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Case Report

Pediatric Cranioencephalic Trauma of Ballistic Origin

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Abbreviations
GCS - Glasgow coma scale
GOSE - Glasgow Outcome Scale-Extended

Abstract

We report 2 cases of stray bullet injury to brain in children of age 3 months and 7 years respectively. One of them had an occipital penetrating wound (with no exit) and the other had trans-temporal wound (with both entry and exit points). The delay in doing a CT scan was 1 and 8 days respectively. The average duration of surgery was 80 min. The average time to complete control imaging was 18.5 days. Follow-up imaging showed cerebral swelling and re-bleeding in one patient while it was unremarkable in the other child. Pediatric head injuries due to firearms are very rare, but with high morbidity and mortality. Their management in limited resource settings is challenging.

INTRODUCTION

Head injuries caused by firearms are often fatal but fortunately rare in the pediatric population. However, their incidence in civilian population has increased in recent years due to a surge in armed conflicts, urban banditry and terrorism.[1-3] About 5 to 13% of injuries in France are due to weapons and 1% of all victims had gunshot wounds. They are common in the head, neck and trunk.[2] In this report, we present our experience in managing two children with ballistic head injury.

CASE PRESENTATION

Case 1

An 3-month-old male infant was referred in an unconscious state from Likasi to Lubumbashi (126 km distance; 3hr-10min travel). He developed sudden cry and bleeding from the temporal scalp during sleep.(Fig. 1) The history is suggestive of injury due to stray bullet (which would have entered the bedroom through the ceiling). Initial resuscitation had been done at a near-by hospital. Blood transfusion, intravenous fluids, paracetamol, phenobarbitone and wound dressing had been given. Onset of unconsciousness prompted referral after 24hr.

On arrival at our center, his pediatric Glasgow Coma Score (GCS) was 7/15. He had hypotonia, bilateral miosis, flat anterior fontanel and a head-circumference of 41cm. There was a trans-temporal wound (having both entry and exit points) with extrusion of brain matter. His injury was classified as Matson grade IV-D. The s100 beta

protein was < 0.05µg/l. Pulsatility index was 3 and diastolic velocity was 7. On the second day of hospitalization a CT scan revealed multiple areas of brain edema and hemorrhagic contusion of both parietal lobes, subarachnoid hemorrhage, pneumocephalus and comminuted fracture of the left temporal bone. (Fig.2) Multidisciplinary management involving a neurosurgeon, neurologist, anesthesiologist and critical care specialist was started. Mannitol, normal saline, antibiotics (gentamicin, ceftriaxone, metronidazole), proton pump inhibitor, phenobarbitone, midazolam and oxygen by oro-tracheal tube were given.

Fig 1. *Photograph (case 1) showing temporal wound*

A surgical operation was performed on the second day of admission. Debridement and closure of the scalp wound was done. Post-operative period was marked by tachycardia, anemia (Hemoglobin 8.8 g/dl), hypoalbuminemia (2 g/dl), hypocalcemia (7.9 mg/dl), wound infection, cerebral ischemia, re-bleed and meningitis. Two episodes of cardiac arrest were successfully revived. Eventually, he recovered. On clinical evolution 2 months after the injury, he was well with a Glasgow Outcome Scale-Extended (GOSE) score of 3.

Case 2

A 7-year-old male child, with no particular history of injury, was referred in unconscious state from Fungurume to Lubumbashi (200 km distance; 3hr-20min travel by road). Ten hour before admission he suddenly developed scalp bleeding while playing with his friends and it was followed by a brief period of loss of consciousness. He also vomited several times and developed seizures. He appeared to have been injured by a stray bullet. Skull radiograph done at another hospital showed a metal foreign body (bullet) inside the brain.(Fig.3)

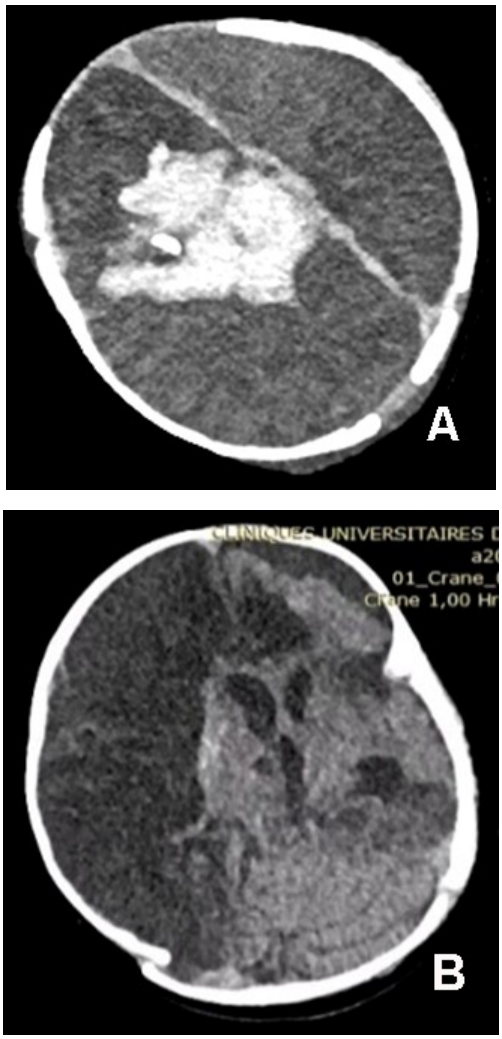

Fig 2. *CT scan (Case 1) showing intra-cerebral bleed (A) and fronto-temporal brain edema (B)*

On arrival, his GCS was 4/15. The pupils were equal and reacting. There was a contused wound of 5 cm diameter (entry wound without an exit point) in the right parietal area. A CT scan of the brain on the day-8 of injury revealed a bullet in the left temporal lobe. The right posterior parietal cortex was contused and edematous with associated temporal bone fracture. Diastolic velocity was 7 and pulsatility index was 3. The s100 beta-protein was < 0.05µg/l. A multidisciplinary treat-

ment was started. Normal saline, mannitol, paracetamol, tramadol, ceftriaxone, metronidazole, sodium valproate and vitamin C were given. On the post-traumatic day-25, the bullet was surgically extracted by trans-cortical approach. Post-operative recovery was uneventful. (Fig. 4) He stayed in the hospital for 40 days.

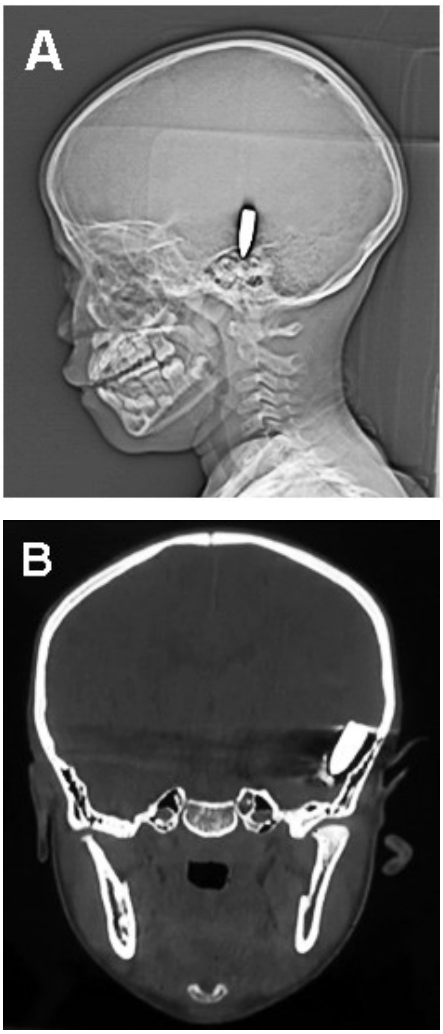

Fig 3. *Plain skull x-ray (A) and CT reconstruction of coronal section (B) of the case 2 showing a bullet in the left temporal brain*

At follow-up 2-months later, his Blantyre score was 5 with a slight ptosis of the left eyelid. He could move all 4 limbs spontaneously; but there was hypertonia of central origin. By then, the surgical wound had healed well and the GOSE score was 3.

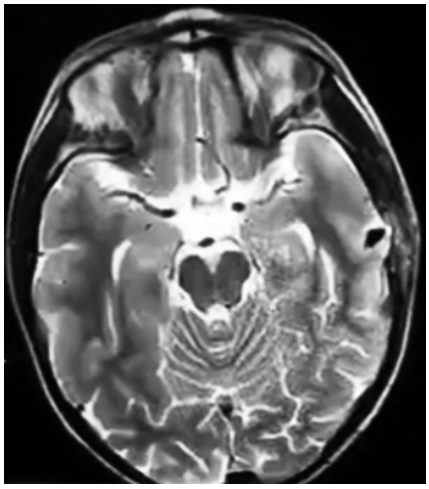

Fig 4. *Follow-up MRI (T2 sequence, axial section) of the case 2, done after 15 days of treatment, showing residual hypodense lesion in the left basi-temporal zone.*

DISCUSSION

Cranioencephalic ballistic injuries are medico-surgical emergencies with a high morbidity and mortality, especially in resource-limited settings. Plasticity of the pediatric brain enables its quick recovery from serious injuries, unlike that of the adults. Therefore, the approach to ballistic head injuries is distinctly different in children.[1-3]

Pediatric head injuries due to firearms are rarely reported in the literature.[1-7,9-11] The mean age of victims is 8.9 years (range 1.6 to 15 years).[1,9] The mean delay in hospital admission is generally prolonged in resource-constrained settings (mean 23hr-43min; range 1 - 65 hours). This is often due to the long distance between the scene of the incident and the specialist surgical center, lack of emergency medical evacuation services and the poor condition of roads. In our hospital, we see more and more of young victims with an average age of 3.6 years (range 3 months - 7 years). The circumstances of firearms injury are exceptional in civil practice (stray bullet). The average delay in specialist consultation is 17 hours (range 10 - 24 hours). The mode of transport of our patients was variable (ambulance or private car) contrary to the literature where patients benefited from the

services of the SAMU (Service d'Aide Médicale Urgente) or the fire brigades.[1,9-11]

Head injuries from firearms are serious with an average Glasgow Coma Score of 7.5 (range 6-9) in the literature.[1,9,13] It was 7 and 14 in our patients respectively. The circumstances of bullet injury in our patients were mysterious. It must have been stray bullets.

As with any head injury, a CT scan is the imaging of choice for the initial assessment. In addition to its availability and low cost, it provides a good demonstration of bone fractures and intracranial hemorrhages.[5] The two main limitations of this technique are artifacts caused by metallic bullets and patient movement. Multi-detector scanners have made it possible to considerably reduce the acquisition time and therefore the movement artifacts. In parallel, the adaptation of acquisition parameters and improvements in reconstruction algorithms have reduced metal artifacts.[3,4,6-9,12] In our patients, the CT scan had been done with a delay of 1 and 8 days respectively.

Management of cranioencephalic ballistic injuries is multidisciplinary involving critical care resuscitators, neurosurgeons, neurologists, physiotherapists and psychologists. The treatment is medico-surgical according to the symptomatology of the patient. The surgical management is controversial as well as challenging.[6,8,12] Some authors prefer minimal local debridement maintaining as much brain tissue as possible, while the others tend to avoid surgery altogether.[8,9] surgical operation may include decompression craniotomy,[11] craniectomy with removal of bone chips, conservative surgical debridement, extraction of the bullet, a water-tight dural closure and providing a skin coverage.[1]

Alvis-Miranda et al[12] summarize the treatment of ballistic head injuries in 4 steps: (1) Immediate saving of life through the control of bleeding and cerebral decompression, (2) Prevention of infection, by extensive debridement of all the contaminated, macerated or ischemic tissue, (3) Prevention of meningo-cerebral scars, (4) Restoration of dural and skin coverings. In our patients, surgical debridement and bullet extraction were indicated. It was done by craniotomy trans-cortical approach with the patients in supine position under general anesthesia and endotracheal intubation. The duration of surgery ranged between 90-130 min.

The severity of ballistic trauma depends on its clinical consequences, the site of injury and the lesion mechanism. Thus, unstable hemodynamic status, injuries involving the neck, trunk (esp. the heart) or groin, injuries by high-velocity bullets or hunting weapons, short-range firing injuries are indications of immediate surgical exploration.[10] The prognosis is variable depending on the expertise of the surgeon, occurrence of infection, surgical accessibility of the lesion site, the type of weapon used, the shooting distance, the age of the patient, the clinical status (e.g. GCS), the ballistic trajectory and the brain scan findings.[6] The additional prognostic factors in our setting are random shooting, low socio-economic level, delay in surgical consultation and insufficient technical platform.

Complications of ballistic head injury may be primary or secondary. Primary complications occurring at the time of original injury include bone fractures, intracranial hemorrhages, cerebral edema, cortical damage, pneumocephalus and pneumo-ventriculia.[6] Secondary complications include associated trauma of other organs, infections (e.g. extracranial soft tissue infection, skull osteomyelitis, meningoencephalitis and ventriculitis), post-operative vascular events (intracranial re-bleed, cortical ischemia due to vessel damage), false aneurysms due to arterial wall laceration, secondary displacement of bullet, hydrocephalus, epilepsy and encephalomalacia.[6,8,12]

CONCLUSION

Ballistic head injuries in children are very rare and serious, with a high morbidity and mortality, especially in resource-limited settings. In our center considerable delay in specialist consultation and inadequacy of technical platform are additional prognostic factors that need to be addressed.

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