Case Report

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Gunshot Penetrating Brain Injury: A Case Report and Review of the Literature

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Gunshot injury to the brain is relatively rare compared to other forms of trauma worldwide. Gunshot injuries are also uncommon in Taiwan due to strict gun ownership policies, with a prevalence of approximately 0.42 per 100,000 people. We report a case of traumatic brain injury (TBI) caused by a gunshot to the brain, who was transferred from other hospital. Despite aggressive surgical treatment, the patient died of severe brain injury. We reviewed articles on the outcomes of a series of patients with gunshot injuries to the brain and compared the risk factors associated with mortality in our case.

Key words: gunshots, risk factor, mortality

Introduction

Gunshot in the brain (GIB) are rare in most societies. Nevertheless, they can occur as a result of suicidal injuries or homicidal assaults. Due to the nature of being rare but acute emergencies, only few studies have examined the risk factors of GIB or its surgical management. Herein, we described our experience of a case of homicidal GIB, and compared the risk factors in our case with those in a recent review article.

Case Report

A 30-year-old female patient with no underlying disease was shot on her left forehead with a homemade handgun by her friend's husband at her home. She was sent to a nearby hospital with an initial Glasgow Coma Scale (GCS) of E1VeM3.

She was transferred to our emergency department (ED) with a GCS of E1VeM2, pupil size: 6.0-/-, and her vital signs were as follows: blood pressure (BP), 117/72; heart rate (HR), 86 bpm, and temperature, 34.8℃ (hypothermia). She had a small round open wound measuring approximately 2 × 2 cm over her left forehead, which was bleeding with the extrusion of brain tissue. Computed tomography (CT) revealed a comminuted fracture with several skull fragments within the left frontal lobe and a bullet in the right tentorium (Fig. 1). Right side subdural hemorrhage (SDH) with a midline shift of more than 5 mm to the left and diffuse pneumocephalus were also noted.

According to the CT image, the bullet

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passed through the left frontal lobe through the left lateral ventricle and right basal ganglion and stopped at the left tentorium just adjacent to the brainstem. However, SDH seems unrelated to the bullet's trajectory (Fig. 2). Due to the midline shift and pupillary dilation, mannitol (20 mg) and hyperventilation were applied owing to a high suspicion of increased intracranial pressure (ICP) and brainstem compression. Laboratory studies showed good hemoglobin levels, electrolytes count, coagulation profile, as well as renal and liver functions.

We performed emergent right-sided hemicraniectomy according to the image. However, when the dura was resected, the brain tissue swelled. The patient then became hypotensive (BP, 60/40 mmHg) in spite of hydration, transfusion, and administration of inotropic agents including norepinephrine and epinephrine, which was suggestive of brain stem failure. Although cardio-pulmonary-cerebral-resuscitation (CPCR) was performed, it was unsuccessful and the patient died 4 hours after the assault.

Discussion

GIB is relatively rare in Taiwan compared

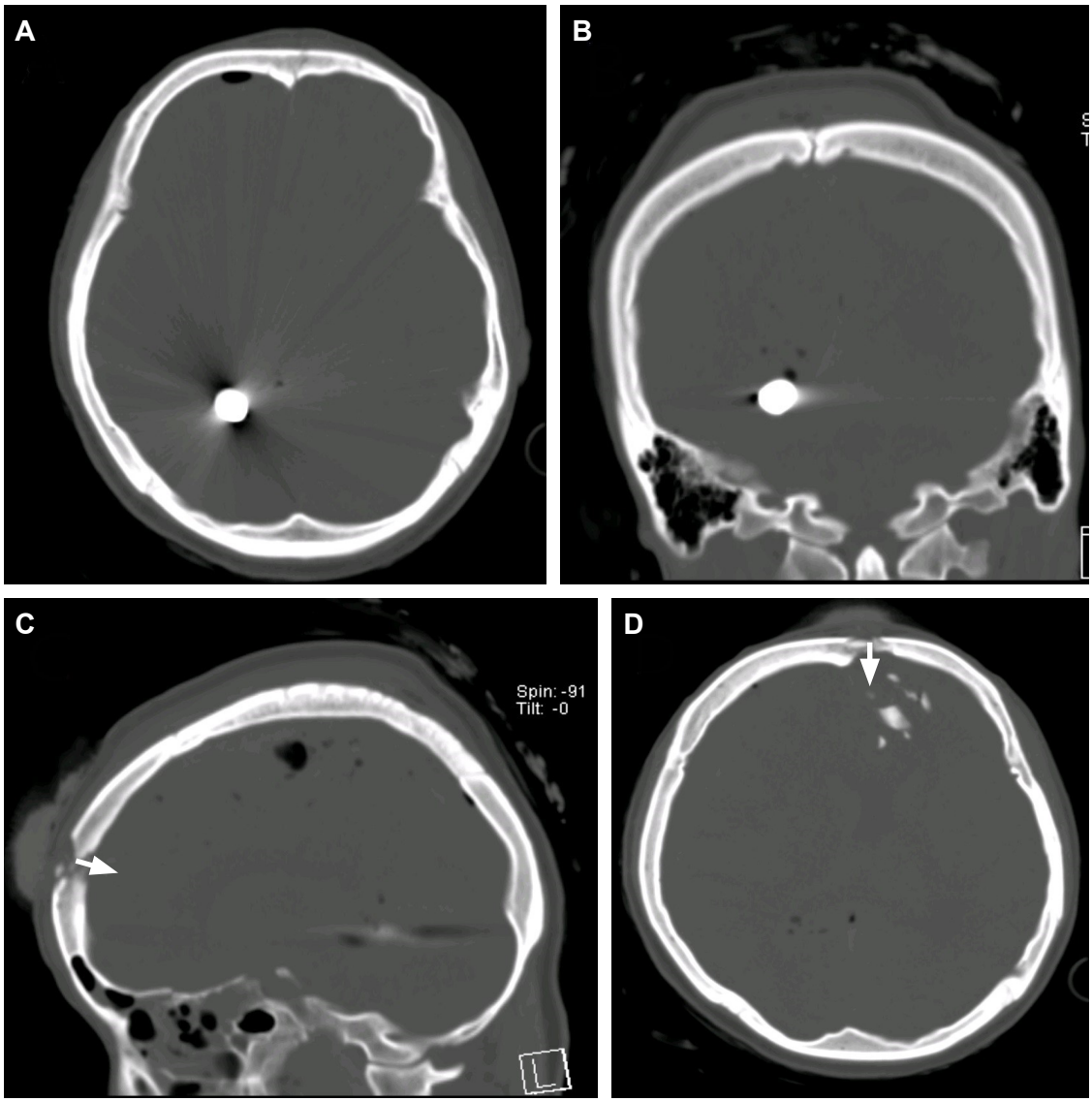

Fig. 1 (A) and (B) A hyperdense lesion over right side tentorium area. (C) and (D) Arrow demonstrated entry point from left frontal area and comminuted skull fracture with several skull fragments within left frontal area.

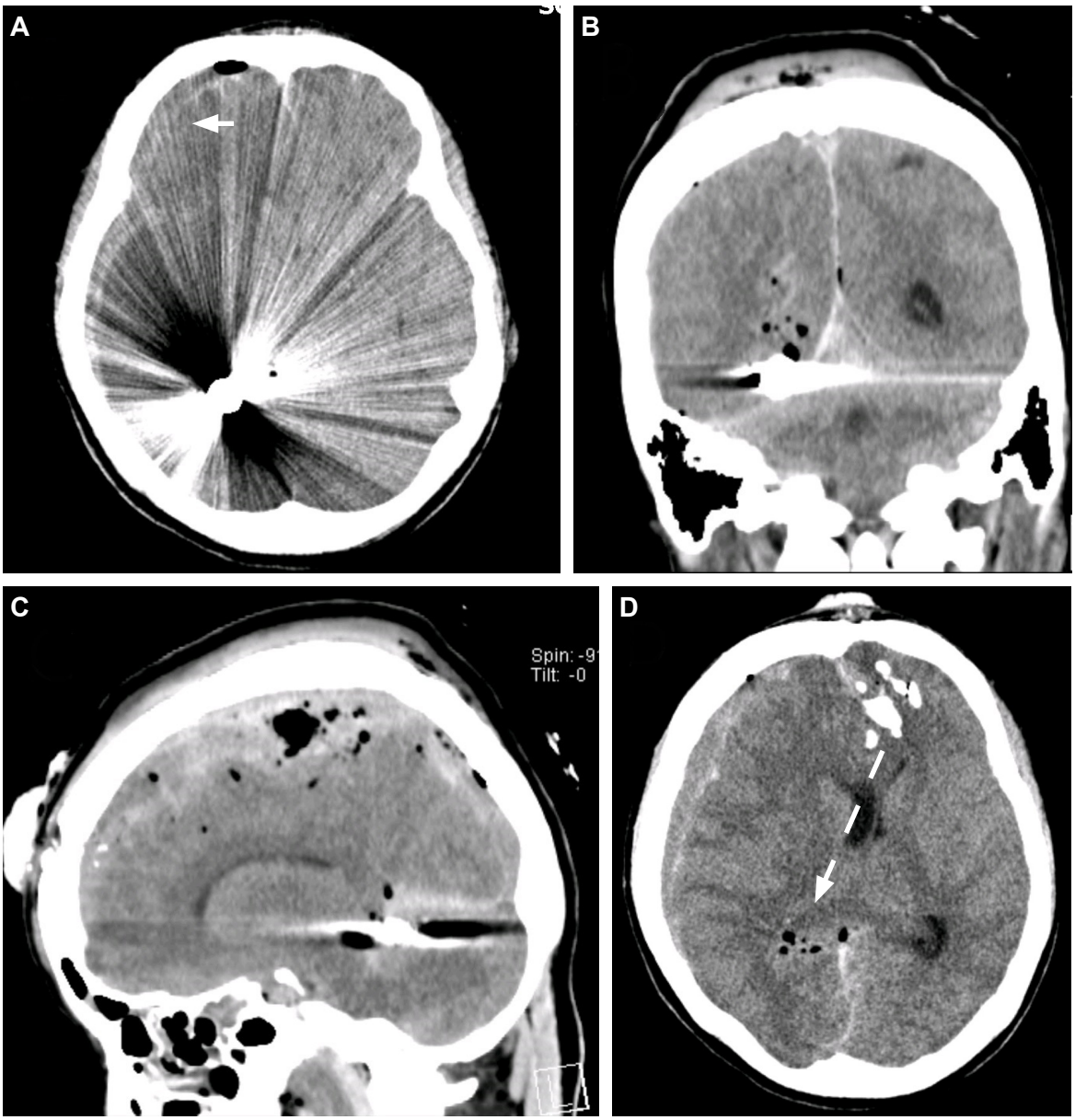

Fig. 2 Very high dense foreign body locate at right tentorium area just next to midbrain. (A) Right subdural hemorrhage and little left SAH. (B) And (C) showed much pneumocephalus over entry point at left frontal area and final position of the bullet. (D) The dash line showing possible trajectory from entry point to final position and also severe midline shift toward left.

to some western countries because of differences in gun ownership policies (Table 1). According to the literature,[1] the overall mortality related to gunshot injuries was 0.42 per 100,000 people in Taiwan. However, this rate is on the increase globally.[2] Previous studies have shown wide variations in mortality from < 10% to > 90%; however, mortality associated factors are unclear. Thus, we report this case with a review of relevant literature to share our perspective regarding the management of GIB.

According to a previous review,[3] several factors can cause brain injury due to gunshots. Direct bullet injuries include physical and hyperthermia injuries. Second, a distorted or ruptured vascular system may cause secondary ischemia. Third, comminuted skull fracture with a possible infective foreign body could cause diffuse delayed intracranial hemorrhage or an infective process. Finally, shockwaves cause diffuse coup or contrecoup injuries. Thus, when encountering GIB, a diffuse brain

Table 1. Showing mortality related to the gunshot per 100,000 people. High variation of gunshot related mortality can be seen between countries, but still low compared to mortality caused by other reason.

Country	Overall mortality	Homicidal assaults	Suicidal injuries	Accidents
America	9.00	2.98	5.75	0.27
Canada	4.78	0.76	3.72	0.22
Taiwan	0.42	0.13	0.12	0.11
Japan	0.07	0.02	0.01	0

injury is more likely than a single foreign body.

Frosen et al.[4] had collected data from 64 patients who were alive after GIB, and separated them into different subgroups according to the cause, shot distance, weapons used, GCS at admission, and image patterns on CT scans. They found several risk factors for the worst outcomes, including initial poor GCS (GCS < 8 at admission), penetrating trajectory through ventricles, or deep structures (basal ganglion, brain stem) injuries. The mortality rates for GCS > 8 and GCS < 8 were 0% and 92%, respectively. Mortality rates between cases with penetrating injuries to deep structures and those with no deep structure injuries (only lobar injury) were 83.3% and 37.5%, respectively. There was no difference in mortality with regard to midline shift or the presence of intracerebral hemorrhage (ICH). Although some patients survived GIB, the median Glasgow outcome scale (GOC) score was 3.

In our case, the initial GCS was E1V1M2, with the trajectory of the bullet passing through the left lateral ventricle and basal ganglion being the poor prognostic factor mentioned in the review article. Even though the patient's initial vital signs were stable and we promptly performed a right hemicraniectomy, the patient expired.

We shared our experience in managing a patient with GIB, even though our patient died despite aggressive decompressive surgery. Risk factors could be included in discussions with the family members of patients regarding the outcome of GIB and to evaluate patients preoperatively. Managing patients with GIB remains a challenging issue; nevertheless, we still suggest the use of aggressive treatment for patients with GIB who have few risk factors, as this may increase their chances of survival.

Conclusions

Patients with GIB have high mortality and morbidity rates, and surgical decisions remain challenging. We evaluated the patient using the factors listed above, such as GCS score at admission, bullet trajectory, and deep structure involvement to predict the patient's outcome.

Author Contributions

Study Design and Data Interpretation, Yu-Duan Tsai; Data Collection, Manuscript Preparation and Literature Search Cheng-Kai Lin. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study did not require ethical approval.

Informed Consent Statement

Not applicable due to patient mortality.

Data Availability Statement

Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

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