Med. J. Cairo Univ., Vol. 86, No. 8, December: 4705-4712, 2018
www.medicaljournalofcairouniversity.net

Penetrating Brain Injuries at Assiut University Hospital: One Year Study

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Abstract

Background: Penetrating Brain Injury (PBI) is defined as head traumain 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 discussesclinical-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 decreasedlevel 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 in3 (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 wasobserved among missile injuries compared to non missile injuries. Mostcases presented with brainmatter herniation or CSF leak. Multi lobar injury is themost 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.*

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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 wavesproduce 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 [5].

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 latagraft. 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%) hadinjury as a result of assault whereas 4/24 (16.66%) had accidentalinjury. 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 clinicalpresentation 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 sequela 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 distrubance, 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 craniectomy 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 residualintra-axialbone 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.

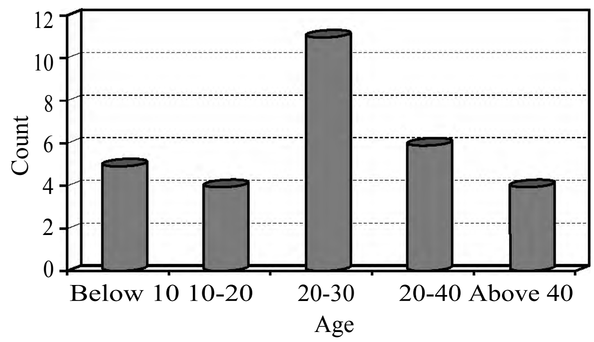

Fig. (1): Age distribution of studied patients.

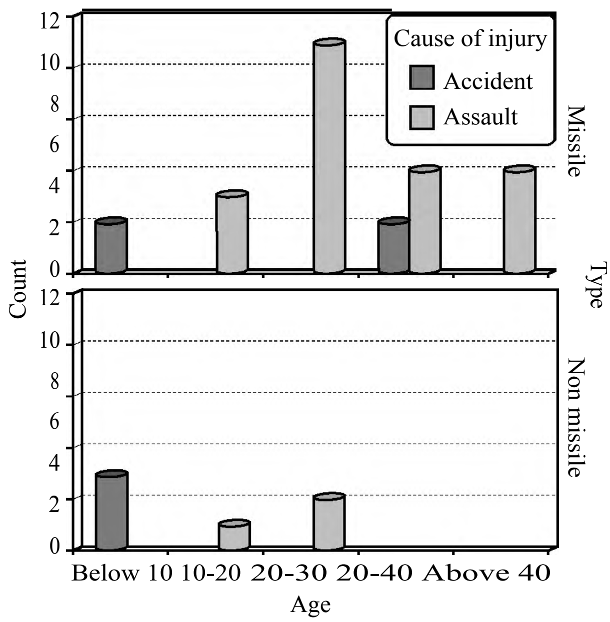

Fig. (2): Relation between type and cause of injury in each age group.

Fig. (3): Achild with non missile (wood) penetrating his skull vault.

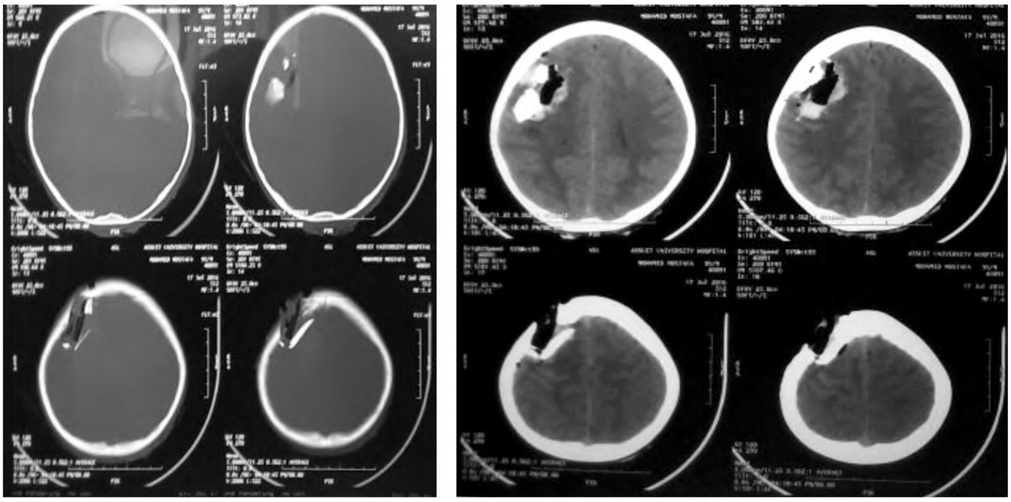

Fig. (4): CT bone and soft tissue window shows right frontoparietal depressed fracture with hypodense foreign object intra-axial.

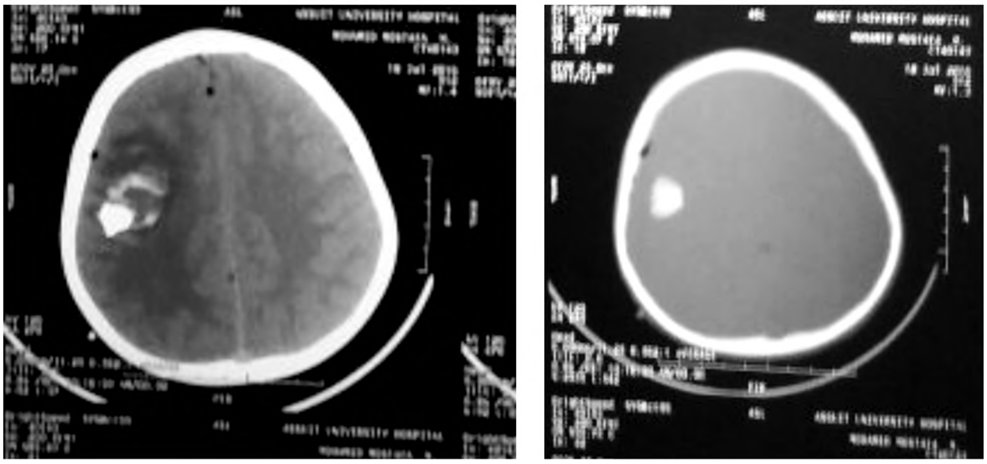

Fig. (5): CT soft tissue window shows complete removal of the wooden object with residual unaccessable bone fragement.

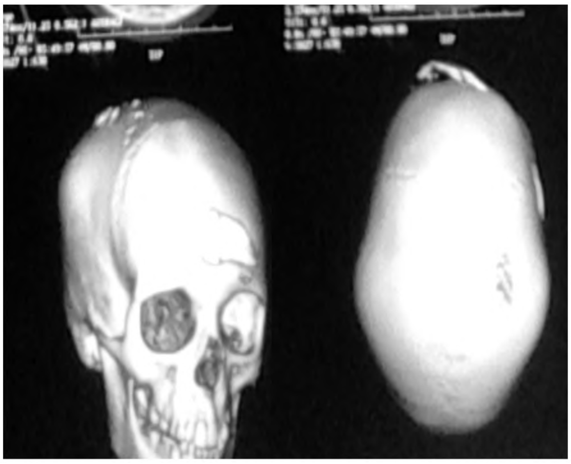

Fig. (6): CT 3D film shows right high parietal depressed fracture and left frontal bone defect.

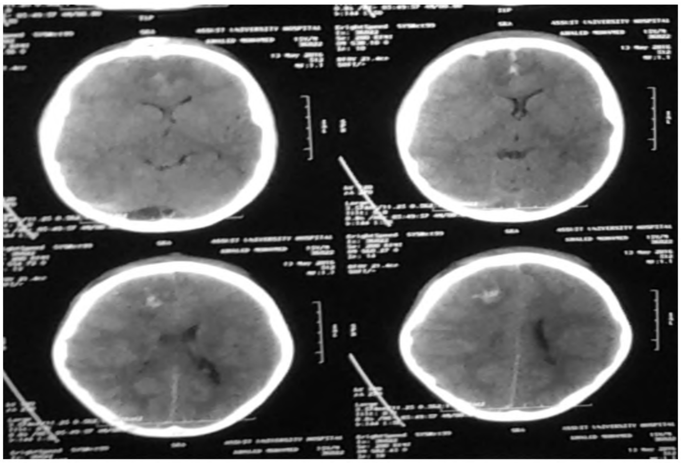

Fig. (7): CT soft tissue window shows right frontal contusion in the track of the missile.

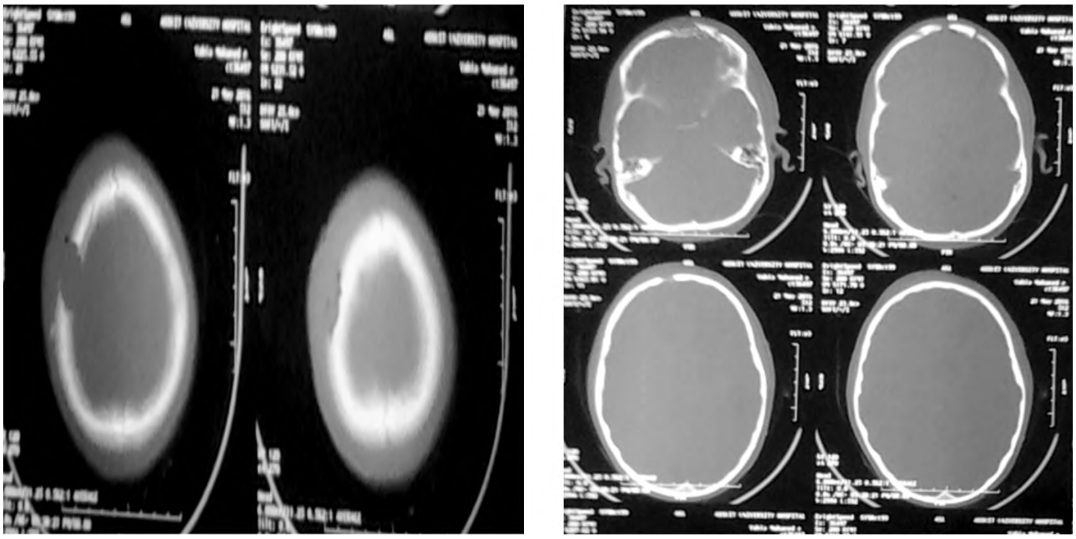

Fig. (8): Post-operative CT bone window shows craniectomy done for dural repair in both inlet (right high parietal) and exit (left frontal) wound.

Table (1): Admission GCS in studied patients.

Admission GCS	Number of cases
3-5	3
6-8	4
9-12	10
13-15	13

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

Clinical presentation	Missile injuries (total 24 cases)	Non-missile injuries (total 6 cases)
• Brain matter herniation and CSF leak	23 cases (95.8%)	5 cases (83.3%)
• Disturbed conscious level	23 (95.8)	3 cases (50%)
• Neurological deficits	16 (66.6%)	4 cases (66.6%)

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

Projectile path	Number of cases
Penetrating	10
Tangential	9
Perforating	5

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

GCS on admission (number of cases)	GOS on discharge (cases number)				
	GOS 1	GOS2	GOS3	GOS4	GOS5
GCS 3-5 (3)	2	0	1	0	0
GCS 6-8 (4)	2	0	0	2	0
GCS 9-12 (10)	4	0	0	3	3
GCS 13-15 (13)	4	0	2	0	7

Discussion

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 [5].

In our study mortality rate was 12 of 30 cases (40%) with high percentage of deathsoccurred in patients GCS (3-5) 66.6% almost the same described in previous studies. We recorded 50% mortality rate in GCS6-8 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.

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

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).

One of the important items in management of penetrating brain injuries is the presence of retained intracranial bone and metallic fragments which is risky in removal. It carries the fear of development of intracranial infections and abscess formation. Experimental studies by Pitlyk et al revealed only 4 to 8% incidence of infection with bone fragments when hair or scalpwas not accompanied along within the brain matter [11]. Brandvold et al., reported no correlation between the presence of retained fragments and subsequent development of infection or epilepsy [12]. In our study there was 3 cases with retained intracranial bone fragments and none of them develop seizures or infections. We found the most associated cause of infection was persistent CSF leak in 3 cases (10%).

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 watertight 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.

Study	Posttraumatic epilepsy %
Pitlyk PJ et al., 1970 [11]	24%
Kazim SF et al., 2013 [14]	30-50
Bal Krishna Ojha et al., 2015 [4]	13.33%
Current study	23.3%

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 themost 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 andcraniectomy 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:

We would like to express our gratitude to Professor Ahmed Ibrahiem El-Gheriany, Department of Neurosurgery, Assiut University. For his continuous support and important advices and revisions during this work. Also our gratitude to Hamada Mohammed Ramadan (MSC1) for his assistance in this work.

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إختراق إصابات الدماغ بمستشفى جامعة أسيوط: دراسة لمدة عام

مقدمة: يتم تعريف إصابة الدماغ (BPI) كصدمة فى الرأس حيث تخترق القذيفة مادة الجمجمة والمادة. وهى واحدة من أكثر أشكال الصدمة القاتلة، وتموت حالات كثيرة فى موقع الصدمة. بالنسبة لأولئك الذين بقوا على قيد الحياة حتى دخول المستشفى، تمثل إدارة إصابات الدماغ اختراق تحديات كبيرة لمقدمى الخدمات الطبية والجراحية. تصنيف إصابات الدماغ المخترقة وفقاً لسرعة قذيفة فى القذائف والإصابات غير الإنشائية. لدينا دراسة مناقشة الملف الإشعاعى – الإشعاعى ونتائج المرضى من إصابات الدماغ اختراق.

الطرق: هى دراسة مستقبلية مستندة إلى المستشفى تضم ٣٠ مريضاً يعانون من إصابات الرأس المخترقة التى تم إدخالها وإدارتها فى قسم جراحة الأعصاب والرضوض بمستشفى جامعة أسيوط خلال عام واحد من مارس ٢٠١٥ إلى مارس ٢٠١٦.

النتائج: متوسط العمر ٢٥ سنة (٢٧) مريض (٩٠٪). كان الفتق العقلى والسائل النخاعى (CSF) التسرب العرض السريرى العادى فى ٢٨ (٩٣.٣٪) من المرضى يليه انخفاض مستوى الوعى فى ٢٦ (٨٦.٦٪) من المرضى. لوحظ إصابة الفص المتعدد فى ١٤ (٤٦.٦٪) من المرضى تليها الفص الجدارى فى ١٠ (٣٠٪) من المرضى. توفى ١٢ مريضاً خلال الإقامة فى المستشفى. تم تفريغ ثلاثة مرضى فى GOS-3، ٥ فى GOS-4، و ١٠ فى GOS-5. وقعت العدوى الجرح فى ٣ (١٠٪) من المرضى، وتطور النوبة فى ٧ (٢٣.٣٪) من المرضى.

الإستنتاجات: تسبب إصابات الدماغ فى تزايد المشكلة فى مجتمعنا. يحدث عادة عند البالغين الشباب (٢٠ إلى ٤٠ سنة) ويحدث بشكل أكثر شيوعاً عند الذكور. السلاح النارى هو النمط المعتاد للإصابة ويحمل تشخيص أسوأ منطرق الإصابة الأخرى. كان معدل الوفيات المرتفع بين الإصابات الصاروخية مقارنة بالإصابات غير الصاروخية. قدمت النخاعى مع فتق العقلى أو تسرب السائل وتعد الإصابة متعددة الفصيلة هى نتيجة شائعة فى كل منها يليها إصابة الفص الجدارى هناك حاجة إلى الإنعاش القسرى فى حالات الإصابات النافذة يرتبط تشخيص بعد.