Penetrating Brain Injuries at Assiut University Hospital: One Year Study

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Abstract

Background: Penetrating Brain Injury (PBI) is defined as head trauma in which a projectile breaches the cranium and dura matter. It is one of the most fatal forms of trauma and many cases die at the site of trauma. For those who survive till hospitalization, the management of penetrating brain injury represents great challenges to medical and surgical providers. Penetrating brain injuries are classified according to projectile velocity into missile and nonmissile injuries.

Aim of Study: Our study discusses clinical-radiological profile and outcome of patients of penetrating brain injuries.

Material and Methods: This is a prospective hospital based study includes 30 patients with penetrating head injuries admitted and managed at Department of Neurosurgery and Trauma Units of Assiut University Hospital through one year from March 2015 to March 2016.

Results: The mean age was 25 years. 27 patients were males (90%). Brainmatter herniation and Cerebrospinal Fluid (CSF) leak was the most common clinical presentation in 28 (93.3%) patients followed by decreased level of consciousness in 26 (86.6%) patients. Multiple lobe injury was noted in 14 (46.6%) patients followed by parietal lobe in 10 (30%) patients. 12 patients died during the hospital stay. Three patients were discharged in GOS-3, 5 in GOS-4, and 10 in GOS-5. Wound infection occurred in 3 (10%) patients, and seizure developed in 7 (23.3%) patients.

Conclusion: Penetrating brain injuries are rising issue in our community. It occurs commonly in young adults (20 to 40 year-old agegroup) and occurs more commonly in males. Firearm is the usual mode of injury and carries worse prognosis than other modes of injury. Higher mortality was observed among missile injuries compared to non missile injuries. Most cases presented with brainmatter herniation or CSF leak. Multi lobar injury is the most common finding followed by parietal lobe injury. Aggressive resuscitation is required in cases of PBI. Prognosis of penetrating brain injuries is highly related to post resuscitation GCS.

Key Words: Penetrating – Head injury – Assiut University.

Introduction

PENETRATING Brain Injury (PBI) is defined as head trauma in which a projectile breaches the cranium and dura matter. Based on the velocity of the penetrating object, PBI can be grouped into missile and non-missile injuries. Missile injuries are commonly caused by a foreign object with velocity more than 100 meter/second. Non missile injuries are usually caused by a foreign object with velocity of less than 100m/second [1].

The immediate intracranial injury occurs as the result of neuronal and vascular destruction caused by the projectile traveling through intracranial tissues causing permanent cavitations. Shock waves produce temporary cavitations in distant site from projectile path. Expansion and retraction of the temporary cavities cause distant punctate hemorrhages and neuronal membrane disruption, this result to a rapid rise in intracranial pressure [2]. PBI is one of the most fatal forms of trauma and approximately 70-90% of cases die before hospitalization. Patients who survive after penetrating brain injuries are at high risk of developing multiple serious complications, including persistent neurologic deficits, infections, CSF leak, cranial nerve deficits, arterio venous fistulas, hydrocephalus and epilepsy. The management of penetrating brain injury represents complex challenges to medical and surgical providers [3].

Aggressive resuscitation following PBI both in pre-hospital and emergency department improves outcome. Pre-hospital care aim is to minimize secondary injury and delivering the patient to a trauma center alive. This is achieved through effective airway maintenance and optimizing oxygenation, ventilation, and cerebral perfusion [4].
Non contrasted Computed Tomography (CT) is the primary neuroimaging modality used in evaluation of PBI as it is quick and available method. Other neuroimaging modalities like CT Angiography (CTA) CT Venography (CTV) and MRI used in indicated cases of suspected vascular injury [8].

Patients and Methods

This is prospective hospital based study includes 30 patients with penetrating head injuries admitted and managed at Department of Neurosurgery and Trauma Units of Assiut University Hospital through one year from March 2015 to March 2016.

According to our hospital protocol patients were admitted to Trauma Unit Emergency Department for resuscitation, stabilization of general condition, supportive care and blood transfusion if needed, endotracheal intubation was done to all patients GCS below 8 and dehydrating measures given. History was taken from relatives about age, cause, exact time of trauma and presence if any chronic medical diseases. Complete neurological examination was done for all cases including post resuscitation GCS, presence of neurological deficit, pupil reaction and careful examination of wounds. The head was examined carefully for presence of inlet and exit wounds in cases of firearm injuries, presence of CSF leak and brain matter herniation then stitching of wounds done with local debridement. General examination of patients done to exclude other organs trauma.

Prophylactic antibiotics were given to all our patients mainly third generation cephalosporin in emergency room, prophylactic antiepileptic was also given to all our patients in form of intravenous phenytoin loading dose (15-20mg/kg) then to be continued in maintenance dose (7-10mg/kg).

After stabilization of general condition patients were transported to radiology department for neuroimaging. Our protocol in penetrating brain injuries imaging is to do multislice non contrasted CT scan (bone and soft tissue windows) for all our cases.

Operative data was recorded for each case individually dural repair type either by simple closure, by using pericranial graft or fascia lata graft. Outcome data was recorded according to Glasgow Outcome Scale (GOS). Follow-up of all patients during hospital stay and 3 months after hospital discharge.

Results

Age and sex: Our study include 30 patients 27 (90%) of them were males and only three females (10%). The patients ages ranged from 3 to 50 years old with mean age 25 years. 17 patients (56%) were between 20-40 years, 5 patients (16%) were below 10 and 4 patients (13.3%) were above 40. Fig. (1).

Mode of injury: 24 (80%) patients sustained firearm injury, majority of them 20/24 (83.33%) had injury as a result of assault whereas 4/24 (16.66%) had accidental injury. Non missile injuries occurred in 6 patients (20%) assault in half cases and accidental in the other half. Fig. (2).

Clinical presentation: In our study, admission GCS was between 3 and 5 in 3 (10%) patients, 6 and 8 in 4 (13.3%), 9 and 12 in 10 (33.3%), and 13 and 15 in 13 (43.3%).

Most common clinical presentation was brain matter herniation and Cerebrospinal Fluid (CSF) leak in 28 (93.3%) patients, followed by decreased level of consciousness in 26 (86.6%) patients, weakness of extremities in 20 (66.6%) patients (Table 2).

Site of injury: Multilobar injury was noted in 14 (46.6%) patients, followed by parietal lobe in 10 (33.3%) patients and temporal lobe injury in 6 (20%) patients.

Projectile path: Among 24 cases of missile injury found 10 cases of penetrating injury with retained bullet (41.6%), 9 cases of tangential injury (37.5%) and 5 cases of perforating injuries (20.8%) (Table 3).

Radiological findings: In non-contrast CT brain contusions and lacerations were found in 21 cases (70%), intra-axial foreign bodies in 13 cases (43.3%): Of these 13 cases, 10 with intra-axial bullets and 3 of non missile objects. Intra-axial bone fragments were found in 10 cases, while intraventricular hemorrhage was found in 3 patients (10%).

Surgical management: Surgery was done to 24 cases (80%) other 6 cases were not operated due to low GCS score below 8, multiple brain pathologies and bad general condition. Our surgery steps were based on identification of skull fractures and dural defect then removal of accessible bone fragments, foreign objects removal and dural repair. In our study we used pericranial graft in dural repair in 22/24 cases (91.6%) and fascia lata graft
in only 2/24 cases (8.3%) we never use synthetic dural graft.

Post-operative complications: Post-operative persistent CSF leak developed in 3/24 cases (12.5). All of the 3 cases developed meningitis despite of usage of prophylactic antibiotics. One case died as a sequel of this complication. One case developed post meningitic hydrocephalus (ventriculitis) that was managed by external ventricular drainage but died later with acute respiratory distress and electrolyte disturbance. The third case responded to conservative treatment, CSF leak stopped and recovered from meningitis. On follow-up 3 months later one case developed osteomyelitic bone, brain abscess and hydrocephalus (ventriculitis) which required decompressive cranietomy of the flap, tapping of the abscess and external ventricular drainage. 7/24 cases (23.3%) developed seizures and one of them died from status epilepticus post-operatively.

Outcome: 12 patients died during the hospital stay. Three patients were discharged in GOS-3, 5 in GOS-4, and 10 in GOS-5. High mortality percentage was found in patients with admission GCS below 8 (Table 4).

Cases presentation:

Case 1: Male child 7 years old presented after heavy object trauma (wood falling from height over his skull vault). On examination patient was GCS 14 agitated with apparent left upper limb paresis. He had large right parietal wound with brain matter herniating from it and wooden object penetrating skull vault Fig. (3).

After stabilization of general condition, emergency MSCT brain was done to the patient which showed right fronto-parietal depressed skull fracture with hypodense object (wood) inside the right parietal lobe and underlying contusion Fig. (4).

Emergency surgery was done to the patient in steps after complete exposure of the depressed segment, removal of the wooden object and bone fragments was done followed by dural repair with pericranial graft and reposition of bone. Post-operative patient regained his conscious level (GCS 15) with left upper limb weakness grade four. Follow-up CT shows complete removal of the wooden object with residual intra-axial bone fragment Fig. (5).

Patient was referred for physiotherapy and after 3 months follow-up patient was GCS 15 and full motor power.

Case 2: Male child 10 years old presented after firearm injury by disturbed conscious level and brain matter herniation from left frontal wound.

On examination GCS was 9 with apparent left side weakness, there were two wounds on skull one was right high parietal small wound mostly inlet wound, the other was large left frontal wound with brain matter herniation.

Emergency MSCT brain was done to our patient with 3D films which shows small right high parietal fracture and large left frontal expressed fracture and right frontal contusion. Figs. (6,7).

For the first 24 hours post injury, our patient was managed conservatively by administration of antibiotics and dehydrating measures then surgery was done in which dural repair of both inlet and exit wounds done with pericranial grafts. Fig. (8).

Post-operative patient improved GCS to 15 dysphasic with left side weakness grade 3 and refereed to physiotherapy.
Fig. (3): A child with non missile (wood) penetrating his skull vault.

Fig. (4): CT bone and soft tissue window shows right frontoparietal depressed fracture with hypodense foreign object intra-axial.

Fig. (5): CT soft tissue window shows complete removal of the wooden object with residual unaccessible bone fragment.
Fig. (6): CT 3D film shows right high parietal depressed fracture and left frontal bone defect.

Fig. (7): CT soft tissue window shows right frontal contusion in the track of the missile.

Fig. (8): Post-operative CT bone window shows craniectomy done for dural repair in both inlet (right high parietal) and exit (left frontal) wound.

Table (1): Admission GCS in studied patients.

<table>
<thead>
<tr>
<th>Admission GCS</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-5</td>
<td>3</td>
</tr>
<tr>
<td>6-8</td>
<td>4</td>
</tr>
<tr>
<td>9-12</td>
<td>10</td>
</tr>
<tr>
<td>13-15</td>
<td>13</td>
</tr>
</tbody>
</table>

Table (2): Clinical presentations of penetrated brain injured patients.

<table>
<thead>
<tr>
<th>Clinical presentation</th>
<th>Missile injuries (total 24 cases)</th>
<th>Non-missile injuries (total 6 cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Brain matter herniation and CSF leak</td>
<td>23 cases (95.8%)</td>
<td>5 cases (83.3%)</td>
</tr>
<tr>
<td>• Disturbed conscious level</td>
<td>23 (95.8)</td>
<td>3 cases (50%)</td>
</tr>
<tr>
<td>• Neurological deficits</td>
<td>16 (66.6%)</td>
<td>4 cases (66.6%)</td>
</tr>
</tbody>
</table>

Table (3): Projectile path in missile injured patients.

<table>
<thead>
<tr>
<th>Projectile path</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetrating</td>
<td>10</td>
</tr>
<tr>
<td>Tangential</td>
<td>9</td>
</tr>
<tr>
<td>Perforating</td>
<td>5</td>
</tr>
</tbody>
</table>

Table (4): Relation between GCS on admission and GOS in discharge.

<table>
<thead>
<tr>
<th>GCS on admission (number of cases)</th>
<th>GOS 1</th>
<th>GOS 2</th>
<th>GOS 3</th>
<th>GOS 4</th>
<th>GOS 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS 3-5 (3)</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>GCS 6-8 (4)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>GCS 9-12 (10)</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>GCS 13-15 (13)</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>7</td>
</tr>
</tbody>
</table>
Penetrating brain injuries occur more frequently in young aged males. In our study male to female ratio (9 to 1) and that correlates with previous studies [recorded male to female ratio (7.8 to 2.1)] [4]. We recorded maximum incidence of these injuries in 20 to 40 age groups (56% of cases). This was nearly the same age groups in previous studies which shows maximum age between 11 to 30 [4].

In missile injuries, the main cause was assault in 83.3% percentage and accidental in only 16.6%, previous studies recorded 94.4 assault and 5.5% accidental [4]. In non-missile injuries we found that half cases is assault and the other half is accidental the same ratio reported by previous studies [6]. Missile injuries carry a worse prognosis than non-missile injuries as demonstrated by high mortality 45.8% to 16.6% respectively, also missile injuries carries a high incidence of morbidity to non-missile injuries.

In PBI, brain injury is the result of energy being transferred from the projectile to the human skull and underlying brain. The penetrating object has kinetic energy equals half of the projectile mass multiplied by square of its velocity (kE=1/2mv2) which means that the projectile velocity has a greater influence than projectile mass [8].

In our study mortality rate was 12 of 30 cases (40%) with high percentage of death occurred in patients GCS (3-5) 66.6% almost the same described in previous studies. We recorded 50% mortality rate in GCS 6-8 which is less than that was recorded in literature (Table 5).

Table (5): Mortality percentage in previous studies and percentage of patients GCS 3-8 in each study.

<table>
<thead>
<tr>
<th>Series</th>
<th>Over all Mortality (%)</th>
<th>No. of patients</th>
<th>GCS score 3-8 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaufman et al., 1986 [7]</td>
<td>66</td>
<td>141</td>
<td>76</td>
</tr>
<tr>
<td>Mancuso et al., 1988 [8]</td>
<td>40</td>
<td>40</td>
<td>48</td>
</tr>
<tr>
<td>Grahm et al., 1990 [9]</td>
<td>59</td>
<td>100</td>
<td>64</td>
</tr>
<tr>
<td>Liebenberg et al., 2005 [10]</td>
<td>69</td>
<td>125</td>
<td>69</td>
</tr>
<tr>
<td>Bal Krishna Ojha et al., 2013 [4]</td>
<td>28</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>Our study 2016</td>
<td>40</td>
<td>30</td>
<td>23</td>
</tr>
</tbody>
</table>

Type of trauma among missile brain injuries greatly affects the outcome. Mortality was highest between perforating injuries representing (75%) then penetrating injuries (60%) and only 30% from tangential injuries. The 3 cases died from tangential injuries died due to complications of infection like brain abscess and hydrocephalus (ventriculitis).

Discussion

Post-operative CSF leak is common complication after surgery for PBI. It occurs frequently in missile injuries. It represented 12.5% in our study (3 cases from total 24 missile injured patients), all of them from missile injuries and recorded no cases of post-operative CSF leak in non-missile injuries and this correlates with previous studies that concluded CSF leakage postoperative in non missile injuries is a rare complication. The low incidence is clearly related to easily accessibility and water-tight suture of the disrupted dura mater [13].

Infectious complications is another common complication in PBI. In previous studies despite antibiotic treatment, the incidence of infectious complications was observed in 64% of cases (a brain abscess was showed in 48%) [7]. In our study we recorded infections in 12.5% of cases (brain abscess in 6.6%). All of these infections occurred related to post-operative CSF leak.

Posttraumatic epilepsy is another complication which is positively correlated with the level of GCS and affects outcome, Kazim et al., recorded 30% to 50% of patients with PBI develop seizures [14] (Table 6).

Table (6): Posttraumatic epilepsy percentage recorded in previous studies.

<table>
<thead>
<tr>
<th>Study</th>
<th>Posttraumatic epilepsy %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kazim SF et al., 2013 [14]</td>
<td>30-50</td>
</tr>
<tr>
<td>Bal Krishna Ojha et al., 2015 [4]</td>
<td>13.33%</td>
</tr>
<tr>
<td>Current study</td>
<td>23.3%</td>
</tr>
</tbody>
</table>

In our study we recorded 23.3% of post traumatic seizures all of them in first week post traumatic and no cases recorded of delayed epilepsy.
Conclusion:

Penetrating brain injuries at Assiut University trauma center although less common than other causes of trauma, it is increasing in incidence after 2011. It carries a worse prognosis. It is more common in young aged males and commonly occurs due to violence in case of missile injuries.

Missile injuries are more common than non-missile injuries and have worse outcome. Brain matter herniation and CSF leak is the common presentation of penetrating brain injuries. Multi lobar injury is the most common finding followed by parietal lobe injury. Aggressive resuscitation is required in cases of PBI to prevent secondary brain injury and improve outcome.

Unless there is an operable hematoma, the main goal in surgery is dural repair and debridement for prevention of CSF leak which may lead to fatal complications like meningitis, hydrocephalus and brain abscess. There is no preferable strategy in surgery and both craniotomy and craniectomy remains options according to surgeons’ preference.

Like any other trauma type low GCS score on admission is predictor for poor prognosis and surgery for patients with low GCS score remains futile except in prevention of complications if there is persistent CSF leak as patients treated surgical has not proved to have better outcome than those treated conservative.

Another factor affect the outcome of PBI patients is seizures as patients developed seizures has generally bad outcome than those who never developed seizures.

Acknowledgment:

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References


اكتت إصابات الدماغ بمستشفى جامعة أسوان: دراسة لمدة عام

السياق: يتم تعريف إصابة الدماغ (BPI) كصدمة في الرأس حيث تخرقت القنفية مادة الجمجمة والمادة. وفي واحدة من أكثر أشكال الصدمة القاتلة، وتمت حالات كثيرة في موقف الصدمة. بالنسبة للآرتس الذين يرغبون في الحياة حتى دخول المستشفى، تمثل إدارة إصابات الدماغ اكتت إصابات كبيرة لمجتمع الخدمات الطبية والجراحية. تصنف إصابات الدماغ المختective وفقاً لدرجة قنفية في القدام والإصابات غير الإشاعية. لدينا دراسة متصلة بالشفاء الكامل الإشعاعي - الإشعاع ونتائج المرضى من إصابات الدماغ اكتت.

الطريق: هي دراسة مستقلة مستندية إلى المستشفى تضم 200 مريضاً حالي رسوم من إصابات الرأس المختيبة التي تم إدخالها وإدارتها في قسم جراحة الأعصاب والرضوضي المستشفى جامعة أسوان خلال عام واحد من مارس 2015 إلى مارس 2016.

النتائج: متوسط العمر 25 سنة (72% مريض)، كان الاتصال العيني والسلال الدماغي (CSF)套房 العيني والسلال الدماغي (CSF) و23% من المرضى، تم نقل مستوي الوعي 16 (8.1%) من المرضى. وبوزع إصابة القفص المخاطورة في 3 (14.2%) من المرضى. تقدر ثلاثة مرضي في GOS-3، و 10 في GOS-4، و 10 في GOS-5. وقعت الاعتداء البشري في 18 (10%) من المرضى، وتطور النوبة في 7 (4.2%) من المرضى.

الاستنتاجات: تسبب إصابات الدماغ في زيادة الشكوفة في مجتمعنا. يحدث عادة عند البالغين الشباب (20 إلى 40 سنة) ويحدث بشكل أكثر شيوعاً عند الذكور. السلاح الناري هو النقط المعتدلين لإصابة ويحمل تشخيص أسواً من الطرق الإصابة الأخرى. كان معدل الوفيات المرتفع بين الإصابات الصاروخية مقارنة بالإصابات غير الصاروخية. قدر النخاع مع نقية القفص في السائل، وجدت الإصابة متحدة القصيلة في حالة إصابة القفص الجداري هناك حاجة إلى النعاس القسري في حالات الإصابات الناجمة يرتبط تشخيص بعد.