Global Scientific JOURNALS

GSJ: Volume 5, Issue 12, December 2017, Online: ISSN 2320-9186
www.globalscientificjournal.com

# AN APPROACH TO NEURO-TRAUMA IN LIBERIA- A CASE SERIES OF OPEN SKULL FRACTURE AND BRAIN EVISCERATION INVOLVING FOUR PATIENTS

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**Abstract**

Head injuries and skull fractures are on a steep rise worldwide. Road traffic accidents are the major cause of skull fractures secondary to the rise in road traffic accident. Out of these, many skull fractures presented as open skull fractures with brain matter being exposed into wound.

**Objective:** We present a case series of four cases of Open Depressed Skull Fracture with Brain Evisceration to share our clinical experience, management approach and outcome in Liberia and compare it with available literature and practice worldwide.

**Methodology**: Over six months (January 2017 to July 2017), we managed four cases of Open Skull Fracture with Brain Evisceration.

**Results:** There were 2 males and 2 females that sustained open skull fracture and brain evisceration. Three of the four cases on admission were hemodynamically stable while one was in hemorrhagic shock. All the patients in the series were unconscious on admission with a GCS below 8/15. Two of the patients with bilateral non-responsive pupils died. All the patients received wound irrigation and debridement with gentle removal of the damaged mater. All patients had primary dural closure. No cranioplasty was performed. Two patients survived without permanent neurological sequelae.

**Conclusion:** The management of Open Skull fracture and Brain Evisceration is a neurosurgical emergency. In the absence of a Neurosurgeon, proper irrigation, debridement of devitalized tissues and removal of damaged eviscerated brain mater is crucial. Primary watertight dura closure is advised to avoid cerebrospinal fluid leakage.

**Abbreviations- CSF: Cerebrospinal Fluid, ER: Emergency Room, GCS: Glasgow Coma Scale, ICP: Intacranial Pressure,**

**Keywords: Calvarium, Cranioplasty, Duraplasty, Evisceration, Hemodynamic, Neurosurgeon, Skull Fracture**

**Introduction**

Head injuries and skull fractures are on a steep rise worldwide. Road traffic accidents are the major cause of skull fractures secondary to the rise in vehicular traffic (1, 2), the high speeding vehicles and drunk driving (2). Out of these, many skull fractures presented as open skull fractures with brain matter being exposed into the wound (2). Depressed skull fracture is a very serious type of trauma occurring in 11% of severe head injuries and may be comminuted in which broken bones are displaced inward (14). Compound depressed fractures are those in which the dura mater is torn (15). Compound depressed fracture poses significant challenges to Neurosurgeon regarding their definite management. Cranioplasty of the frontal orbital region is a major challenge to the surgeon because of the proximity to the globe, the sinuses, the eyebrows and eyelids (18). Inadvertently, fracture segments are removed in emergency which worsens the cosmetic problem (17). Rarely, pulling out the fracture segment may damage vital parts of the brain and lead to neurological deficit or may cause profuse bleeding, when close to a major dural sinus (17).

**Objective:** We present a case series of four cases of Skull Fracture with Brain Evisceration to share our clinical experience, management approach and outcome in Liberia and compare it with available literature and practice worldwide.

**Methodology**

Over the past 6 months from (January 2017 to July 2017), we managed four cases of Open Skull Fracture with Brain Evisceration. Three of these patients were treated at the John F. Kennedy Medical Center, Liberia premier referral center while one of the patients was treated at The ELWA Hospital, a missionary hospital in Liberia. All the Patients were seen by a Surgical Resident supervised by a General Surgeon. None of the facility has a Neurosurgeon. All the patients came as neurosurgical emergency and could not be sent for imaging preoperatively. A patient with systolic blood pressure below 90mmHg was considered hemodynamically unstable. A CT-scan could not be done as it is not available in these facilities. None of the patients could be placed on ventilators postoperatively as it is not available in both facilities.

**Case 1**

A 6yr old female was rushed into the ER by relatives with complaint of bleeding from a right open frontoparietal skull wound after allegedly being shot in the head with a shotgun by an 11yr old male playmate. There was immediate loss of consciousness following the incident with bloo oozing from the site of injury but no reported seizures. She brought to the ER within 1 hour of her injury. Patient was met lying with blood stained clothing. She was hemodynamically stable on arrival. Her neurological exam revealed a modified Glasgow Coma Scale (GCS) of 7/15 (Best Eye: 1, Best Verbal: 1, Best Motor: 5) dilated right pupil weakly reactive to light with left upper limb monoplegia Knee. There was an opened right temporo-parietal skull injury 4cm/5cm in diameter with evisceration of cortical brain tissue about 20 grams of tissues, cerebrospinal fluid leakage, with active scalp bleeding. She was diagnosed of Open Frontoparietal Skull Fracture with Brain Evisceration 2nd Gunshot. Secretions and blood were suctioned from the airway with saturation at 96% on room air. She was given 20ml/kg bolus of normal saline and started on intravenous Ceftriaxone. An informed consent form was acquired as the

patient was rushed to the operating theater. Under general anesthesia endotracheal intubation, the wound was irrigated with normal saline. The eviscerated brain mater was gently removed. The wound edges were debrided with removal of some pellets and bony fragments. Primary dura repair was performed with interrupted absorbable sutures. The scalp was closed with interrupted 2.0 nylon. Cranioplasty could not be achieved. Postoperatively, she was started on anticonvulsants and mannitol with continuation of antibiotics. Her immediate postoperative course was remarkable for left hemiplegia with GCS of 7/15 but no seizures or fever. She recovered gradually over a period of 10 days without any neurological sequelae. Her mini mental examination was unremarkable.

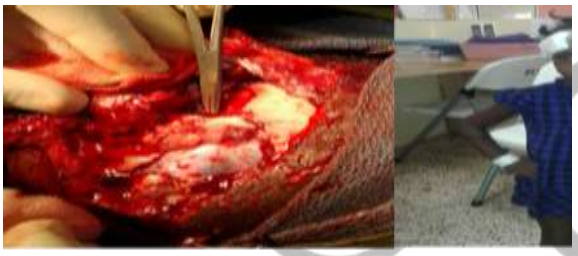


**Figure 1. Panel A** shows open frontoparietal skull injury with evisceration of brain tissue. **Panel B** shows full recovery of (case 1).

**Case 2**

A 10 year was rushed into the ER by relatives with bleeding from an open left frontal skull wound. He was a motorbike passenger involved in a head-on collision with a speeding truck. He lost consciousness at the scene with two episodes of tonic-clonic generalized seizures. He arrived at the hospital within 3 hours of the incident hemodynamically unstable with a GCS of 5/15 (Best Eye: 1, Best Verbal: 1, Best Motor: 3) bilateral dilated pupil poorly reactive to light. There were findings of otorrhagia, rhinorrhagia, periorbital ecchymosis with an open Left fronto-orbital skull injury with evisceration of about 30 grams of tissue. Patient was diagnosed of Open Left Fronto-orbital Skull Fracture with Brain Evisceration complicated by Basal Skull Fracture and Hemorrhagic Shock. In the absence of a ventilator and saturation of 85% on room air, she was given 10 liters of oxygen per nasal prong with repeated suctioning of the airway. Two 18-gauge cannula was opened with 20ml/kg of normal saline boluses given. Two units of O-RH negative blood product was mobilized from the blood bank. Hemostasis was achieved along the bleeding scalp after irrigation and removal of damage tissue followed by primary closure of the dura mater and scalp tissue in the ER. He was started on anticonvulsants and intravenous Ceftriaxone. He died of Fatal Brain Damage within 30 minutes of hospital stay.

**Figure 2**. show an open fronto-orbital skull fracture with evisceration of brain tissue and periorbital ecchymosis. (Case 2).

**Case 3**

A 15-year-old female presented through the ER unconscious with open left fronto-parietal skull wound an hour before presentation after her head was inadvertently pull into a sawmill. No history of seizure, otorrhea or rhinorrhea was reported with the incident. She arrived hemodynamically stable but a GCS of 7/1515 (Best Eye: 1, Best Verbal: 1, Best Motor: 5) dilated left pupil non-reactive to light with right hemiparesis 2/5. She had an open left frontoparietal skull fracture with evisceration of about 20 grams of brain mater and CSF leakage. She was diagnosed of an Open Left

Frontoparietal Skull fracture with brain evisceration. She was given initial intravenous doses of tetanus toxoid, ceftriaxone, phenobarbital, fluid and prepared for emergency surgery. The wound was irrigated and debrided of debris and bony fragments. Primary dura repair was performed with continuous absorbable sutures. The scalp was closed with interrupted 1.0 nylon. Cranioplasty was not possible. Postoperatively, the anticonvulsants, along with the antibiotics were continued and mannitol was served in boluses. Her postoperative recovery was speedy and was discharged home in two weeks without neurological deficit.

**A** **B**

**Figure 3. Panel A:** Open left frontoparietal skull fracture with brain evisceration. **Panel B**: Full recovery (Case 3).

**Case 4**

A 40-year-old male was brought in unconscious through the ER with a right open fronto-orbital wound 2 hours before presentation. He was a motorbike passenger involved in a head-on collision with a moving vehicle. Otorrhea and rhinorrhea was reported during the incident but no seizures. He came in hemodynamically stable but GCS of 5/15 (Best Eye: 1, Best Verbal: 1, Best Motor: 3) bilateral nonresponsive pupil. There were findings of CSF otorrhea and rhinorrhagia, with an open right fronto-orbital skull injury with evisceration of about 25 grams of tissue. Patient was diagnosed of Open Right Fronto-orbital Skull Fracture with Brain Evisceration complicated by Basal Skull Fracture. He received intravenous doses of tetanus toxoid, ceftriaxone, phenobarbital, fluid and prepared for operating theater. Under general anesthesia endotracheal intubation, the wound was irrigated and debrided of debris and bony fragments. The dura was repaired with continuous absorbable sutures. The scalp was closed with interrupted 2.0 nylon. Cranioplasty was not possible. He remained unconscious and died 7 hours postoperatively due to fatal brain injury.

**Figure 4.** Open Right fronto-orbital Skull Fracture in a 40-year-old male. (Case 4)

**Results**

| Case Series | Age | Sex |
|---|---|---|
| Case 1 | 6 years | Female |
| Case 2 | 10 years | Male |
| Case 3 | 15 years | Female |
| Case 4 | 40 years | Male |

**Table 1. Demography:** There was an equal male to female ratio as three of the patients were in the pediatric age range with one middle age adult.

| | Mechanism of Injury |
|---|---|
| Case 1 | Tangential Gunshot Injury |
| Case 2 | Motorbike-Vehicle head-on collision |
| Case 3 | Penetrating Sawmill Injury |
| Case 4 | Motorbike-Vehicle head-on collision |

**Table 2. Mechanism of Injury:** Two of the injury sustained were the result of motorbike-vehicle accident.

| TOPOGRAPHY OF OPEN SKULL FRACTURE | |
|---|---|
| Case 1 | Right Frontoparietal |
| Case 2 | Left Fronto-orbital |
| Case 3 | Left Fronto-parietal |
| Case 4 | Right Fronto-orbital |

**Table 3. Topography of Open Skull Fracture:** Anatomically, the case series revealed two cases of open frontoparietal skull fracture and two open fronto-orbital skull fracture; all with brain mater evisceration.

**CLINICAL PARAMETERS**

| Case Series | Gram of mater eviscerated | Hemodynamics | Level of Consciousness | Pupillary Status | Outcome |
|---|---|---|---|---|---|
| Case 1 | 20 grams | Stable | unconscious | Right dilated | Recovered |
| Case 2 | 30 grams | Unstable | unconscious | Bilateral | Died |
| Case 3 | 20 grams | Stable | unconsciouss | Left dilated | Recovered |
| Case 4 | 25 grams | Stable | unconscious | Bilateral | Died |

**Table 4. Clinical Parameters:** All patients had eviscerated brain mater. Three of the four cases on admission were hemodynamically stable while one was hypotensive. All the patients in the series were unconscious on admission with a GCS below 8/15. Two of the patients with bilateral non-reactive pupils died.

**APPROACH CONSIDERATIONS**

| Case Series | Mechanical Ventilation | Anticonvulsant | Antibiotics | Mannitol |
|---|---|---|---|---|
| Case 1 | Not available | Phenobarbital | Cetriaxone | Yes |
| Case 2 | Not available | Phenobarbital | Ceftriaxone | Yes |
| Case 3 | Not available | Phenobarbital | Ceftriaxone | Yes |
| Case 4 | Not available | Phenobarbital | Ceftriaxone | Yes |

**Table 5. Approach Considerations:** Mechanical ventilator was not available for any of the patients. All patients received phenobarbital in the absence of phenytoin. All our patients were served ceftriaxone and mannitol at some point during their care.

**Surgical Approach**

| Case Series | Irrigation/Debridement | Primary Dural Closure | Cranioplasty |
|---|---|---|---|
| Case 1 | Yes | Yes | No |
| Case 2 | Yes | Yes | No |
| Case 3 | Yes | Yes | No |
| Case 4 | Yes | Yes | No |

**Table 6. Surgical Approach:** All the patients received wound irrigation and debridement with gentle removal of the damaged mater. All patients had primary dural closure as no cranioplasty performed.

**Discussion**

Skull fractures are classified into linear, depressed and comminuted (5). A depressed fracture is one wherein the fractured fragment driven inwards. Depressed fractures can be either closed or open (clean or dirty/contaminated) (20). On the other hand, in elevated fracture, the fractured portion is elevated above the level of the intact skull (1). Compound elevated fractures are caused by tangential injuries which slice off a portion of the scalp, skull and the underlying Dura and brain (5). They are frequently due to assaults with sharp edged weapons (6). The principle of management is identical to those of compound depressed fractures with the elevated bone fragments being replaced into position after proper closure of the Dura (5). Delay or failure to operate these may result in meningitis or formation of abscess (8).

The locations of depressed skull fractures are fronto-parietal in 75% cases, temporal location in 10%, occipital in 5% and others 10% (17). As high as, in 75-90% of cases, the depressed fractures are compound in nature (7).

Patients with depressed skull fractures present with history of trauma, depression over the skull, neurological signs, seizure, CSF leak, brain mater may come through the wound in compound depressed fracture (16). Plain X-ray

skull will demonstrate the fracture, type, its location, its degree of depression. CT scan is helpful in the diagnosis of skull fracture and associated intracranial lesion (16). Regardless of whether clinical evidence of penetration exists or not, all patients with Traumatic Brain Injury should undergo CT-scan, except in extreme cases that require surgical intervention, or when the patient is clinically and neurologically moribund and there is no hope for survival (14).

Seizure medications are recommended if the chance of developing seizures is higher than 20% and open fractures, if contaminated, may require antibiotics in addition to tetanus toxoid (20). Epilepsy develops because of primary brain injury and not because of persisting bone fragments in situ (22). Therefore, cases with evidence of parenchymal penetration or laceration are commenced on Phenytoin which is the recommended antiepileptic drug (21).

The role of surgery is limited in the management of most skull fractures. Infants and children with open depressed fractures require surgical intervention (20). Most surgeons prefer to elevate depressed skull fractures if the depressed segment is more than 5 mm below the inner table of adjacent bone (20). Indications for immediate elevation are gross contamination, dural tear with pneumocephalus, an underlying hematoma and brain evisceration (20).

Compound depressed skull fractures are surgical emergencies, and unless treated promptly and properly, complications like meningitis, cerebral abscess, osteomyelitis or post-traumatic seizure may supervene (16). If dura is torn, lacerated brain mater may present in the wound that should be sucked out, after proper hemostasis, dural tear should be repaired in watertight fashion. If needed, the use pericranial graft or fascia lata is feasible (16).

To repair depressed fractures of the skull, wire ligatures are usually sufficient. However, complex depressed fractures of the skull in which the bone is smashed into several fragments are difficult to reconstruct by wiring (16). Therefore, bone flaps tend to be mobile but may result in deformed appearance. The treatment of serious cranial defects has always been a fascinating and controversial issue for craniofacial surgeons (9).

Reconstruction of the craniofacial defects can be carried out with autogenous tissue (calvarium, rib and iliac crest), allogeneic implants (lyophilized cartilage) or alloplastic material (methacrylate, hydroxyapatite, titanium implants and mesh systems). Selection of the implant material used for reconstruction is still controversial (10).

Some authors have stated intracranial bone fragments that are not removed can cause infection (15). Other authors revealed that the bone fragments did not increase the infection rate itself, but that the infection rate became 10 times higher if the fragments are combined with scalp tissue or hair (19).

There are several predictors of poor outcome in craniocerebral wound, correlating with morbidity and mortality: advanced age, high velocity missiles or handguns fired from a very close range as in suicide attempts, admission GCS score 3 and 4 (with mortality rates near 90%), bilateral fixed dilated pupils, delayed and poor mode of transportation, apnea at admission, associated injuries to chest, abdomen and great vessels generating massive bleeding, haemodynamic instability (hypotension), postoperative rise in ICP, abnormal coagulation states on admission or even disseminated intravascular coagulopathy (11, 12, 13).

**Conclusion**

The management of Open Skull fracture and Brain Evisceration is a neurosurgical emergency. A Glasgow Coma Scale of 5 and below, bilateral non-reactive pupils and hemodynamic instability are associated with increase mortality. In the absence of a Neurosurgeon, proper irrigation, debridement of devitalized tissues and removal of damaged eviscerated brain mater can be performed by General Surgeons. Primary watertight dura closure is advised to avoid cerebrospinal fluid leakage. Duraplasty and craniosplasty is possible if the expertise is available. Tetanus prophylaxis is a useful adjunct. Broad Spectrum antibiotics are recommended to reduce complications of meningitis and brain Abscess. Anticonvulsants should be given if the risk of seizure is high.

**Acknowledgment**

The authors wish to thank Lydia T. Olasupo, Eric Cassell, Marianne Saint Jean, Utam Terseer, Saygbah Vanyanbah, John F. Kennedy Medical Record Department and the ELWA Hospital Record Department for their support.

**Consent**

A written informed consent was acquired from for each patient and other relevant information were retrieved from the chart.

**Conflict of Interest**

The authors declare no conflict of interest regarding this publication.

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