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CASE STUDY

24 HOURS WITH AN INTRACRANIAL BULLET WITHOUT NEUROLOGICAL DEFICIT

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ABSTRACT

Gunshot injuries occur when oneis shot by a bullet or other sort of projectile from a firearm. Peace time gunshot injuries occur in a variety of different situations: criminal and terrorist incidents (including shots fired by law enforcement agents), attempted suicides as well as unintended firearm 'accidents' (both civilian and amongst the armed forces). Penetrating traumatic brain injury is the most lethal form oftraumatic head injury. Approximately 70-90% of these victims diebefore arriving at the hospital, and 50% of those who survive to reachthe hospital die during resuscitation attempts in the Emergency Department. We report a case of a 17 year old male patient whowas previously well.He wasaccidentally was shot on his head by a friend, he did not lose consciousness and neither did he have any seizures, but was complaint of mild headache. On examination, hemodynamically stable, he had a punctate scalp wound on the left temporal area anterior to the ear with crusted blood around it and no exit wound, his Glasgow coma scale was 15/15, hispupils were 3mm bilaterally andreactive to light, he had no cranial nerve deficit with normal conjugate eye movement,Motor and sensory examination was normal. He was communicating and mobilizing very well. Skull x-ray showed the bullet in the cranium. Unenhanced Computer Tomography (CT) scan of the brain confirmed the intracranial bulletin the suppratentorial space with hemorrhagic contusion in the left cerebellar hemisphere and posterior fossa pneumocephalus. There was effacement of sulci and gyri and no evidence of intraventricular hemorrhage. The patient was then admitted to a high dependency unit for observation with a diagnosis of penetrating head injury secondary to gunshot wound. He remained fully conscious and neurologically intact for 24hours after which his level of consciousnesssuddenly started deteriorating associated with vomiting; he passed on while he was being taken for repeat and futher imaging of the brain. A post mortem examination was consistant with the CT Scan findings including massive subarachnoid hemorrhage and brain swelling.

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INTRODUCTION

Cranio-Cerebral Gunshot Wounds (CCGW) are the most devastating injuriesin humans, affecting central nervous systemstructures, representing a real concern to the community as a whole (Federico C Vinas, 2009; Antic and Spaic, 2006; Rosenfeld, 2002). CCGW could be: penetrating - in which aprojectile breaches the cranium but doesnot exit it, made by low-velocity bullets asair rifle, projectiles, nail guns used inconstruction devices, stun guns used foranimal slaughter, shrapnel produced duringexplosions, but also perforating - in whichthe projectile passes entirely though thehead, leaving both entrance and exitwounds, by high-mass and velocity metaljacketbullets fired from military weapons,or guns fired from a very close range as inaggression or suicide attempts (Erdogan *et al*., 2002; Majer and Iacob, 2010).

Case presentation

We report a case of a 17 year old previously well male patient who was accidentally was shot on his head by a friend. The patient had visited his friend's house and while playing the friend took his father's pistol and started playing with it like a toy after which the friend accidentally shot the patient on his head, patient did not lose consciousness and neither did he have any seizures, but was complaining of mild headache, he was taken to a local hospital where subsequently was transferred to our emergency department.On examination, his blood pressure was: 110/68mmhg, pulse 67beats/minute,

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respiratory rate 18breaths/minute, temperature 36.1°C, oxygen saturation was 100% on free air, he waswell hydrated and had a punctate scalp wound on the left temporal area anterior to the ear with crusted blood around it and no exit wound, his Glasgow coma scale was15/15, hispupils were 3mm bilaterallyand reactive to light, he had no cranial nerve deficits and there was normal conjugate eye movement. His motor and sensory exam was normal. He was communicating fluently and could mobilise without any problems.Full blood count was normal with Hemoglobin of 13.5g/dl, White cell count 7.0x10^{11}, platelets 240x10^{9}, mean corpuscular volume 83. Urea and electrolytes: Sodium 136mmol/L, Potassium 4.1mmol/L, urea 3mmol/L, creatinin 59mmol/L.Skull x-ray taken showed a bullet in the cranium; CT scan brain confirmed the bullet placement in the suppratentorial space with hemorrhagic contusion in the left cerebellar hemisphere and posterior fossa pneumocephalus. The sulci and gyri were effaced and no evidence of intraventricular hemorrhage.Patient was then admitted to high dependency unitfor observation with a diagnosis of penetrating head injury secondary to gunshot wound and managed as per head injury management protocol, he remained fully conscious and neurologically intact for 24hours after which his level of consciousnesssuddenlystarted deteriorating associated with vomiting, he demised while was being rushed to the imaging suite for a repeat CT scan of the brain. A post mortem examination was findings of which confirmed the CT scan images in addition to massive subarachnoid hemorrhage.

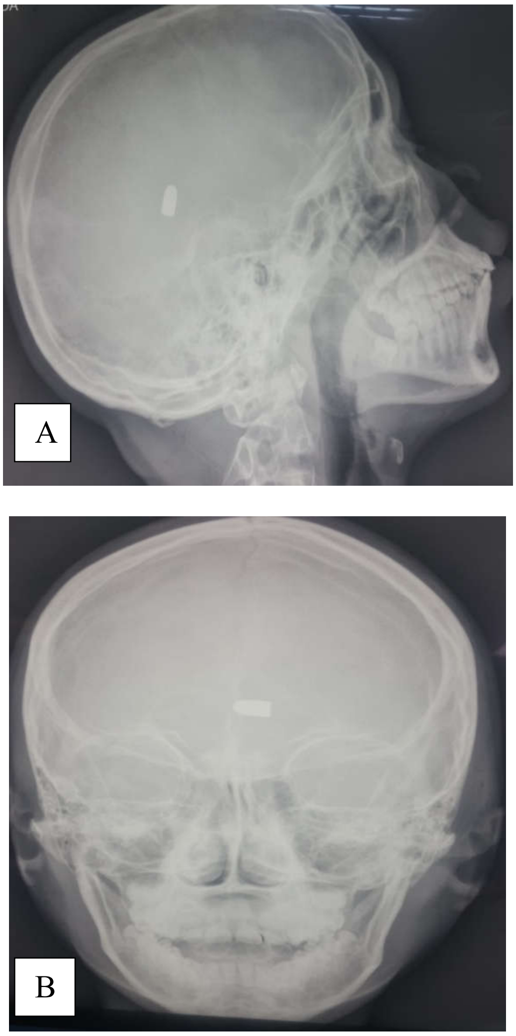

Figure 1. The skull X - ray (antero– posterior (B) and lateral views(A)) showing a bullet in the intracranium

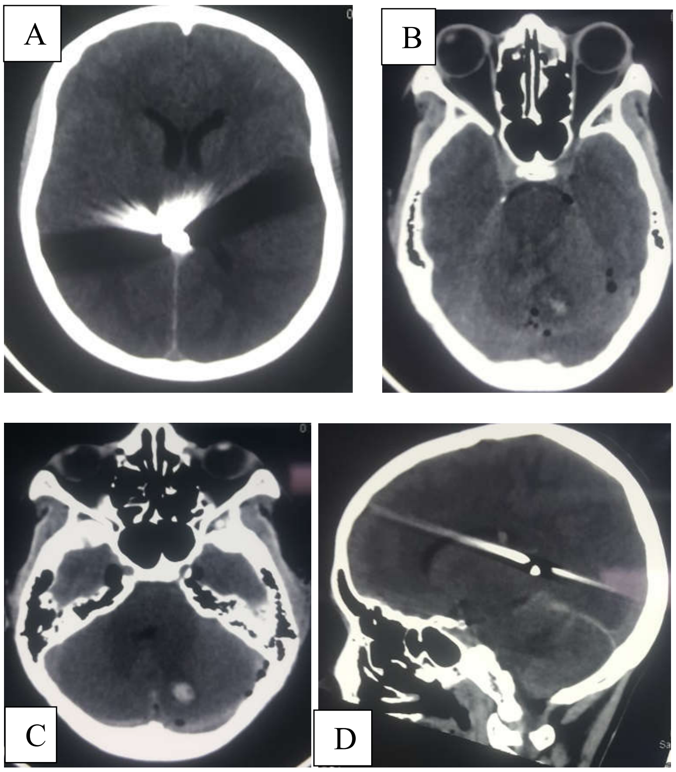

Figure 2. Axial CT brain without contrast the bullet in the midline; the bullet did not exit the intracranial cavity (A and D). A left sided intraparenchymal cerebellar hematoma is present with posterior fossa pneumocephalus (B and C). Diffuse sulcal effacement is appreciated in all images

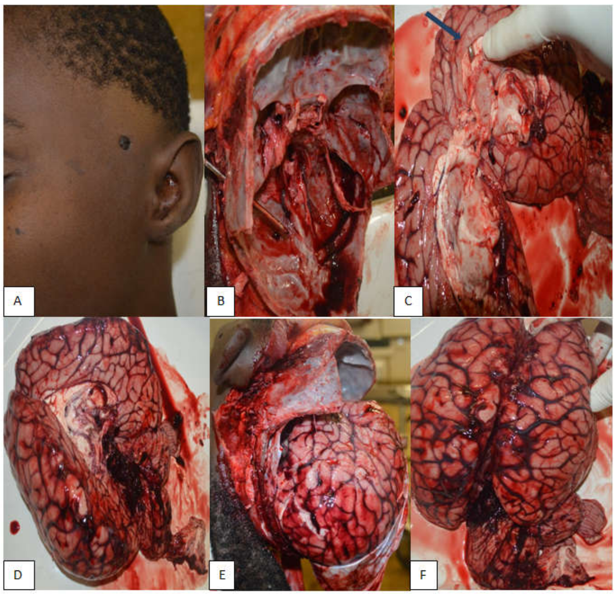

Figure 3. Post mortem pictures: punctured scalp wound, entry point (A), bony entry (B), bullet in the splenium of corpus callosum (bleu arrow) (A), subarachnoid hemorrhage with huge intracerebellar hematoma (D, E and F)

DISCUSSION

Traumatic brain injury (TBI) occurs when thebrain is damaged as a result of physical trauma. TBImay be caused by a penetrating (open) head injury, in which an object pierces the skull and enters thebrain tissue, or a closed head injury, in which the skull is, not breached (lker *et al*., 2009) and frequently results inthe major long-term disability of individualssurviving head injuries sustained in war zones.

Cranial gunshot wounds often result in severe injuryto the brain and related central nervous system (CNS) structures (Erdogan *et al*., 2002; lker *et al*., 2009). Such wounds can beclassified as tangential, perforating, or penetrating. The latter are the most devastating type ofmissile injury to the head. Penetrating gunshotwounds, especially those that cross the coronal ormidline sagittal planes, are usually fatal. Penetrating head injuries are becoming increasinglycommon as a result of the widespread availability offirearms. Civilian penetrating head injury is a leadingcause of morbidity and mortality and represents a significantpublic health problem. The severity of the injury isrelated to several factors, including velocity of the bullet,refraction of a bullet after hitting a hard structure, distanceof flight, caliber, and trajectory of passage through the cranium,expressiveness of the damaged brain, vascular injuryand bullet migration (Castillo-Rangel *et al*., 2010). Immediate intracranial injury occurs as the result of neuronal andvascular destruction caused by the projectile traveling throughintracranial tissues. Once the projectile strikes the head and transfersits kinetic energy to extra and intracranial tissues, destruction occursin tissue both in the projectile's path as well as in distant tissues outsidethe projectile's trajectory. Permanent cavitation occurs in tissuesdirectly in the projectile's path, but sonic waves followed by pressurewaves of as much as 30 atmospheres produce temporary cavitation (Aarabi *et al*., 2015).

Expansion and retraction of the temporary cavities cause distantpunctate hemorrhages and neuronal membrane disruption. The resultis a rapid rise in intracranial pressure (ICP) as hematomas enlarge, andcerebral edema increases as early as 30 minutes after the initial injury (Blissitt, 2006). Concurrently, cerebral perfusion pressure decreases andinfarction can follow. If severe, herniation can occur (Van Wyck *et al*., 2015). The utility of various neuroimaging methods used in patients with Penetrating brain injury (PBI) lies on the potential management and prognosticimplications of these modalities (Neuroimaging in the management of penetrating brain injury, 2001; Offiah and Twigg, 2009). Important findings include: entry and exit sites; intracranial fragments; missile track and itsrelationship to both blood vessels and air-containing skull-basestructures; intracranial air; transventricular injury; basal gangliaand brain stem injury; missile track crossing the midline; multilobarinjury; basal cisterns effacement; brain parenchymalherniation and associated mass effect (Neuroimaging in the management of penetrating brain injury, 2001; Offiah and Twigg, 2009).

Neuroimaging is vitalfor surgical decision making, the type of surgery, the size and siteof craniotomy, the route for extraction of foreign body, etc. aswell as the decision to choose non-surgical management, whichis also not uncommon in PBI (Kazim *et al*., 2011). Plain radiographs of the skull can be of considerable valuein identifying the cranial wound (s), the location of missileand bone fragments, and the presence of intracranial air. However, evaluating the projectile trajectory withplain radiographs alone can be misleading in the presenceof intracranial ricocheting or fragmentation (Neuroimaging in the management of penetrating brain injury, 2001). Besides, theavailability of computed tomography (CT) scanning largelyprecludes the use of plain radiography, and it is not routinelyrecommended. Computed tomography (CT) scanning of the head is now theprimary modality used in the neuroradiologic evaluation ofpatients with PBI. This is because CT scanning is quick andprovides improved identification of in-driven bone and missilefragments, characterization of the missile trajectory, evaluationof the extent of brain injury, and detection of intracranialhematomas and mass effects (Kazim *et al*., 2011). Magnetic resonance imaging (MRI) is generally not recommendedfor use in the acute management of PBI, as it is time consumingand can be potentially dangerous when there are retainedferromagnetic objects because of possible movement of theobject in response to the magnetic torque (Gutiérrez-González *et al*., 2008). However, MRI canbe a useful neuroradiologic modality, if the PBI is caused by awooden object (Green *et al*., 1990). Cerebral angiography (either CT or catheter) is recommendedin patients with PBI where there is an increased risk of vascularinjury. This would include those cases where the wound'strajectory is through or near the Sylvian fissure (location of M1and M2 segments of the middle cerebral artery), the supraclinoidcarotid artery, the vertebrobasilar vessels, the cavernous sinusregion or the major dural venous sinuses.Peripheralbranches of the middle cerebral artery followed by the anteriorcerebral artery are more vulnerable in craniocerebral penetratinginjury than the internal carotid artery. The developmentof otherwise unexplained subarachnoid hemorrhage (SAH) ordelayed hematoma could also suggest the presence of a vascularinjury, and thus warrant angiography (Kazim *et al*., 2011; Vascular complications of penetrating brain injury, 2001). Surgical treatment consists of adequate debridement of allgrossly necrotic tissue, removal of significant intracranialhematomas, and easily accessible bone and metallic fragments. Overaggressive debridement and repeat operationssolely for the purpose of removing retained fragments iscurrently contraindicated (James M. Ecklund and Panayiotis Sioutos, 2014).

The surgical treatment of penetrating brain injury has evolvedsignificantly over the past century. Prior to 1889, pTBI patients did nottypically undergo surgery due to ineffective hemostasis and poor postoperativeinfection control (Assassination of Abraham Lincoln and the Evolution of Neuro-Trauma Care). Dr. Harvey Cushing was the first todevelop a formal approach to the management of pTBI, and advocatedcomplete removal of metallic and bone fragments, as well ascraniectomies to relieve ICP. Radical debridement continued to bestandard throughout World Wars I and II, the Korean War, and theVietnam War. (Assassination of Abraham Lincoln and the Evolution of Neuro-Trauma Care; Jallo and Loftus, 2009) In the 1980s during the Israeli-Lebanon conflict, however, a shift was made toward conservative debridement in aneffort to preserve as much cerebral tissue as possible. The results, according to Brandvold *et al*., were similar with regard to acute andchronic outcomes as compared to soldiers who underwent radicaldebridement in the Korean and Vietnam conflicts (Van Wyck *et al*., 2015). The mostrecent conflicts in Afghanistan and Iraq have resulted in furtherrefinements to surgical management with a trend toward earlydecompression with conservative debridement and duroplasty. This approach appears to yield improved survivability not seen in priorconflicts (Van Wyck *et al*., 2015; Aarabi *et al*., 2014; Rosenfeld and Cooper, 2010). A challenging aspect to the surgical management of pTBI is theselection of appropriate surgical candidates. There is extensiveliterature that has attempted to identify which patients may benefitfrom surgery. Poor prognostic indicators have previously beenidentified as old age, low admission GCS, abnormal pupil reactivity, bihemisphericinvolvement, path of the projectile, and loss of the basalcisterns on imaging (Jallo and Loftus, 2009; Rosenfeld *et al*., 2015).

A GCS of 3-5 and/or a projectile pathcrossing the midline at the level of the corpus callosum, through thebilateral thalami, basal ganglia posterior fossa/brainstem or through anarea 4cm above the dorsum sellae containing the vessels of the Circleof Willis known as the "zonafatalis" has historically resulted in thewithholding of surgical care (Martins *et al*., 2003) like in our case we opted for conservative management as the bullet was deep seated, reached the midline at the level of corpus callosum, crossed the posterior fossa and part of basal ganglia. Lateral penetrating injuries haveworse outcomes when compared with antero-posterior injuries like in our case (Jallo and Loftus, 2009). Another common indicator, the "tram track sign" or a hypodensewound track with hyperdense blood on either side has been associatedwith poor outcomes (Rosenfeld *et al*., 2015). Tram track signs are more common with lowcaliber projectiles. With modern surgical and intensive caremanagement, however, some series have shown markedly improvedsurvival rates even in those with the low post-resuscitation GCS scores (Weisbrod *et al*., 2012). Mortalityrates are higher in patients with penetrating braininjuries compared to those with closed brain injury. In one study, patients with penetrating braininjuries were approximately seven times morelikely to die compared to closed brain injuredpatients.

Conclusion

One of the first challenges in managing patients with guns hot wounds (GSW) to the head is determining whether any intervention will result in an outcome thatis acceptable to the patient, family, and society. This generallyrequires an individualized approach because the definition of anacceptable result can vary with different patients and families. Itcan also be partially dependent upon the resources available for rehabilitative and supportive care in individual societies.

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