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Case Report

Bullet fragments spontaneously migrating in opposite directions after a cardiac arrest treated with extracorporeal cardiopulmonary resuscitation following a gunshot wound to the head: A case report

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A R T I C L E I N F O

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A B S T R A C T

Gunshot injuries to the head are associated with a poor neurological prognosis, have a high risk of mortality, and make the return of spontaneous breathing and circulation after cardiopulmonary arrest difficult. Bullets or bullet fragments can cause penetrating injuries to the brain tissue and sometimes remain in the skull, potentially migrating within the skull. Herein, we describe a rare patient who achieved a return of spontaneous circulation after cardiopulmonary (ROSC) arrest caused by a gunshot wound, following extracorporeal cardiopulmonary resuscitation. After ROSC, repeated computed tomography (CT) identified spontaneously migrating bullets/fragments in the right hemisphere and the metal fragment was excreted from the skull, while another fragment had moved from the left temporal to the occipital fossa. The patient died on the 15th day of hospitalization. The present case had a rare clinical course, suggesting that ROSC may be achieved under adequate respiratory and circulation management in cases of cardiac arrest with a head injury. The scans showed differing movements of the bullet fragments at each lesion, which was difficult to predict from the first CT scan. When surgical treatment is required to remove bullet fragments remaining in the skull (due to lead poisoning, or infection, among others), it may be useful to be aware that fragments may move in various directions, even out of the skull. Furthermore, we recognized the usefulness of CT scanning for detecting the location of the foreign body in cases of gunshot injury to the head.

Introduction

Traumatic brain injuries are common worldwide. Gunshot head injury as penetrating head injury is also seen among civilians, and the number of civilian deaths has increased in the last decade, reaching an estimated count of 35,000 [1]. Knowing how to effectively diagnose and treat gunshot injuries is therefore, globally relevant. Mortality rates related to gunshot wounds vary by the area of the injury, the Injury Severity Score (ISS), Revised Trauma Score (RTS), and Glasgow Coma Scale (GCS) score. This variance notwithstanding, gunshot wounds to the head (GSWH) are often fatal, with a mortality rate of about 90% [2,3]. Active bleeding in the brain requires urgent surgery to control shock and coagulopathy, decompress pressure on the brain, and to prevent injury to the vascular structures by debriding bone and metal fragments. However, exploration of deep fragments should be avoided due to the associated risk of morbidity. Nevertheless, removing metal fragments and debriding are required in cases of confirmed heavy metal toxicity, large metal fragments lodged within the ventricles or cerebrospinal fluid cistern, hydrocephalus, and fragments related to large

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vessels [3].

When surgery is required, information on the duration and site of the injury, as well as the trajectories of the bullet fragments, is required. Computed tomography (CT) can be a useful tool in the assessment of prognostic indicators, such as diffuse fragmentation, midline shift, brain stem injury, and vessel injury [3]. However, occasionally, the bullet or bullet fragments are not found in the lesion when examined by CT, as a result of migration into the cranial cavity. In fact, 4.2% cases of civilian GSWH present with bullet or bullet fragment migration [4], which may lead to abscess formation, heavy metal toxicity, and an increased risk of vessel injury or hydrocephalus, along with challenges in removing the foreign body and necrotizing tissue during surgery.

Herein, we report a case of GSWH with an unusual bullet fragment migration following an out-of-hospital cardiac arrest due to gunshot head injury. After the return of spontaneous circulation, we performed a CT scan to assess the extent of the brain damage while the patient was unconscious. More than two bullet fragments, initially too deep to remove without a significant increase in morbidity risk, were observed to have migrated simultaneously, but in different directions. These phenomena occurred owing to gravity and intracranial pressure. This was likely because of the primary damage caused by the bullet itself and the secondary damage caused by the swelling and the necrotizing brain tissue.

Case report

A 45-year-old man was found down with a bleeding gunshot wound to the right temporal region. The bullet had entered through the right temporal region. The paramedics found the patient in cardiac arrest and started cardiopulmonary resuscitation. The first recorded heart rhythm was pulseless electrical activity. During the resuscitation, the patient's cardiac rhythm had shifted from pulseless electrical activity to ventricular fibrillation. After arriving at our emergency department, we continued chest compression for 69 min, treating with cardioversion 19 times and repeated epinephrine and amiodaron hydrochloride (total: 450 mg) according to the Advanced Cardiac Life Support algorithm. Because the patient had refractory ventricular fibrillation, he was treated with veno-arterial extracorporeal cardiopulmonary resuscitation without using systemic anticoagulation to maintain circulation and respiration.

A CT scan revealed swelling of the brain with sulcal effacement and several bihemispheric pieces of metal (Fig. 1, Panel A, B). His GCS score was 3 (E1VTM1), and his pupils were fixed and dilated. Unstable and unconscious, the patient did not undergo surgery, and his deep body temperature was maintained < 37.0 °C.

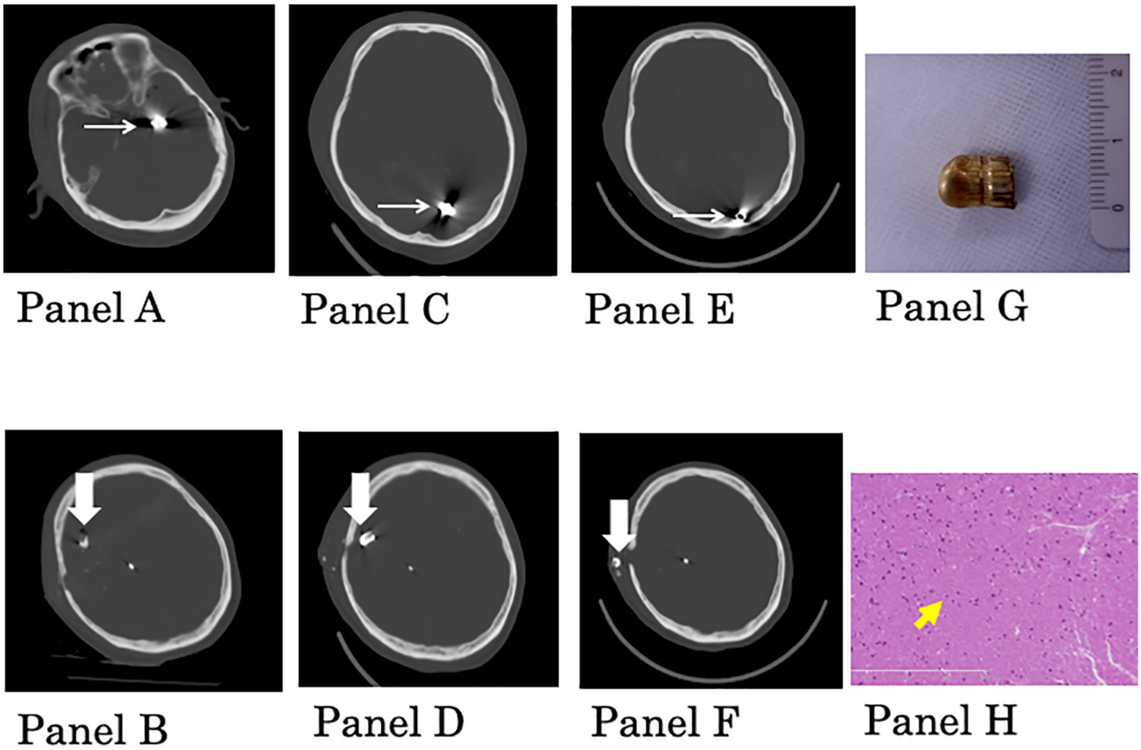

Fig. 1. Axial computed tomography (CT) scans show the spontaneous migration of metal fragments in the skull at different time points as follows: Panel A and B at admission to our emergency department. Panel C and D on the seventh day of hospitalization. Panel E and F on the eleventh day of hospitalization. The white narrow arrows show the migration of the bullet fragment as a result of gravity (Panel A, C, E). The thick white arrows show the migration of a metal fragment in the reverse direction along the original trajectory (Panel B, D, F). Panel G shows the same fragment as that in Panel F (thick arrow) after it had spontaneously migrated out of the skull. Panel H shows that the specimen of the tissue found on the excreted metal includes neural cells (yellow arrow) (hematoxylin and eosin staining).

The patient achieved a sustained return of spontaneous circulation after 2 h of enforced extracorporeal cardiopulmonary resuscitation, his heartbeat was regular, heart contraction sufficient, and hemodynamic state stabilized with GCS score of 4 (E1VTM2). Immediately afterwards, his GCS score became 3 (E1VTM1) with dilated pupils. His temporary spontaneous breathing appeared intermittently. After 26 h of hospitalization, we withdrew veno-arterial extracorporeal membrane oxygenation. Subsequently, his blood pressure maintained circulation stability. At this point, his ISS was 25, RTS was 0.29, probability of survival (Ps) was 0.0203, and Trauma Score–Injury Severity Score (TRISS) was 0.97965. Because he remained at GCS 3 (E1VTM1) with apnea, a CT scan was performed to evaluate the extent of brain damage. A further CT scan revealed swelling of the brain and presence of migrated bullet fragments. One piece of metal, previously located in the right hemisphere, had moved toward the outer edge of the skull cavity on the 7th day of hospitalization (Fig. 1, Panel C, D). Another piece, previously in the left hemisphere, had moved from the temporal lobe to the occipital fossa, following the direction of gravity exerted in the CT scanner on the 11th day of hospitalization (Fig. 1, Panel E, F). We removed the metal fragment that used to be in the right hemisphere, along with the surrounding tissue, on the 11th day of hospitalization. A histopathological examination revealed neural cells in the tissue that surrounded the metal fragment expelled from the body (Panel G, H). Although the patient's GCS score remained 3 (E1VTM1), his blood pressure gradually decreased, and he died on the 15th day of hospitalization.

The patient's family was identified and approached for consent to treatment. They provided informed consent for all treatment procedures, and for the publication of this case. The ethics board of our hospital approved the preparation and publication of this case study.

Discussion

Penetrating injuries due to GSWH have a poor prognosis and are fatal in most cases [5]. Rosenfield et al. estimated that 66–90% of GSWH victims die before reaching the hospital [3]. Furthermore, it is difficult for patients with GSWH to return to sustained circulation after cardiac arrest. Karaca et al. reported that patients with intracranial injuries brought to the hospital in cardiac arrest have a poorer prognosis than patients without cardiac arrest [2]. Our patient had an out-of-hospital cardiac arrest and difficulties in returning to sustained circulation, even though his electrocardiogram showed refractory ventricular fibrillation. Extracorporeal cardiopulmonary resuscitation for refractory ventricular fibrillation provided an adequate hemodynamic state and oxygenation level in this patient [6]. However, his brain gradually swelled due to the cardiac arrest and disturbed breathing. Because his electrocardiogram showed ventricular fibrillation at admission, he underwent extracorporeal cardiopulmonary resuscitation to restore sustained circulation.

The ability to predict the likely prognosis of a patient with a GSWH is crucial to treatment decisions. It requires assessment of clinical and imaging results, patient's age, admission GCS, pupil response to light, trajectory of the bullet, presence and extent of intraventricular hemorrhage, and obliteration of the basal cistern on a CT scan after resuscitation [3,7,8]. Gressot et al. have advocated the use of a scoring system to predict the outcome of a GSWH [8]. Based on this scoring system, our patient was unlikely to survive; he was at a high risk of death, and surgical treatment was likely to expedite this outcome.

Four mechanisms might account for bullet/bullet fragment migration after a GSWH: bullets are present in the ventricular system, fragments are present in the necrotic liquefied brain tissue, projectiles travel along the trajectory of the crushed brain tissue, and intact heavy fragments sink due to gravity [9,10]. In the present case, one fragment moved in liquefied brain tissue due to gravity; another moved in the direction of the point of entry, following cerebral softening and local tissue damage along the injury trajectory. The present case suggests that gunshots do not cause uniform brain injuries; rather, the specifics of the injury may vary based on the extent of direct damage, impact of heat, volume of necrotizing tissue, and presence of metal, among others. Performing repeated CT scans may be a suitable method for identifying the correct location of the foreign body in the skull, given the presence of severely damaged brain tissue.

In summary, although bullets or bullet fragments due to a GSWH rarely move within the skull, migration, where present, can occur in different directions, depending on the underlying mechanism. The trajectories of the injury may act as canals for foreign bodies. Repeated CT scans might help in locating bullets or bullet fragments. Moreover, ROSC may be achieved under adequate respiratory and circulation management in cases of cardiac arrest with head injury.

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Declaration of competing interest

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References

[1] M.T. Vakil, A.K. Singh, A review of penetrating brain trauma: epidemiology, pathophysiology, imaging assessment, complications, and treat, Emerg. Radiol. 24 (2017) 301–309.
[2] M.A. Karaca, N.D. Kartal, B. Erbil, et al., Evaluation of gunshot wounds in the emergency department, Uls Travma Acil Cerrahi Derg 21 (4) (2015) 248–255.
[3] J.V. Rosenfield, R.S. Bell, R. Armonda, Current concepts in penetrating and blast injury to the central nervous system, World J. Surg. 39 (2015) 1352–1362.
[4] L.G. Rapp, C.A. Arce, R. McKenzie, W.R. Darmody, D.R. Guyot, D.B. Michael, Incidence of intracranial bullet fragment migration, Neurol. Res. 21 (1999) 475–480.
[5] H.R. Alvis-Miranda, R. Adie Villafane, A. Rojas, G. Cerra-Alcala, L.R. Mascote-Salazar, Management of craniocerebral gunshoto injuries: a review, Korean J. Neurotrauma 11 (2015) 35–43.
[6] J.A. Bartos, K. Carlson, C. Carlson, et al., Surviving refractory out-of-hospital ventricular fibrillation cardiac arrest: critical care and extracorporeal membrane oxygenation management, Resuscitation 132 (2018) 47–55.
[7] B. Aarabi, B. Tofighi, J.A. Kufera, et al., Predictors of outcome in civilian gunshot wounds to the head, J. Neurosurg. 120 (5) (2014) 1138–1146.
[8] L.V. Gressot, R.B. Chamoun, A.J. Patel, et al., Predictors of outcome in civilians with gunshot wound to the head upon presentation, J. Neurosurg. 121 (2014) 645–652.
[9] Y. Fujimoto, H.T. Cabrera, F.H. Pahl, A.F. de Andrade, J.R. Marino, Spontaneous migration of a bullet in the cerebellum –case report, Neurol. Med. Chir. (Tokyo) 41 (2001) 499–501.
[10] H. Duman, I.M. Ziyal, A. Canpolat, Spontaneous subfalcial transcallosal migration of a missile to the contralateral hemisphere causing deterioration in neurological status – case report, Neurol. Med. Chir. (Tokyo) 42 (2002) 332–333.