



Case Report

Craniocerebral gunshot injury bullet migration to the cardiac right ventricle

Taylor Duda¹, Euan Zhang², Kesava Reddy¹

¹Department of Neurosurgery, McMaster University, Hamilton, ²Department of Diagnostic Imaging, Health Sciences North, Sudbury, Ontario, Canada.

E-mail: *Taylor Duda - taylor.duda@medportal.ca; Euan Zhang - euan.zhang@medportal.ca; Kesava Reddy - kesh@keshreddy.ca



*Corresponding author:

Taylor Duda,
Department of Neurosurgery,
McMaster University, Hamilton,
Ontario, Canada.

taylor.duda@medportal.ca

Received : 04 March 2021

Accepted : 11 September 2021

Published : 30 September 2021

DOI

10.25259/SNI_221_2021

Quick Response Code:



ABSTRACT

Background: Missile embolism is the process of slow velocity projectiles penetrating into vascular spaces followed by arterial, venous, or paradoxical embolism of the fragments. This is a rare complication in craniocerebral gunshot injuries (CGI), with only five other cases previously published demonstrating pulmonary or arterial emboli from these injuries. There is a high rate of mortality from these injuries.

Case Description: A patient presented with a CGI from an occipital trajectory, causing penetrating fragments into the venous sinus system. The weapon was a Glock Model 17M 9 mm with a hollow-point bullet, fired close range. Initial chest X-ray demonstrated only atelectasis. After stabilization, 18 min from the initial chest X-ray, subsequent computed tomography (CT) imaging demonstrated extensive intracranial injuries and fragmentation of the bullet with the expected devastating intracranial injuries. Unexpectedly, chest CT revealed metallic fragments in the right cardiac ventricle which was redemonstrated on follow-up chest X-ray. Unfortunately, his extensive intracranial injuries and poor clinical status were nonsurvivable, and thus the family elected to discontinue supportive measures.

Conclusion: This case demonstrates radiographic imaging of a metallic intravascular fragment from CGI through presumed transvenous mechanisms. The imaging provides a consistent timeline demonstrating migration can occur in the acute phase. This study additionally supports the presumed mechanism for pulmonary migration through the right heart. Fragment embolization should be considered in cases of acute deterioration in this patient population.

Keywords: Bullet migration, Case report, Craniocerebral gunshot injury, Neurotrauma

INTRODUCTION

Missile embolism was first reported by Thomas Davies in 1834 and later recognized during the Vietnam War as associated with small caliber, slow velocity projectiles penetrating vasculature and fragments becoming emboli. They have been classified as arterial, venous, or paradoxical. Systemic arterial embolism is 80% of reports.^[6,9]

Bullet-related embolism is rare, with few cases published. Bullet embolism has also been reported from gunshot injuries to the lower back,^[10] chest,^[6] neck,^[2] and abdomen.^[9] Migration events can occur at the time of injury or in a delayed fashion. Some migration events are extravascular.^[15]

This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

©2021 Published by Scientific Scholar on behalf of Surgical Neurology International

The first report of a cranial venous sinus embolus to the heart was reported in 1964. It was treated through craniotomy for control of intracranial hemorrhage and craniotomy 19 days later for retrieval of the bullet fragment entering the left anterior descending coronary artery.^[8] Previous cases report pulmonary artery infarction secondary to bullet embolism^[4,5,13] and represent the five total published cases of this complication. Analysis of 2187 penetrating brain wounds presenting to a United States Army Hospital in Vietnam described postoperative pulmonary embolus in only four patients, a rate of 0.23%.^[7] A follow-up study of 103 American soldiers who sustained brain injuries in Vietnam and treated at a neurosurgical facility noted two of eight delayed deaths were due to pulmonary embolism. One patient was an alert 28-year-old and the other was a bedridden 18-year-old who was somnolent, due to a brain abscess following debridement. The authors describe pulmonary embolism as a significant cause of mortality in this group of neurosurgical patients.^[3]

Previous reviews suggest that there is a high morbidity rate and that venous extraction may be mandatory.^[14] Endovascular techniques for treatment have earned support after a successful case series was reported by Miller *et al.*^[12]

CASE REPORT

A middle-aged male presented to the trauma bay with a craniocerebral gunshot injury (CGI). Collateral history revealed a close-range injury from a Glock Model 17M 9 mm hollow-point bullet. Airway was secured with intubation at the scene by the emergency medical service (EMS), but a subsequent air leak necessitated replacement of the

endotracheal tube on arrival. Cardiopulmonary resuscitation was ongoing with EMS due to a narrow complex rhythm pulseless electrical activity on scene. Return of spontaneous circulation was achieved with one cycle of epinephrine 1 mg intravenously as per Advanced Cardiac Life Saving guidelines.^[1] He subsequently deteriorated into ventricular tachycardia but was subsequently stabilized with a 200-joule synchronized cardioversion into a sinus tachycardia. He was transfused and fluid resuscitated until normotensive. An initial chest X-ray was performed to rule out other missed projectiles and demonstrated only right upper lobe atelectasis. Examination demonstrated a midline trachea, good air entry bilaterally, a benign abdomen, and no abdominal or thoracic injuries on logroll. Gunshot injuries were found to the upper left arm and left occiput. The arm injury was a linear superficial abrasion only and was dressed. The left occipital injury did not have an associated exit site. A significant volume of left occipital scalp bleeding and suspected brain debris at the wound was observed. Bleeding was controlled with a suture over the site of the occipital artery.

Subsequent computer tomography (CT) scan was performed 18 min after the initial chest X-ray. This included CT of the head, neck, full spine, chest, abdomen, and pelvis as well as CT angiography of the carotids. CT demonstrated penetrating injury to the left occipital bone with comminuted fractures extending to the mastoid temporal bone, right occipital condyle, bilateral carotid canals, and sphenoid sinuses [Figure 1a]. Intracranial bone fragments were noted [Figure 1b]. Minimally displaced fractures of the left maxillary nasal process, right nasal bone, right orbital floor,

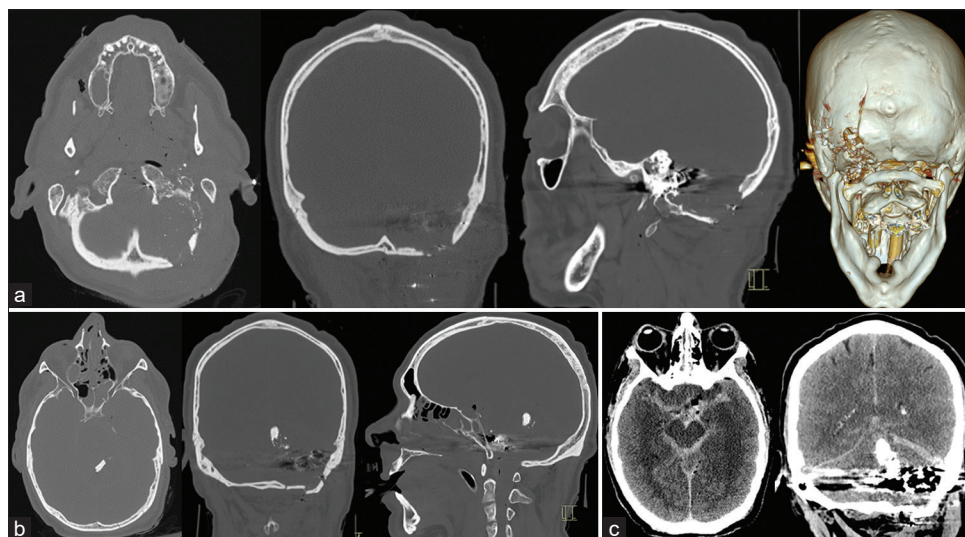


Figure 1: Computer tomography scans of the brain showing the left occipital entry wound (a), displaced bony fragments from the bullet (b), and the subsequent traumatic subarachnoid, subdural, and intraparenchymal hemorrhage with metallic fragment related artifact (c).

inferior orbital rim, and right maxillary sinus walls were demonstrated.

Diffuse traumatic subarachnoid hemorrhage, a moderate-volume intraventricular hemorrhage, subdural hemorrhage, epidural hemorrhage, and a 1.5 cm × 0.6 cm × 0.5 cm left lateral pontine intraparenchymal hemorrhage was found [Figure 1c]. Subtle hypoattenuation of the bilateral basal ganglia, medial temporal lobes, and occipital lobes suggested anoxic injury. High intracranial pressure was demonstrated by diffuse sulcal effacement, upward transtentorial herniation, and downward tonsillar herniation. CT angiography demonstrated likely left petrous internal carotid artery injury, likely right vertebral dissection, acute transection of the left occipital artery. Multiple bullet fragments were present in the left cerebellar hemisphere, along the left petrous apex and otic capsule, into the jugular foramen [Figure 2].

CT of the chest demonstrated a small metallic fragment within the right ventricle, without any other penetration or associated injuries to the chest or abdomen [Figure 3]. Surrounding structures did not appear injured. Follow-up chest X-ray was performed shortly after the scan confirming the presence of a metallic fragment in the right ventricle,



Figure 2: Computer tomography scans of the brain showing the metallic bullet fragment lodged in the jugular foramen.

which was not previously appreciated, measuring 2 mm in diameter [Figure 3].

The patient remained at a GCS of 3, with fixed dilated pupils and no brainstem reflexes, including no spontaneous respiratory effort. The extensive nature of his injury was discussed with the family, and a decision was made to pursue supportive end-of-life care without organ donation as consistent with the patient's previously expressed wishes.

DISCUSSION

This case demonstrates likely migration of a metallic fragment from the CGI through presumed transvenous route to the right cardiac ventricle. Given no dynamic imaging of the process of migration was possible, only serial imaging minutes apart, this study is limited in conclusively stating the path of migration, though a transvenous route through sinus or tributary is the most likely possibility. Although in this case, the patient was clinically neurologically unsalvageable, it demonstrates that migration of fragments may occur in the acute phase. While it is challenging to determine whether this contributed to this young man's demise, in the context of acute deterioration, an embolism of bullet fragments should be considered. This case adds to other literature demonstrating subacute pulmonary embolism of such fragments by radiographically confirming the interim step of acute emboli in the right ventricle.

The capacity of CGI emboli migrating acutely, as is likely in this case, or in a delayed fashion, as in previous cases, has implications for treatment decisions. When decompressive or other surgery is offered, classical teaching is to avoid pursuing deep intracranial bullet retrieval, though there is no documented evidence addressing this.^[11] In the case of fragments potentially violating large venous spaces, this adage may have to be carefully considered, especially if surgery is already being pursued for other reasons such as hematoma evacuation or decompression.

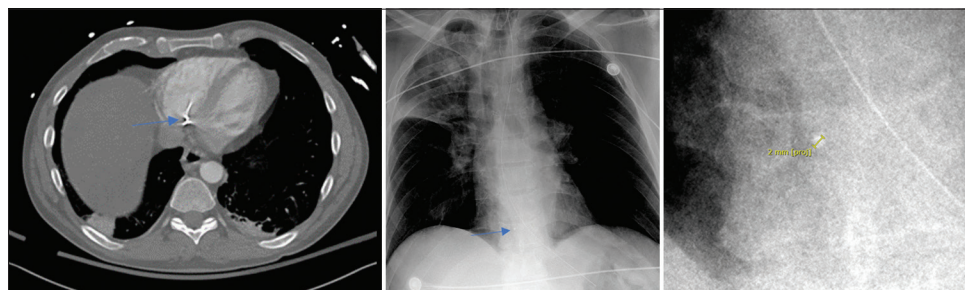


Figure 3: Computer tomography scan and chest radiograph showing the migrated bullet fragment. The radiograph is intentionally windowed to visualize the bullet fragment. The bullet fragment measured 2 mm on cross-section.

CONCLUSION

Cranio-cerebral gunshot injuries can cause fragmentation of bullet or bone to venous sinuses. Venous sinus injuries have the potential for not only exsanguination but also transvenous migration of embolic material. Bullet fragment-related embolism should be considered on the differential of gunshot patients who have the possibility of venous injury.

Declaration of patient consent

Patient's consent not required as patient's identity is not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- American Heart Association. Advanced Cardiovascular Life Support (ACLS) Provider Manual. 16th ed. United States: American Heart Association; 2016.
- Breeding JM, Smith RS, Dort JM. Bullet embolus to the heart after gunshot wound to the neck: A case report. *Am Surg* 2007;73:1245-6.
- Carey ME, Young HF, Rish BL, Mathis JL. Follow-up study of 103 American soldiers who sustained a brain wound in Vietnam. *J Neurosurg* 1974;41:542-9.
- Duke E, Peterson AA, Erly WK. Migrating bullet: A case of a bullet embolism to the pulmonary artery with secondary pulmonary infarction after gunshot wound to the left globe. *J Emerg Trauma Shock* 2014;7:38-40.
- Goldman RL, Carmody RF. Foreign body pulmonary embolism originating from a gunshot wound to the head. *J Trauma* 1984;24:277-9.
- Govindaraju RC, Kolwalkar JP. Missile embolism from pulmonary vein to systemic circulation: Case report with systematic literature review. *J Emerg Trauma Shock* 2019;12:218-21.
- Hammon WM. Analysis of 2187 consecutive penetrating wounds of the brain from Vietnam. *J Neurosurg* 1971;34:127-31.
- Hiebert CA, Gregory FJ. Bullet embolism from the head to the heart. *JAMA* 1974;229:442-3.
- Khomenko I, Tsema I, Shklyarevych P, Kravchenko K, Holinko V, Nikolaienko S, *et al.* Pulmonary artery embolism by a metal fragment after a booby trap explosion in a combat patient injured in the armed conflict in East Ukraine: A case report and review of the literature. *J Med Case Rep* 2018;12:330.
- Kovalev V, Salaiz OD. Surgical management of a bullet embolism to the pulmonary artery. *Cureus* 2020;12:e8138.
- Loggini A, Vasenina VI, Mansour A, Das P, Horowitz PM, Goldenberg FD, *et al.* Management of civilians with penetrating brain injury: A systematic review. *J Crit Care* 2020;56:159-66.
- Miller KR, Bennis MV, Sciarretta JD, Harbrecht BG, Ross CB, Franklin GA, *et al.* The evolving management of venous bullet emboli: A case series and literature review. *Injury* 2011;42:441-6.
- Nehme AE. Intracranial bullet migrating to pulmonary artery. *J Trauma* 1980;20:344-6.
- Shannon F, McCroskey B, Moore E, Moore F. Venous bullet embolism: Rationale for mandatory extraction. *J Trauma* 1987;27:1118-22.
- Siddiqui MI, Hawksworth SA, Sun DY. Removal of migrating lumbar spine bullet: Case report and surgical video. *World Neurosurg* 2019;131:62-4.

How to cite this article: Duda T, Zhang E, Reddy K. Cranio-cerebral gunshot injury bullet migration to the cardiac right ventricle. *Surg Neurol Int* 2021;12:491.