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Case Report

Delayed focal seizures following gunshot wound to the head in a child with minimal initial sequelae[☆]

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ABSTRACT

A 6 year old girl accidentally discovered a gun in her home and shot herself in her mouth. A bullet lodged in her right frontal lobe, but she remained neurologically intact with minimal symptoms. Her diagnosis was delayed due to the family leaving the emergency room for long wait times and later noticed over 72 hours from the injury at a dentist appointment. She was sent back to the emergency department, where head imaging revealed the injury to be inoperable. Six months later, the patient developed focal impaired awareness seizures. This was treated with oxcarbazepine, and patient responded well with no further spells. The case was highly unusual as the neurological symptoms were mild compared to the severity and the risk of initial intracranial injury. It emphasizes the frequently overlooked risk of leaving guns unsecured in households with children.

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Introduction

Gunshot wound to the head (GSWH) is an important etiology for morbidity and death in children [1,2]. GSWH is associated with mortality of 20%-65% in the pediatric population [3,4]. Few institutional case series or case reports have been reported in the literature [3–5]. We present the case of a 6-year-old girl who accidentally shot herself in the left side of the mouth. The bullet crossed the midline through the skull base and left frontal lobe and lodged in the right frontal lobe,

yet she exhibited minimal neurological symptoms despite the high morbidity and mortality rates typically associated with pediatric intracranial ballistic injuries [2–4].

Case presentation

A 6-year-old girl with a premorbid history of Attention Deficit Hyperactivity Disorder (ADHD) shot herself in the mouth while playing with an unsecured .22 caliber handgun at home.

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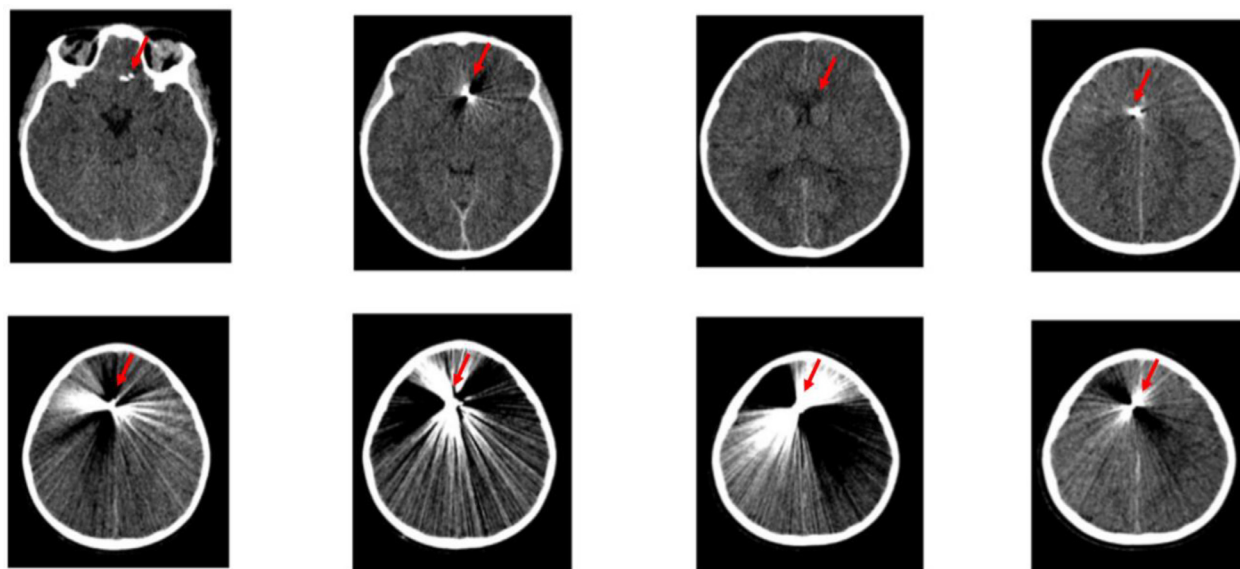


Fig. 1 – Head computed tomography (CT) without contrast showing the bullet track through the medial anterior frontal lobes with retained fragments along the track and larger bullet fragment superiorly in the right frontal lobe as indicated by the red arrows. There is an associated parenchymal contusion with small hemorrhage and edema at the genu of the corpus callosum and along the falx cerebri.

Her family found her shortly thereafter, conscious, with only dental trauma apparent. They denied knowledge of the injury and suspected she fell down from the bed. They brought her to a local emergency department (ED) after 48 hours due to facial swelling but left the ED without being seen due to prolonged wait time.

She subsequently was seen by a dentist 24 hours later, who noted the oral trauma and referred her back to the ED. Her initial Glasgow Coma Scale (GCS) was 15, and her vitals were within normal limits and stable. Additionally, her neurologic examination showed equal round and reactive pupils, intact cranial nerve examination, full strength, symmetric reflexes, and normal gait without focal neurologic deficits. In the ED, both head computed tomography (CT) without contrast and magnetic resonance imaging (MRI) of the brain without contrast were ordered simultaneously to evaluate oropharyngeal lesion noted at the dentist's office. Head CT without contrast revealed that the bullet passed through her left maxilla, skull base, and left cerebral frontal lobe with fragments coming to rest in her right frontal lobe (Fig. 1). The MRI of the brain was acquired prior to the read and report of the head CT, confirming the injuries were nonoperable (Fig. 2). A safety issue was raised by the neurology service with an interdepartmental morbidity and mortality conference to discuss the ordering of CT and MRI simultaneously as foreign bodies can migrate when exposed to the magnetic field of the MRI scanner. This conference resulted in additional safety protocols to reduce exposure of patients to the MRI scanner before the identification of foreign bodies by CT or plain film studies. Fortunately, she remained stable during her ensuing 10-day admission and was discharged without apparent deficits.

She again presented to an ED 6 months later with suspected focal impaired awareness seizures. The electroencephalogram (EEG) revealed right frontotemporal epilepti-

form discharges congruent with her known injuries. She was started on oxcarbazepine without seizure recurrence. At 3-month follow up she was doing well with no further seizures.

Discussion

The dangers of leaving firearms unsecured in households with children has previously been reported [6]. Greater than 50% of US household store a gun in an unlocked container and often loaded [7,8]. A survey in 2004 showed more than 1 firearm was held by over 20% US households and more than 3 firearms were held by about half of the firearm owners [9]. While gun ownership is not directly annually surveyed in every state, gun sales and suicides which proxy gun ownership by state have been rising from 2013 to 2022 [9–11]. Practices for safe gun storage include keeping the guns unloaded and locked up with ammunitions locked separately have been widely emphasized to reduce risk of injury to children at homes [7,8,12]. Education to parents and families through medical, social and other professional societies have been found to be effective [11,12]. Other steps that can be taken to reduce the injuries include legislative measures, refining the tools for screening the household availability of guns when there are children, providing free firearm storage devices, and economic incentives to keep safe firearm storage devices [1,12–14]. It should be noted that special care should be taken in households with children with ADHD who are at higher risk of head injury/traumatic brain injury compared to their peers without ADHD [15].

GSWH is a preventable cause of morbidity and death in children [1,2]. Survivors of GSWH often have comorbid seizures, cranial nerve dysfunction, weakness/paralysis, neu-

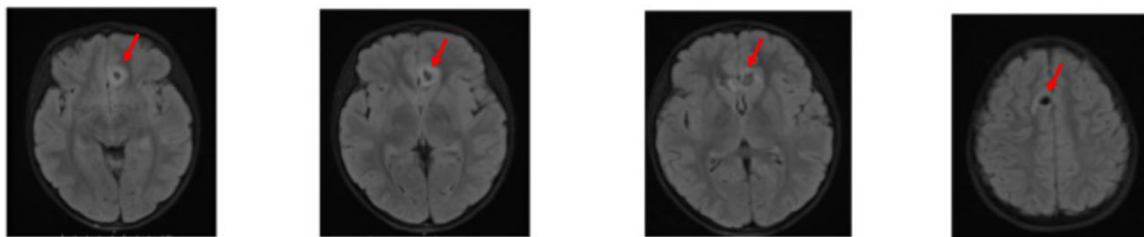


Fig. 2 – Magnetic resonance imaging (MRI) of the brain without contrast with T2 fluid attenuated inversion recovery (FLAIR) sequence showing findings consistent with the previously acquired CT with retained bullet fragments, blood, and acute penetrating injury from the gunshot wound entering the left anterior maxillary alveolar process and coursing superiorly into the brain parenchyma involving the left and right medial frontal lobes. The bullet track is highlighted by the red arrows.

rocognitive, and psychosocial deficits [3,16]. Penetrating head injuries including GSWH is a recognized etiology of acquired epilepsy [16]. Factors for poor prognosis in GSWH include bullets crossing midline causing cerebrospinal fluid leaks from ventricular injuries, penetration of 3 or more lobes, elevated intracranial pressure (ICP) of more than 30 cmH₂O, injury to third ventricle, and injury to the deep nuclei [3]. Relatively better neurological outcomes with reduced mortalities have been observed in the pediatric population experiencing GSWH compared to the adult population [3]. Reduced mortality in this age is likely due to younger age and neuronal plasticity [4].

Our case was highly unusual in that the patient had a GCS of 15 with stable vitals and intact neurologic examination at presentation and throughout the subsequent inpatient admission. She did remarkably well despite extensive intracranial injuries, including bullet fragments lodged in the brain. She had relatively spared neurologic functions and examination, likely due to a variety of reasons. The bullet trajectory injured predominantly the frontal lobes, which for her age were underdeveloped compared to adults [17]. She also was previously diagnosed with ADHD, which is associated with underlying dysfunction of executive functions of the prefrontal cortices, such that her acquired lesion from the GSWH may not have significantly impacted her neuropsychiatric examination due to her underlying condition [18,19]. Additionally, her eloquent cortices were not injured as these are posterior to the bullet tract [20]. She later had focal impaired awareness seizures confirmed with interictal EEG abnormalities, likely due to gliosis from her GSWH injury, that responded well to oxcarbazepine.

Few case reports have been reported in the literature with GSWH of this type with significant neurological recoveries. Doan et al. reported a young male of 18 years with GSWH to the left frontal region with the bullet exiting the right frontal region following a transventricular route and severe intracranial injuries requiring medical as well as surgical interventions such as external ventricular drain placement for elevated ICP, and decompressive craniectomy [4]. He survived with an eventually impressive neurological recovery [4]. Tandean et al. reported a similar case of a 12-year-old boy who was shot by a revolver while playing with his friends [5]. He sustained a bullet injury entering the mid frontal region and exiting from the right occipital region [5]. His initial GCS was 8, and his course was complicated by hydrocephalus requiring ventriculoperi-

toneal shunt and cranioplasty and eventually had a reasonable neurological recovery including return to daily school activities [5]. Coughlan et al. retrospectively reviewed a case series of 30 children with craniocerebral gunshot injuries with early posttraumatic seizures as the most common complication [21]. Despite these cases of impressive neurologic recovery in children largely owing to neuronal plasticity, GSWH remains both dangerous and preventable, and efforts must be taken by families and our community to mitigate these often devastating injuries [2,4].

Conclusion

This case of a young child with GSWH was remarkable due to the paucity of neurologic symptoms and the initial failure to recognize the severity of the injury. It highlights the danger of unsecured guns in households with children.

Ethical statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

Patient consent

Written consent was acquired from the family prior to drafting this manuscript.

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