CASE REPORT

Left pulmonary artery bullet embolism following a penetrating cardiac gunshot injury

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African relevance

• Bullet emboli occur when bullets migrate from an entry point to an abnormal endpoint via blood vessels or bowel.
• A high index of suspicion is advised in patients who present with thoracic gunshot wounds where exit wound(s) are not identified.
• Radiographic imaging is important in identifying bullet embolisation and planning management.
• Haemodynamic instability should prompt urgent surgical exploration.

Introduction

Bullet embolus to the pulmonary artery was first reported by Moresten [1] in 1903. Most projectile emboli result from low-velocity, small calibre civilian gunshot. Reported survival following penetrating cardiac injury in the largest published series was 84% [2]. Mechanism of injury and physiological status on arrival were the most important determinants of outcome in those patients. Transthoracic cardiac gunshot wound with subsequent pulmonary arterial missile migration is rare. These patients often present with challenging, confusing clinical pictures [3].

Case report

A 33-year-old man presented to the Trauma Centre of Inkosi Albert Luthuli Central Hospital (IALCH) in South Africa, following multiple gunshot wounds to the right upper limb, chest, and flank. Examination revealed gunshot wounds in the following anatomical areas:

• On the proximal right humerus, with an exit wound at the proximal antero-medial humerus;
• In the mid-forearm, with a palpable bullet at the medial side of the right elbow joint;
• In the right infra-scapular region, without a corresponding exit wound;
• At the proximal antero-lateral right chest, and
• The right posterior flank and right upper quadrant (RUQ) of the abdomen.

On arrival, the patient’s airway was self-maintained, and breathing was spontaneous. Bilateral air entry was generally good; only slightly reduced in the right lower zone. The trachea was noted to deviate to the right. He was pale and hypothermic, with an initial blood pressure of 176/135 mmHg and heart rate of 132 beats per minute. His Glasgow Come Scale was 13/15, and he was notably confused, anxious and...
include the force of bloodflow, missile size and velocity, gravity, body energy, it may traverse only one wall of a vessel or hollow viscus. The generally tend to follow a straight trajectory. As the bullet loses kinetic energy, it may traverse only one wall of a vessel or hollow viscus. The main factor affecting the migration of a bullet in the venous system includes the force of blood flow, missile size and velocity, gravity, body position, and respiratory movement [6]. In the index case, the missile initially penetrated the right arm, then entered the right hemi-thorax, passing through the pulmonary parenchyma and lower lobe bronchus before eventually perforating the superior vena cava and entering the right atrium. It then ricocheted off the medial right atrial wall and embolised via the right ventricle to the left pulmonary artery.

Missiles in a right sided cardiac chamber may either embolise to the pulmonary artery or become entrapped in the endocardial trabeculae, becoming encysted with fibrous tissue. Due to the cardiac wound, a retained missile in the heart manifests itself immediately; this presents clinically with tamponade and/or intra-thoracic haemorrhage [7]. The clinical presentation following missile embolus to the pulmonary artery ranges from asymptomatic to features such as chest pain, dyspnoea, and haemoptysis. The diagnosis of bullet embolisation should be suspected in a patient with no exit wound, and, on radiograph, no visible bullet in the area of injury [7]. Given the sequence of collapse in the index patient, which began with acute hypoxia, followed by extreme agitation, and then profound hypotension, the assumption is that the missile had penetrated the right atrium but had insufficient energy to perforate the medial wall (Fig. 1). The distended neck veins suggest tamponade without active haemorrhage. For a brief period, the bullet may have remained in the right heart but eventually embolised to the left pulmonary artery and completely occluded the lumen. In conjunction with a major lower airway injury to the right hemi-thorax, acute hypoxia ensued causing extreme agitation and hypertension of sufficient magnitude to blow off any clot that was controlling the caval injury. Profound haemorrhage and hypotension then followed.

A diagnosis of bullet embolisation should be based on three observations:

- An incongruent number of gunshot wounds,
- A radiograph localising a bullet outside of the anticipated trajectory, and/or
- Serial radiographs demonstrating a moving foreign body.

These observations should raise suspicion of the trajectory and prompt further investigation [8]. Radiological evaluation should be guided by clinical presentation and physiological status. Modalities for imaging include plain chest radiography, computerised tomography (CT), and trans-thoracic and/or trans-oesophageal echocardiography [9].

The management options for bullet embolisation depend mainly on haemodynamic status [10]. The challenge is compounded when the patient develops haemorrhagic shock, as in the index patient. Haemodynamically stable patients allow for chest radiography and, where available, whole-body trauma CT angiography. This helps to confirm the bullet trajectory, exact location of the bullet(s), and site(s) of active bleeding. The index patient became acutely unstable and this precluded imaging. Such patients require urgent surgical exploration. The indications for emergency thoracotomy include massive bleeding with

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**Discussion**

Bullet embolisation is a rare but serious complication of gunshot wounds [4]. There are three known types: arterial, venous, and paradoxical. An arterial embolus is more commonly observed compared to a venous embolus at a 4:1 ratio [5]. Paradoxical emboli, where the bullet crosses from the venous to the arterial system (or vice versa), are exceedingly rare.

When a bullet penetrates body tissue, apart from striking bone, it generally tends to follow a straight trajectory. As the bullet loses kinetic energy, it may traverse only one wall of a vessel or hollow viscus. The main factor affecting the migration of a bullet in the venous system includes the force of blood flow, missile size and velocity, gravity, body position, and respiratory movement [6]. In the index case, the missile initially penetrated the right arm, then entered the right hemi-thorax, passing through the pulmonary parenchyma and lower lobe bronchus before eventually perforating the superior vena cava and entering the right atrium. It then ricocheted off the medial right atrial wall and embolised via the right ventricle to the left pulmonary artery.

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persistent blood loss, bronchial injury with a massive air leak, oesophagel injury, cardiac tamponade, great vessel injuries, and acute deterioration of the patient’s condition [5]. Survival to hospital following a cardiac gunshot wound is rare and removal of the bullet depends on a multitude of factors, including: the haemodynamic stability of the patient, bullet location, experience, expertise, and equipment available to the attending surgeon [11]. Indications for venous embolectomy remain controversial. Proponents advise bullet retrieval when the bullet is in the pulmonary artery or its branches, either by thoracotomy, median sternotomy or percutaneous catheterisation [5]. Over 65% of these patients are asymptomatic [12]. Missile extrication by invasive procedures carry inherent risk, exposing the patient to intervention-associated morbidities. As such, opponents of venous bullet embolectomy also advocate that cardiopulmonary bypass should be used with caution and simple cardiac injuries repaired where possible.

**Conclusion**

A high index of suspicion is advised in patients who present with thoracic gunshot wounds where exit wounds are not identified. Radiographic imaging is important in identifying bullet embolisation and planning management. Haemodynamic instability prompts surgical exploration. Successful management of these patients remains a challenge.

**Dissemination of results**

This case was presented at the local mortality and morbidity forum.

**Author contribution**

All authors substantially contributed to the conception and design of the work; case acquisition, drafting the work and revising it critically, and final approval of the version to be published. All authors agreed to be accountable for all aspects of the work.

**Conflict of interest**

TH is an editor of this journal, but was not involved in the editorial workflow of this paper. No further conflicts of interest were declared.

**Appendix A. Supplementary data**

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.afjem.2018.07.001.

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