

Embolic Stroke Caused by Lower Extremity Gunshot Wound

AUTHORS:

Sayed A. Arshad, MD; Jonathan Marinaro, MD;
Sundeep S. Guliani, MD

CORRESPONDENCE AUTHOR:

Sundeep S. Guliani, MD
University of New Mexico School of Medicine
Dept Of Surgery- Vascular Division
MSC 10-5610,
1 University of New Mexico
Albuquerque, NM 87131
Phone: 505-272-4531
E-mail: Sguliani@salud.unm.edu

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| Background | A 34-year-old male presented with close-range shotgun discharge to the left thigh with subsequent embolic stroke from missile projectile. |
| Summary | Bullet embolization is a rare complication of gunshot wounds. Embolization to the heart, great vessels, and distal extremities has been well published, however, embolization from a lower extremity vessel to the brain has not previously been described. We present the case of an otherwise healthy 34-year-old male who presented with a close-range shotgun discharge to the left thigh. He was initially communicative and appropriate, but become acutely agitated in the emergency room, requiring emergent intubation. The patient had selective advanced imaging and was taken for operative repair of a superficial femoral artery injury. Shortly after arrival to the intensive care unit postoperatively, the patient developed bradyarrhythmias and was found to have a blown left pupil. Emergent computed tomography (CT) scan of the head revealed a pellet occlusion of the left middle cerebral artery (MCA) with left cerebral swelling and 1.2 cm midline shift. The patient required emergent left craniectomy and frontotemporal lobectomy. |
| Conclusion | We present a patient who was admitted with an isolated gunshot wound (GSW) to the left thigh. His medical course was complicated by bullet embolization to the brain causing stroke and requiring emergent craniectomy and frontotemporal lobectomy. A whole-body CT scan may have detected the embolized bullet leading to earlier diagnosis and intervention. This, to our knowledge, is the first documented instance of a lower extremity gunshot causing an embolic stroke. |
| Keywords | Gunshot wound, embolization, stroke, computed tomography, craniectomy |

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The authors have no conflicts of interest to disclose.

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Case Description

A 34-year-old male presented as a trauma activation after close-range shotgun discharge to the left thigh. He was initially communicative and appropriate, as well as neurologically and hemodynamically intact. X-ray of the left thigh demonstrated multiple pellets (Figure 1). Pelvic X ray showed an isolated pellet overlying the left hemipelvis (Figure 2).



Figure 1. Left Femur X-ray (localized wound)



Figure 2. Pelvic X ray (arrow points to isolated suspect pellet)

The patient shortly thereafter became agitated requiring emergent intubation. He then underwent computed tomography (CT) angiography of the lower extremity revealing a short segment occlusion of the left distal superficial femoral artery (SFA) in addition to a traumatic arteriovenous fistula to the left femoral vein. The patient underwent intra-operative angiography (Figure 3) and repair of these injuries (endovascular SFA Viabahn covered stent placement) and was transferred to the intensive care unit (ICU) intubated.



Figure 3. Left thigh intraoperative angiography showing occlusion of superficial femoral artery

After arriving in the intensive care unit, the patient developed bradyarrhythmias and was found to have a blown left pupil. An emergent CT scan of the head revealed pellet occlusion of the left Middle Cerebral artery (MCA) with left cerebral swelling and 1.2 cm midline shift (Figure 4). The patient was taken emergently to the operating room for left craniectomy and also required a frontotemporal lobectomy.

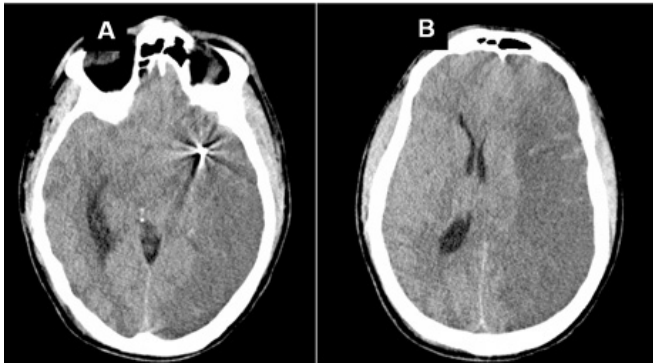


Figure 4. Computed tomography showing (A) pellet occlusion of left Middle Cerebral artery and (B) midline shift

Postoperatively, the patient had right-sided motor neuro deficits as well as aphasia. He was eventually discharged on postoperative day 13. On subsequent outpatient follow-up appointments, his motor deficits were noted to have nearly resolved, and his aphasia was improving.

Retrospective review of his initial CT imaging revealed the absence of a pelvic pellet on his scout film (Figure 5). This was concerning for pellet embolization during his initial presentation and the presumed cause of his acute onset agitation.

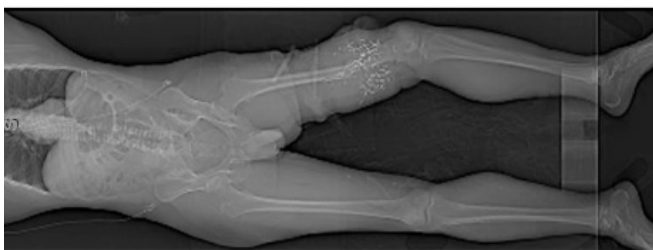


Figure 5. Computed tomography scout film, showing absence of pelvic pellet

Discussion

Bullet embolization is a rare complication of gunshot wounds. Studies from the military have shown rates from 0.3 to 1.1%.^{1,2} Embolization to the heart, great vessels, and distal extremities has been well published, however, embolization from a lower extremity to the brain has not previously been described.^{3,4} A trend appreciated during our literature review showed that most bullet emboli are from close range shotgun blasts. The close range allows for penetration of multiple bullet pellets into the soft tissue giving a greater chance of one of these projectiles to enter into the vascular channels. The surface of the bullets is usually smooth and spherical in shape allowing for easy

travel throughout the vascular system. There have been cases describing stroke secondary to bullets from gunshot wounds to the neck, chest, and upper extremities, however, this to our knowledge, is the first documented instance of a lower extremity bullet causing embolic stroke.

Given that the bullet was able to traverse from the systemic venous system and into the arterial system without becoming lodged in the pulmonary vasculature, our patient must have had a patent foramen ovale (PFO). Occult PFO prevalence has been observed in 20 to 30% of patients in autopsy studies.^{5,6} The patient did undergo a transthoracic echocardiogram (TTE) with agitated saline bubble study, which demonstrated no interatrial shunt; however, there is a known rate of false-negative bubble studies. TTEs are often unable to directly visualize a PFO, but the presence of a PFO can be concluded based on visualization of bubbles within the left atrium.⁷ The right to left atrial shunt can also be intermittent in nature, and the inability of a patient to appropriately perform a Valsalva maneuver during time of study can further lead to false negative studies.⁷ One study noted a 35% rate of shunting on TTE with bubble study, with 48% of these only being appreciated after maneuvers, such as Valsalva, which increase intrathoracic pressure and therefore increase right atrial pressure over that of left atrial pressure, thus causing shunting.⁸ As our patient was intubated at time of TTE, no Valsalva maneuver was able to be performed. Mechanical ventilation itself has been shown to increase intrathoracic pressure enough to cause right to left atrial shunting and identification of a PFO on TTE—but a certain threshold of pressure must still be reached.⁹ The possibility does exist that other maneuvers during initial evaluation or resuscitation, such as bag-valve-mask ventilation, may have caused sufficient increase in intrathoracic pressure to cause temporary shunting that may have led to the bullet crossing into the arterial system.

Although the literature for covered stent repair for proximal lower extremity injuries is limited, published data does report reasonable outcomes with some advantages over open repair in select patients.^{9,10} While comparative studies show an advantage of native tissue bypass as compared to stenting in distal peripheral vascular disease, long-term studies of the use of stents in vascular injuries are evolving. Given that this patient's injury was in a proximal vessel, the segment of occlusion was a short dissection, and there was a large destructive soft tissue defect from the multiple shotgun pellets, we elected to perform the less invasive endovascular intervention (covered stent placement). We do believe that in select patients, stenting proximal vascular injuries does afford patients certain advantages over

open repair, such as decreased operative time, decreased blood loss, decreased recovery time, and overall decreased morbidity.

A CT of the head and neck for this intubated patient would have identified the embolization of the bullet with the initial trauma evaluation and prompt treatment likely would have saved the patient from an ischemic stroke and its sequelae. Previous observational and retrospective studies have shown outcome and mortality benefits to whole body CT (WBCT) scans^{12,13}; however, more recent studies, including randomized control trials such as the REACT-2 trial, have shown no difference in 24-hour mortality (8% in the intervention group versus 6% in the control group, $p = 0.23$), 30-day mortality (17% in the intervention group versus 16% in the control group, $p = 0.69$), or all patient mortality (15.9% in the intervention group versus 15.7 in the control group, $p = 0.92$).^{14,15}

Conclusion

We present a patient who presented with a single gunshot wound to the left lower extremity with multiple retained foreign bodies. The patient's hospital course was complicated by embolization of a bullet to the left MCA resulting in stroke and significant morbidity. This, to our knowledge, is the first documented instance of a lower extremity bullet causing an embolic stroke.

Lessons Learned

Bullet embolization, particularly to the brain, is a rare phenomenon. Based on final location after embolization, neurovascular deficits may be present. Although a gunshot wound may appear localized at first, if there are unaccounted for deficits or a clinical suspicion for embolus, additional imaging should be performed to aid in diagnosis.

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