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Projectile embolization to the left femoral artery with stroke following gunshot wound to the chest

Srinivasarao Badugu[a,*], Jeffrey Bennett[b] and Nicholas Slamon[c]
[a]*Department of Pediatric Intensive Care and Cardiology, University of Florida, Gainesville, FL, USA*
[b]*Department of Neuroradiology, University of Florida, Gainesville, FL, USA*
[c]*Department of Anesthesia and Critical Care Medicine, Nemours/duPont Hospital for Children, Wilmington, DE, USA*

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Abstract. Missile embolization is a rare phenomenon with most cases reported in the literature as a consequence of direct or indirect vascular trauma. Despite their characterization as toys, traumatic injuries from pellet guns are associated with significant rates of morbidity related to their vascular and neurological complications. We present a 9-year-old boy who was shot in the chest with a pellet gun and suffered a femoral arterial occlusion and a delayed stroke in the middle cerebral arterial distribution.

Keywords: Projectile, embolus, stroke

1. Introduction

Despite the frequency of air gun injuries and their potential to cause serious morbidity and even mortality, they remain unregulated and are used as harmless 'toy guns' by children. Bullet embolism with a non-powder gun is an uncommon consequence of firearm injuries, rarely observed in pediatric practice. The migration of a bullet in the systemic arterial system is predominately affected by the size of the projectile, force of blood flow, and the anatomy of the arteries. Although projectile injuries with systemic arterial embolization have been published in the literature, it is rare to find simultaneous limb and brain injuries after primary chest impact in children, as presented below [1].

*Corresponding author: Srinivasarao Badugu, Department of Pediatric Critical Care and Pediatric Cardiology, University of Florida, 1600 Archer Road, Gainesville, FL 32601, USA. Tel.: +1 352 265 0462; Fax: +1 352 265 0443; E-mail: srinivasbadugu@peds.ufl.edu.

We present a 9-year-old boy who was shot in the chest with a pellet gun and suffered a femoral arterial occlusion and a delayed stroke in the middle cerebral arterial distribution.

2. Case report

A healthy 9-year-old male presented to the emergency department with sudden onset sharp pain in his left shoulder and a minor bleed. Examination revealed a 0.5 mm wound in the left shoulder, and absence of left dorsalis pedis and posterior tibial pulses. No other entry or exit wounds were found. Whole body radiographic survey revealed a fragment from a pellet gun in the left thigh and no other metallic fragments. The child was then transferred to our facility for further management.

On arrival, the child was noted to be awake and alert, hemodynamically stable with no respiratory distress. Plain radiographs revealed a left parenchymal

lung injury with a small pleural effusion and a left mid thigh foreign body that suggested a pellet gun fragment. An echocardiogram did not reveal any aortic or cardiac injuries. Computed tomographic angiography (CTA) showed left mid-thigh projectile (Fig. 1) and a bullet track through the left lung parenchyma with indirect signs of possible vascular injury with increased densities around the vessels in the mediastinum (Fig. 2) and a trivial pericardial effusion. The assumption was that the bullet might have penetrated the aorta, with the projectile embolizing to the superficial femoral artery. The projectile was removed surgically without any complications. The child was transferred post operatively to the pediatric intensive care unit.

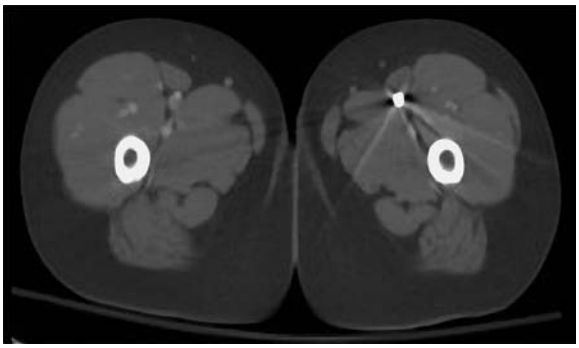

Fig. 1. A computed tomography-angiographic image at the level of the mid-thigh shows the pellet gun projectile in the left femoral artery (arrow).

Approximately 24 h after the injury, the child was noted to have slurred speech, right-sided hemiparesis and facial palsy. The left leg appeared normal with good pulses and perfusion. A magnetic resonance imaging of the brain showed patchy areas of restricted diffusion in the left putamen, insula, and centrum semiovale, as well as punctate areas of restricted diffusion in the left parieto-temporal region, all in the distribution of the left middle cerebral artery (Figs. 3A and 3B). Magnetic resonance angiography (MRA) showed no discrete stenotic, dissected, or occluded cerebral vessels or pellet fragments. The child had partial improvement of his facial palsy and was referred to physical and occupational therapy for outpatient rehabilitation.

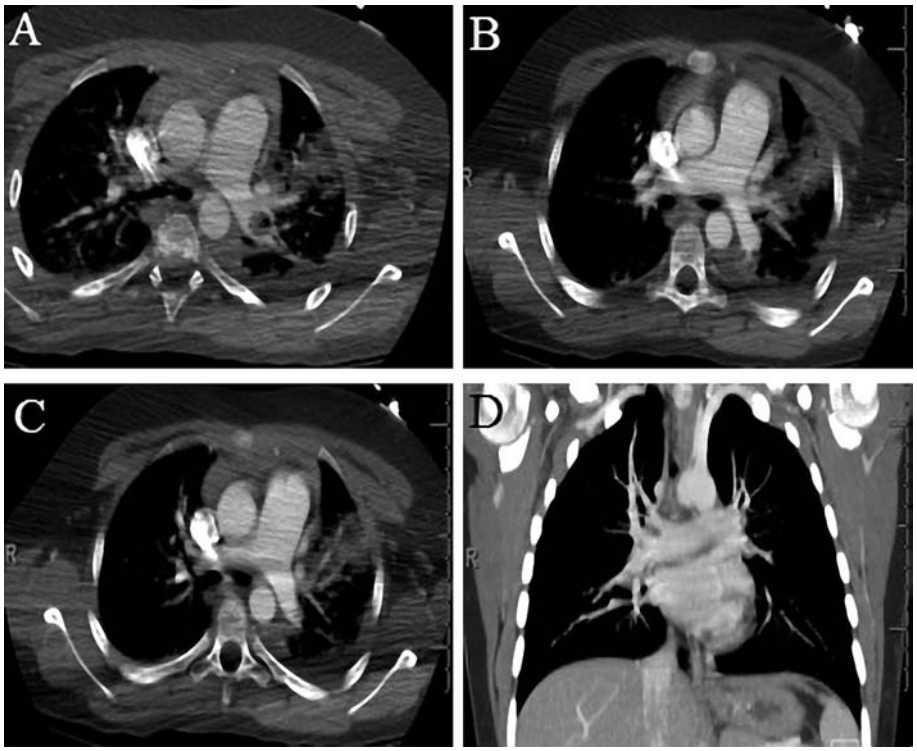

Fig. 2. Select axial and coronal computed tomography-angiographic images demonstrate the projectile's track through the left lung. The perivascular space around aorta is not clear, and a small pericardial effusion is present as well.

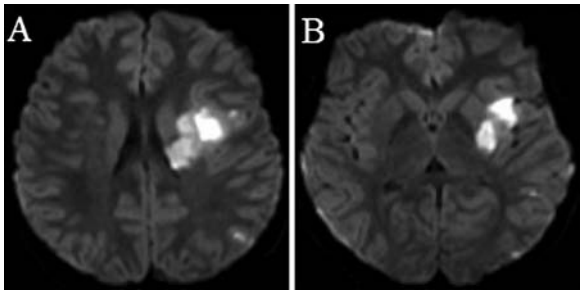

Fig. 3. Diffusion-weighted, 3T magnetic resonance images (b = 1000) show areas of restricted diffusion consistent with acute infarction in the left middle cerebral artery territory.

3. Discussion

Penetrating trauma from non-powder guns (NPGs), such as birdshot and pellet guns, may cause significant complications in children including permanent neurologic impairment, blindness, and even death [1–4]. Although most NPG injuries are accidental, they have been reportedly used for suicide, assault, and homicide [1,3,5]. NPGs are often colorful, easily accessible, and thought of as harmless 'toys' by children, parents, and even physicians. However, the reality is that NPGs are dangerous weapons. Approximately 32,000 NPG injuries are reported annually, with more than 60% occurring in the pediatric population [5]. The most common sites of injuries reported in NPG related traumas are the extremities (39%), head and the neck (33%), thorax (13%), and eye (8%) [5]. Abdominal wounds were frequently associated with visceral injury and multiple perforations, usually of the small bowel. Peritoneal penetration is associated with a more than 80% chance of visceral injury. The pellets from air guns have a propensity to embolize if the missile enters a blood vessel or the heart. The lightweight of air gun pellets allows the missile to be swept by the blood flow more readily than heavier, higher-energy projectiles [6]. Factors that affect the site of embolization include the size of the foreign body, vessel anatomy and blood-flow force. Schowengerdt et al. [7] found that pellets <3 mm in size are more likely to embolize to the head and neck, making them more dangerous than larger projectiles. Lower limb emboli were reported in 47% of cases, and, in those in which a side is documented, 65% occurred on the left because the left common iliac artery exits the aorta at a shallower angle than the right (30° as compared to 45°) [8].

The location of the entry wound and the possible path of embolization raise some interesting issues in our case. Though we cannot be certain about the path the bullet took, arterial embolization of the bullet fragments may occur after transcardiac penetration of the left ventricular wall, transcardiac penetration from the right to the left heart across the septum, penetration through a pulmonary vein, penetration through direct injury to the aorta, or via paradoxical embolization from the right heart across a septal defect to the left heart [9]. We believe that penetration of the left ventricular wall and or perforation of the septum are unlikely given the absence of structural damage, intracardiac shunting, conduction defects, or significant pericardial effusion. However, we cannot rule this path out with certainty, as there are reported cases in the literature, in which the perforation caused by a projectile penetrating the left ventricle near the apex and the interventricular septum was sealed off with minimal bleeding [8,10–12]. The possibility of the bullet perforating the pulmonary veins and entering the arterial system cannot be completely excluded from the imaging studies that we obtained. Similarly, the possibility of aortic injury causing femoral arterial embolization was not excluded completely with our investigations. There is a track through the lung and a possible defect in the left pulmonary artery (it is apparent on only one slice) was noted as shown in Fig. 2. The perivascular space around aorta is not clear. Although the association with perivascular abnormalities in the aorta raises the suspicion of direct aortic injury, we cannot say with certainty that this is the path of bullet migration. A repeat computed tomography (CT) scan as an outpatient did not show any pulmonary vascular or aortic abnormalities. Imaging by transthoracic echocardiography with agitated saline bubbles did not reveal any atrial septal defect or patent foramen ovale ruling out the possibility of paradoxical embolism.

The neurological changes in our patient raise another interesting issue. Although we are not certain about the exact etiology of the stroke, there is a possibility of the projectile fragments embolizing to the intracranial vessels as mentioned in [13], we excluded this possibility by the radiographs of the skull at the time of admission. The possibility of an aortic dissection extending into the left carotid artery was ruled out by CTA and MRA of the head and neck. The possibility of an arteriovenous fistula created by the bullet in its path can explain the femoral embolus and neurological symptoms; however, this was ruled out by CTA and MRA as well. Our final opinion was that the stroke was most likely due to air or thromboembolism.

Appropriate pre-hospital and emergency care is crucial in the management of children with projectile injuries to the chest. The path of the projectile cannot always be ascertained precisely. Depending on the presentation, initial evaluation in cases of entry wound in the chest should include 2-dimensional echocardiography, contrast-enhanced CT, and an electrocardiogram. The combination of 2-dimensional echocardiography and contrast-enhanced CT allows for accurate, noninvasive evaluation of missile location, vascular injury, structural cardiac damage, and pericardial effusion [14]. Intensive care unit management depends on the thoracic organs involved and includes close monitoring of respiratory and hemodynamic status. Injury to the great vessels can be associated with significant complications and should be monitored closely for ischemic complications.

The clinical picture of systemic arterial bullet embolization ranges from various degrees of ischemia to completely asymptomatic [15,16]. The complications are dependent on the level and degree of arterial occlusion, and the existence of collateral circulation. Extensive radiographic imaging, including angiography should be considered in situations of suspected projectile embolization without an exit wound. Management depends on the site involved and may include surgical removal or expectant management. Early embolectomy and thrombectomy may be considered depending on the symptoms and the site of embolization. Expectant management as an option has been reported in case of peripheral venous and peripheral lung emboli, right-heart or pulmonary vasculature missiles which are firmly lodged, smooth, uncontaminated by passage through the gastrointestinal tract, <5 mm, and not causing dysrhythmias or valvular dysfunction [17,18].

In conclusion, projectile injury to the chest leading to distal embolization with compromised limb perfusion and a delayed stroke is a rare phenomenon. Aggressive resuscitation, precise localization of the embolus, and early thrombectomy should be considered in the acute management of these patients.

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