

Nail embolization to the femoral artery

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ABSTRACT

Modern air-nailing tools are known to cause penetrating trauma. We report the unusual case of a pneumatically fired carpenter's nail that penetrated the chest of a 30-year-old man and subsequently embolized from the heart to the left femoral artery without clinical evidence of having entered the heart. The nail was surgically removed, and the patient was discharged from hospital without sequelae after 10 days. This case and the relevant literature are discussed from the perspective of the emergency department investigation and care of such patients.

Key words: embolism; ballistics; trauma

RÉSUMÉ

Les clouuses pneumatiques modernes peuvent causer des traumatismes pénétrants. Nous présentons un cas inhabituel de pénétration d'un clou de charpentier à déclenchement pneumatique dans le thorax d'un homme de 30 ans. Le clou s'est par la suite embolisé à partir du cœur vers l'artère fémorale gauche sans signe clinique de pénétration du cœur. Le clou fut retiré chirurgicalement et le patient reçut son congé de l'hôpital après dix jours, sans séquelle. Le présent cas et la littérature pertinente sont discutés du point de vue de l'investigation au département d'urgence et des soins à donner à un tel patient.

Case report

A 30-year-old man presented to our emergency department (ED) by private vehicle after being unintentionally shot with a pneumatic nail gun at his workplace. Thirty minutes prior to arrival the patient was standing underneath a wooden board when a colleague, who was sitting above him, fired a nail through the board and into the patient's chest. On arrival the patient was diaphoretic and anxious. His blood pressure was 68/52 mm Hg, heart rate 133 beats/min, respiratory rate 18 breaths/min, room air oxygen saturation 96%, and he had a Glasgow Coma Scale

score of 14. There was a round entry wound 5 mm in diameter over the mid-sternum (Fig. 1). No exit wound was identified. Chest auscultation revealed normal air entry and lung sounds bilaterally, and normal heart sounds. There was no jugular venous distension, and the abdomen was soft and non-tender. A detailed examination of the extremities was not initially performed.

The patient was immediately placed on 100% oxygen by a non-rebreather mask, and two 16-gauge peripheral intravenous lines were established. After a rapid infusion of 2 L of crystalloid, the patient's blood pressure rose to 151/98 mm Hg with sinus tachycardia at 110 beats/min by cardiac

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Received: Nov. 4, 2004; final submission: Apr. 20, 2005; accepted: Apr. 26, 2005

This article has been peer reviewed.

Can J Emerg Med 2005;7(4):278-81

monitor. A portable posterior–anterior (AP) chest radiograph showed normal lung fields, a normal heart and mediastinum, and no evidence of a foreign body.

Twenty minutes after arrival at the ED, the patient began to complain of left leg pain. Physical examination of the leg revealed no external trauma or neurological deficits; however, the left femoral pulse was diminished and the left popliteal, posterior tibial and dorsalis pedis pulses were all absent by both palpation and bedside Doppler ultrasound. Radiographs of the chest (AP and lateral), abdomen, pelvis, left femur and leg were taken and revealed a nail-shaped metal-density foreign body in the proximal left thigh (Fig. 2).

Results of echocardiography were normal, with no evidence of cardiac wall motion abnormality, septal injury or pericardial effusion. CT of the chest showed an anterior mediastinal hematoma and a normal aorta to the level of the external iliac artery. Angiography also found the aorta to be



Fig. 1. Thirty-year-old patient with round entry wound 5 mm in diameter over the mid-sternum, caused by a pneumatically fired carpenter's nail.

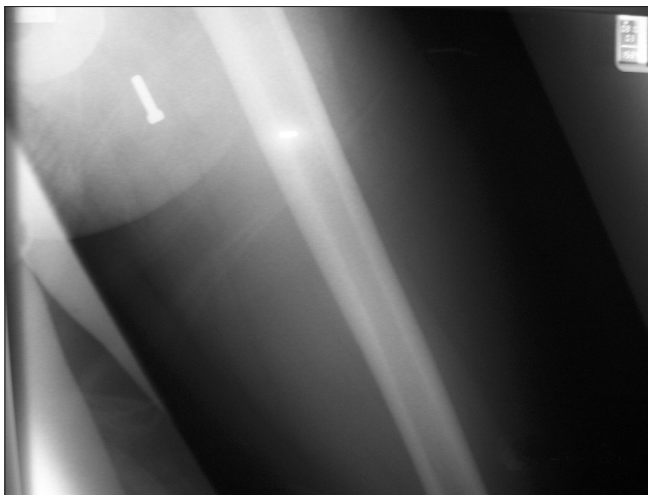


Fig. 2. Radiograph of the left femur and leg revealed a nail-shaped metal-density foreign body in the proximal left thigh.

normal, but demonstrated complete occlusion of the left superficial femoral artery by the nail (Fig. 3). Within 6 hours of presenting to the ED the patient underwent arteriotomy of the left superficial femoral artery and removal of the nail. He was discharged from hospital without sequelae after 10 days. At 1-month follow-up, the patient was ambulating well and had no complaints. His peripheral pulses were symmetrical, and a repeat CT of the chest was normal.

Discussion

To our knowledge, this is the first report of arterial embolization of an intracardiac nail projectile. A MEDLINE search (1970–2004) identified 181 cases of projectiles, predominately bullets or pellets, embolizing within the vascular system. Numerous entrance sites have been reported, including the head,¹ neck,² thoracic aorta,³ abdominal aorta,⁴ superior vena cava,⁵ inferior vena cava,⁶ portal vein,⁷ pelvic veins,⁸ upper limb veins,⁹ upper limb arteries,¹⁰ lower limb veins¹¹ and lower limb arteries.¹² Thirty-six cases of arterial embolism following penetrating heart injury have been reported, some from as long ago as the early 1800s.^{13–39} All the identified reports were written from the perspective of surgery, radiology or forensic medicine. Our discussion will focus on embolization of intracardiac

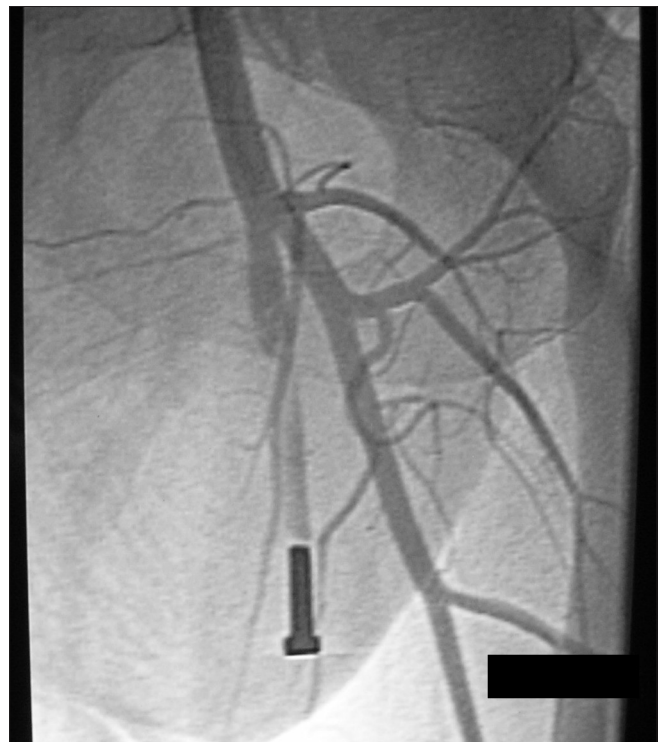


Fig. 3. Angiography found the aorta to be normal, but demonstrated complete occlusion of the left superficial femoral artery by the nail.

projectiles, as occurred in the case we present, and the challenges that emergency physicians face in the diagnosis and management of this rare condition.

In 11 of the 36 reported cases of arterial embolism following penetrating heart injury, the heart was proven by thoracotomy, sternotomy or autopsy to be the entrance site to the vascular system. In 12 cases the heart was identified as the point of entry without supporting evidence, and in 13 cases the authors assumed it was the point of entrance. Cases involving projectiles transiting the anterior or posterior chest wall were reported, with no apparent predilection for the right or left side. In the cases that documented the size of the projectile, 3 were 22-caliber bullets and 7 were pellets. The nail in the case we report was 24-mm long, 5-mm wide at the tip and 8-mm wide at the head. This approximates the size of a 22-caliber bullet.

Emergency physicians must be aware that embolization of intracardiac projectiles is often occult. Only 5 of the 36 reports described symptoms from embolization. These included pain, numbness and hemiplegia. Of note, only 3 of the reports described signs of cardiac tamponade. Initial presentations ranged from a stable hemodynamic status to exsanguination.

In the case presented, we hypothesize that the nail entered the heart through the interventricular septum. The septum is thickest and strongest area of the heart, and can seal a tract, thus preventing hemorrhage. This could explain the absence of a pericardial effusion on echocardiogram. Our hypothesis is supported by previous reports describing the cardiac wall sealing off with minimal bleeding after a projectile penetrated the left ventricle near the apex or the interventricular septum.^{28,30,31,32} The fact that cardiac penetration and embolization can present with subtle findings underscores the importance of considering embolization in all thoracic projectile wounds, particularly if the projectile is not found in the suspected region and did not appear to exit the body, and even if signs or symptoms of cardiac injury or distal ischemia are lacking.

Treatment varied in the 36 cases above and included endotracheal intubation (3 patients), chest tube insertion (7 patients), pericardiocentesis (2), sternotomy (2) and thoracotomy (2). Fluid resuscitation, with up to 3 L of crystalloid, was documented in 5 cases that survived. Our patient required only fluid resuscitation, likely because his hypotension was primarily vasovagal in etiology. It is noteworthy that the symptoms of embolization in our patient commenced after fluid resuscitation. It is unclear whether this was a coincidence or our patient had blunted perceptible or descriptive abilities while hypotensive, or because the intravenous fluid bolus advanced the projectile along

the vascular tree. The literature is not helpful in addressing this question, since the majority of cases do not describe ED care. We suspect aggressive fluid resuscitation is safe if a projectile is distal to the left subclavian artery. If a projectile is proximal to the left subclavian artery, it has the potential to embolize intracranially with catastrophic results,^{23,24,34} and a more cautious approach to fluid administration may be warranted.

Factors that affect where a projectile embolizes include the size of the foreign body, vessel anatomy and blood-flow force. Schowengerdt found that pellets <3 mm in size embolize exclusively to the head and neck,²⁷ making them more dangerous than larger projectiles. Lower limb emboli occur in 47% of cases, and in those in which a side is documented 65% occur on the left. Most bullet emboli from the heart travel to the lower limbs, with a predilection for left side because the left common iliac artery exits the aorta at a shallower angle than the right (30° as compared to 45°).³⁰

Diagnosing embolization of an intracardiac projectile can be difficult. All the cases we reviewed involved thoracic entry wounds without exit wounds. In all cases, the projectile was not found in the suspected region. In such situations, radiographs should be obtained to search for embolization, even if signs or symptoms are absent. These can include skull, neck, abdomen, pelvis and limb radiographs. An angiogram is required to precisely localize the projectile prior to embolectomy, and should be performed as soon as the patient's condition permits. Of the 36 cases reviewed, 8 patients died prior to treatment, 19 underwent embolectomy, and 4 had asymptomatic projectiles in non-vital areas which were left in situ. Five cases had no documentation of treatment or outcome.

Conclusions

The possibility of projectile embolization should be considered in all cases of penetrating thoracic trauma with a missing or fragmented projectile, particularly when no exit wound is identified. Clinical evidence of projectile embolization may be lacking, and if initial chest radiography does not identify the foreign body, further radiographs are indicated. Angiography is necessary to precisely localize the foreign body prior to open embolectomy, which is the treatment of choice in most cases.

Competing interests: None declared.

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