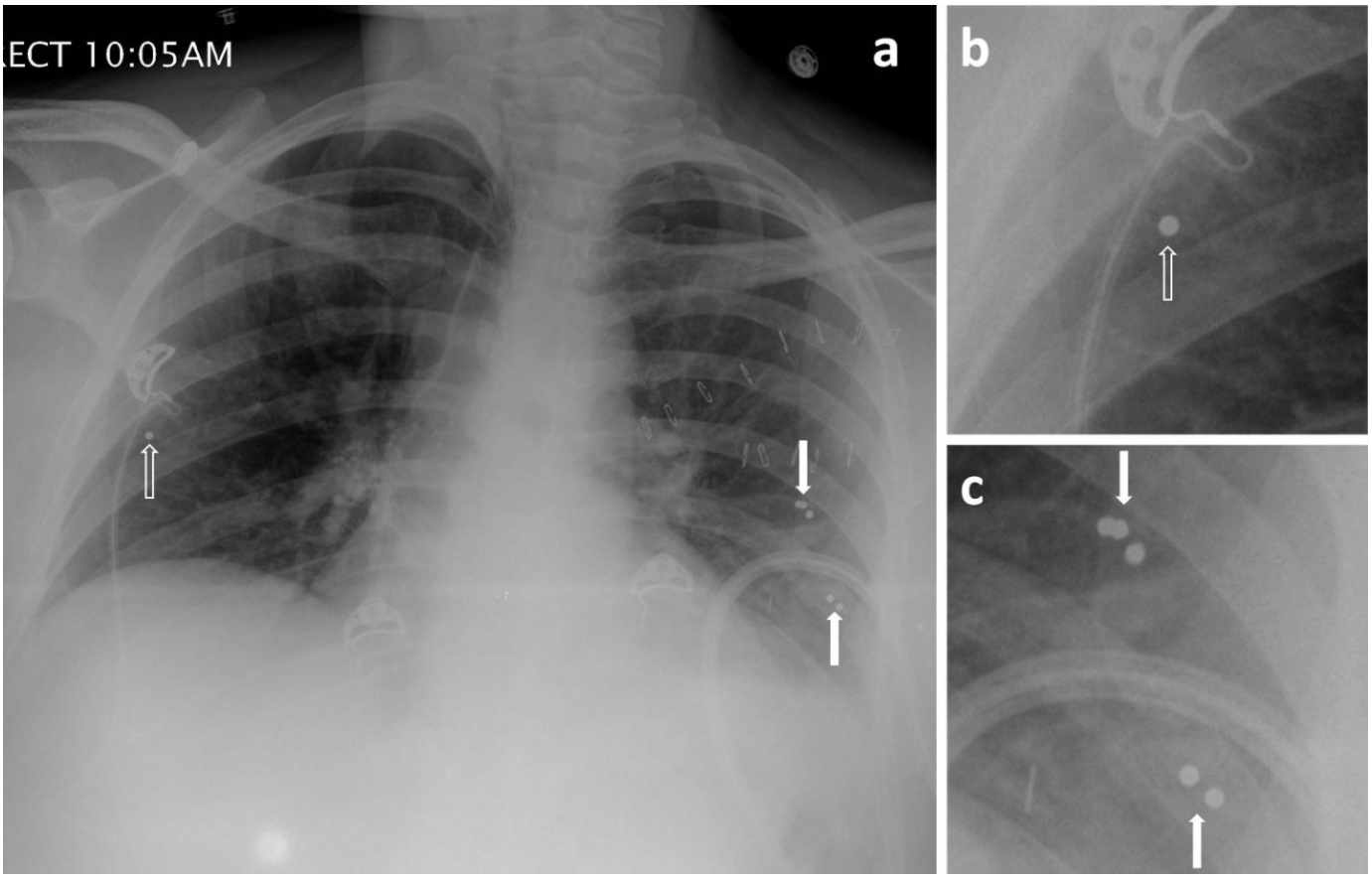

Figure 5: 54-year-old female with bilateral shotgun pellet pulmonary emboli following a left upper extremity shotgun wound. Anteroposterior chest radiograph (a) and detail views of the right lung (b) and left lung (c) two weeks following the initial trauma. Compared to the prior radiograph (Fig 4), the left sided shotgun pellets now project more peripherally over the left lung in two distinct groupings (white arrows in a and c), suggesting migration of the shotgun pellet pulmonary emboli. A pellet now projects over the periphery of the right mid lung (open white arrows in a and b), suggesting embolization of a pellet to the right lung as well. (Protocol: Anteroposterior portable chest radiograph, 70 kV, 5 mAs).

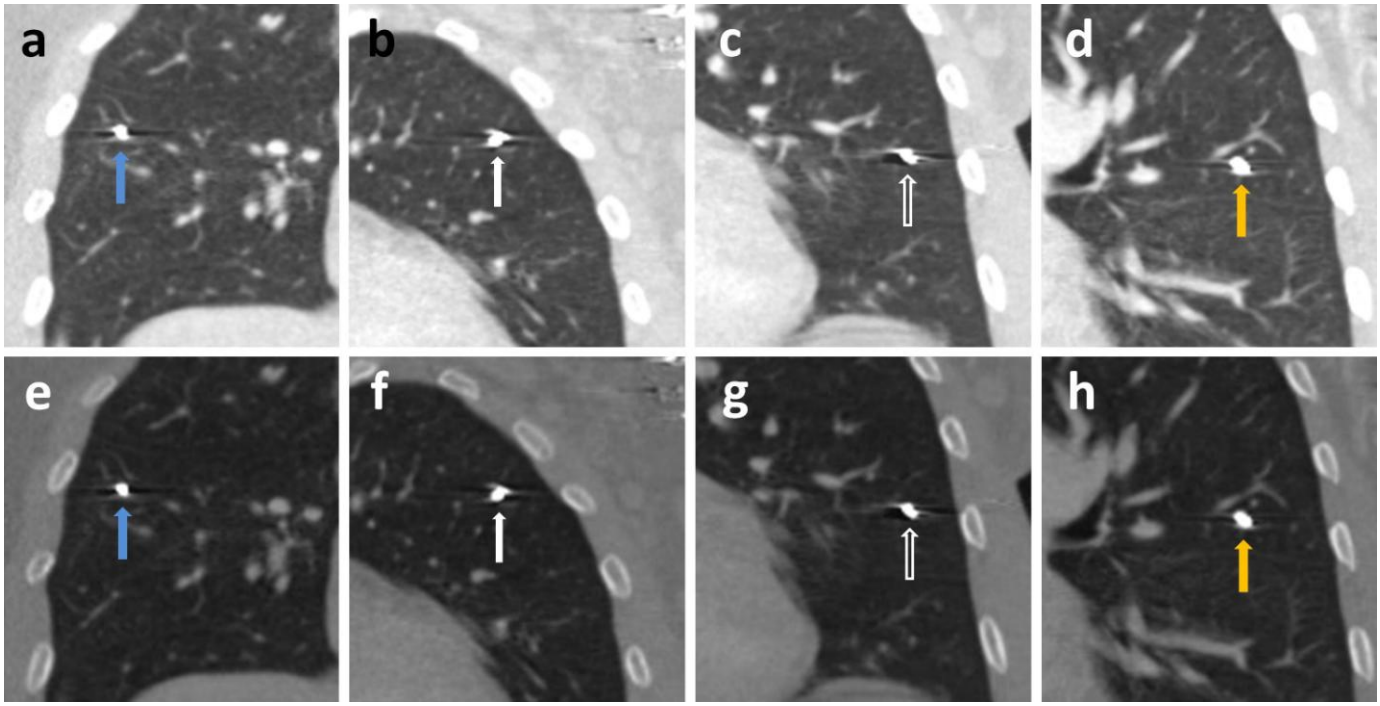

Figure 6: 54-year-old female with bilateral shotgun pellet pulmonary emboli following a left upper extremity shotgun wound. Coronal images at lung window settings (a, b, c, and d) and corresponding images at bone window settings (e, f, g, and h) from computed tomography examination of the lungs with intravenous contrast demonstrating shotgun pellets within the right middle lobe (blue arrows in a and e) and at 3 separate locations in the left upper lobe (white arrows in b and f, open white arrows in c and g, orange arrows in d and h). The bone windows demonstrate the metallic density of the pellets to advantage. (Protocol: CT of the lungs with 100 mL Isovue-370 intravenous contrast injected at a rate of 3 mL per second, scanned in pulmonary arterial phase, 120 kV, 176 mAs, coronal images at 1mm slice thickness; lung window width 1500 and level -500, bone window width 2000 and level 300; Siemens Somatom Senstation 16 CT scanner.)

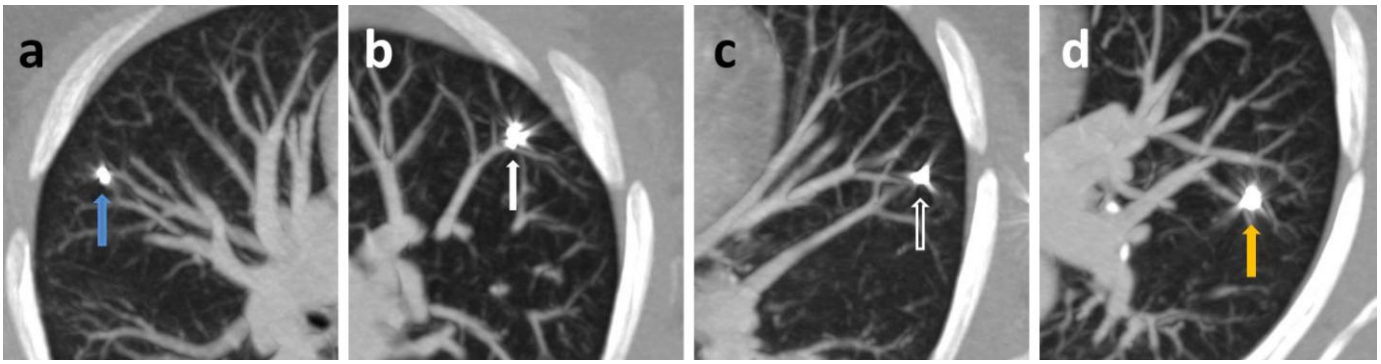

Figure 7: 54-year-old female with bilateral shotgun pellet pulmonary emboli following a left upper extremity shotgun wound. Axial maximum intensity projection images from computed tomography examination of the lungs with intravenous contrast depicting the relationship of the shotgun pellets to the pulmonary vessels within the right middle lobe (blue arrow in a) and at 3 separate locations in the left upper lobe (white arrow in b, open white arrow in c, orange arrow in d). (Protocol: CT of the lungs with 100 mL Isovue-370 intravenous contrast injected at a rate of 3 mL per second, scanned in pulmonary arterial phase, 120 kV, 176 mAs, axial maximum intensity projection images using 12 mm slab thickness; window width 1800 and level -80; Siemens Somatom Senstation 16 CT scanner.)

Etiology	Gunshot wound or other penetrating trauma from a missile resulting in vascular injury
Incidence	Missile embolization occurs in 0.3% of vascular trauma due to explosive devices and gunshot wounds [10]
Gender ratio	3:1 male to female [9]
Age predilection	Reported age range 17 to 52 years [9]
Risk factors	• Gunshot wound or other penetrating missile trauma. • Vascular injury associated with the trauma. • Right to left shunts (for paradoxical embolization).
Treatment	• Depends on location of embolus and presence or absence of symptoms. • In symptomatic patients, endovascular removal is preferred. • Open surgical removal may be necessary if endovascular retrieval is not possible. • Asymptomatic patients may be observed if the embolus is not easily accessible via an endovascular approach.
Prognosis	Depends on size and location of embolus
Finding on imaging	• Change in location of missile on serial radiographic examinations. • Missile not found in expected location based on entry site and apparent trajectory (although this can be difficult to determine in the setting of multiple projectiles). • Missile found in unexpected location based on entry site and apparent trajectory (although this can be difficult to determine in the setting of multiple projectiles).

Table 1: Summary table for intravascular missile embolization

Entity	X-Ray	CT pulmonary angiography	Pulmonary angiography	Ventilation-perfusion scan
Bullet/missile pulmonary embolus	• Bullet/missile projects over lung on both PA and lateral views • May change position on serial x-rays	• Hyperdense (metallic) filling defect within pulmonary artery branch • May change position on serial examinations	• Hyperdense (metallic) filling defect within pulmonary artery branch • May change position on serial examinations	• Segmental ventilation-perfusion mismatch
Pulmonary thromboembolus	• Normal or abnormal chest x-ray (e.g. pleural effusion, atelectasis, regional oligemia)	• Filling defect within pulmonary artery branch	• Filling defect within pulmonary artery branch	• Segmental ventilation-perfusion mismatch
Bullet/missile within lung	• Bullet/missile projects over lung on both PA and lateral views • No change in position on serial x-rays	• Bullet/projectile within lung • No pulmonary artery filling defect	• No pulmonary artery filling defect	• No segmental ventilation-perfusion mismatch
Bullet/missile within chest wall	• Bullet/missile projects over chest wall on both PA and lateral views • No change in position on serial x-rays	• Bullet/missile within chest wall • No pulmonary artery filling defect • No change in position on serial examinations	• No pulmonary artery filling defect	• No segmental ventilation-perfusion mismatch
Bullet/missile within bronchial tree	• Bullet/missile projects over lung on both PA and lateral views • May change position on serial x-rays • May result in atelectasis due to bronchial obstruction	• Bullet/missile within the bronchial tree • May change position on serial examinations	• No pulmonary artery filling defect	• No segmental ventilation-perfusion mismatch • May demonstrate matched ventilation-perfusion defect

Table 2: Differential table for missile pulmonary embolus

ABBREVIATIONS

CT = Computed Tomography

KEYWORDS

Shotgun pellet; pulmonary emboli; intravascular; migration; surgery