The Egyptian Journal of Hospital Medicine (January 2020) Vol. 78 (1), Page 42-47

Surgical Management of Open Traumatic Head Injury

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ABSTRACT

Background: Head injury remains one of the most common causes of death worldwide. Approximately 10 to 50% of patients with head injury developed disability at some point in their illness, and represent one of the most common brain casualty encountered by neurosurgeons**.**

Objective: This study was aimed to assess and evaluate a group of patients with open head injury including depressed skull fracture and skull fractures associated with epidural hematoma, subdural hematoma, intracerebral hematoma or foreign body penetration regarding surgical management and post-operative results.

Patients and methods: The study was done prospectively in the Neurosurgery Department, Al-Azhar University Hospitals and Matareya Teaching Hospital; the study included 30 patients with acute open traumatic head injury requiring surgical intervention in the form of Decompressive. Craniotomy with evacuation of hematomas if existed or elevation of depressed skull fractured bones.

Results: In this study, depressed fracture was present in 17 cases, fissure fracture in 7 cases, skull base fracture in 2 cases, diastatic fracture in 1 case and beveling (bullet inlet and exit) in 1case. Also, in this study, 9 cases (30%) had Glasgow Outcome Score I (GOS I), 3 cases (10%) had GOS III, 3 cases (10%) had GOS IV and 15 cases (50%) had GOS V. Regarding the overall complications, chest infections were detected in 4 cases, frontal manifestations in 1 case, grade 4 Lt. sided weakness in 1 case, stable GCS at 14 in 2 cases, reoperation in 1 case and right hemiparesis in 1 case.

Conclusion: It could be concluded that surgical intervention is the ideal solution for the management of acute traumatic brain injury (TBI) with persistent increased ICP when the other medical management fail under the good circumstances of early intervention and the other factors.

Keywords: Open Traumatic, Head Injury, Depressed skull fracture, Skull fractures, Epidural hematoma, Subdural hematoma, Intracerebral hematoma

INTRODUCTION

Head injury can be classified by mechanism of injury to closed injury or open injury, by morphology to fractures, focal intracranial injury, and diffuse injury, or by severity of injury to mild, moderate, and severe **[(1)]**.

Skull fractures are classified based on pattern (linear, diastatic, comminuted, depressed), by anatomic location (convexity, basal) and by type (simple, compound). Compound fracture can be linear, depressed. Skull fractures are usually associated with some degree of brain injury, varying from mild concussion, to diffuse brain injury, to intra cranial hematomas **[(2)]**.

Compound depressed fractures having depression in the skull more than 8-10 mm or more than the thickness of skull, most commonly found in the parietal and frontal bones and communicates with the external environment through scalp injuries or escape of CSF or brain matter from scalp wound, the nose or the ear **[(3)]**.

Compound depressed fractures are surgical emergencies and unless treated promptly and properly, complications like meningitis, cerebral abscess, osteomyelitis of the skull or post traumatic epilepsy may supervene **[(4)]**.

Incidence of epidural hematoma (EDH): 1% of head trauma admissions (which is ≈ 50% the incidence of acute subdurals). Road Traffic Accident (RTC) with head injury is a major cause of mortality and morbidity. Other causes of head injury like assaults, fall from height, industrial accidents, sports injuries etc. also impart a significant proportion to this. Assessing the GCS and size of pupils and reaction to light considered as initial neurologic examination. Prove alcohol intoxication lowers initial GCS in TBI patients **[(5)]**.

Computed tomography (CT) of the head is used for both confirming TBI and follow up patients over time after impact. CT scan can be used to know the type and severity of the injury; with upper hand for detecting intracranial hematomas. About 50% of moderate TBI patients have abnormal finding in CT scan **[(6)]**.

This study was aimed to assess and evaluate a group of patients with open head injury including depressed skull fracture and skull fractures associated with epidural hematoma, subdural hematoma, intracerebral hematoma or foreign body penetration regarding surgical management and post-operative results.

PATIENTS AND METHODS

This prospective study included a total of 30 patients suffering from acute open traumatic head injury resulting in different pathologies

Received:2/09/2019
Accepted:11/10/2019

causing increased ICP, attending at the Neurosurgery Department, Al-Azhar University Hospitals and Matareya Teaching Hospital. Written informed consent of all the subjects was obtained.

Ethical approval

The study was approved by the Ethics Board of Al-Azhar University and an informed written consent was taken from each participant in the study.

Patients with acute open traumatic head injury requiring surgical intervention in the form of Decompressive Craniotomy with evacuation of hematomas if existed or elevation of depressed skull fractured bones. The prehospital report included the items shown in Table (1).

Table (1): Pre-hospital report included:

Mechanism	How did injury occur? Presence of drugs or alcohol Deaths at scene Confounding issues
Injury	Primary survey Glasgow Coma Scale
Vital data	Heart rate Blood pressure Respiratory rate Oxygen saturation Temperature (if applicable)
Treatment	Airway (airway management) Breathing (oxygen administration, needle or tube thoracotomy) Circulation (intravenous access established and fluids administered) Disability—neurologic (spine precautions) Extra information (medications administered, procedures performed)

The patients were all treated with similar prehospital emergency treatment and routine brain CT scan was performed, phenytoin (15-20 mg/kg) was given and Mannitol (0.5-1mg/kg), Lasix (0.25mg/kg) were given if indicated preoperatively regarding there is no hypotension.

1. **History:**
   a. Age, gender.
   b. Mechanism of injury.
   c. Time of trauma.
   d. Time of loss of consciousness, presence of lucid interval.
   e. Pre-hospital post-traumatic fits.

2. **Clinical Findings:**
   a. Conscious level (preoperative GCS)
   b. Presenting symptom.
   c. Scalp injuries, bleeding orifices.
   d. Pupils.

3. **Radiological Findings:**
   a. Patients will be diagnosed by computed tomographic (CT) scan post admission
   b. Imaging for associated injuries.

4. **Surgical variables:**
   a. Type of surgery,
   b. Time elapsed from accident to surgery.

5. Surgical procedures:
   - Decompressive Craniectomy in case of increased intracranial pressure.
   - Elevation of depressed fracture and cleaning to prevent infection and for cosmetic causes.

6. **The following were assessed (postoperatively after follow up CT scan):**
   a. Residual of any pathology.
   b. Need for Re –operation.

7. **Postoperative treatment:** Based on the conditions of intracranial pressure after operation, Mannitol (0.5 mg/kg), Lasix (0.25 mg/kg), were given. Prophylactic antiepileptic, antibiotics, hemostatic, and neurotropic drugs were routinely used for all the patients.

8. **Follow Up and outcome:**
   a. Postoperatively patients were admitted to the ICU and had at least one CT scan performed within 72 hours after operation. All survivors were followed up after operation with CT scan and neurological examination including GCS till the patients are discharged from the hospital.
   b. They were assessed by the Glasgow coma Scale (GCS) and the outcome

was graded using the Glasgow Outcome Score (GOS), which defines.

- Grade I as death,
- Grade II as persistent vegetative state,
- Grade III as severe disability (being conscious but disabled),
- Grade IV as moderate disability (being disabled but independent), and
- Grade V as good recovery.

c. Unfavorable outcome was defined as GOS 1-3 and favorable outcome as GOS 4 and 5.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Independent-samples t-test of significance was used when comparing between two means.
- Chi-square (x^2) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant as the following:
- Probability (P-value)
  - P-value <0.05 was considered significant.
  - P-value <0.001 was considered as highly significant.
  - P-value >0.05 was considered insignificant.

RESULTS

Demographic data:

The mean age of the cases included in the study was 26.41 ± 21.16 years, the minimum age was 8 months and the maximum age was 76 years. 21 cases (70%) of the cases were males and 9 cases were females (30%). These data are shown in table (2).

Table (2)**:** Demographic data of the study cases.

Age:		
Mean+SD	26.41+21.16	
Median (Min-Max)	24 (8 Months – 76 years)	
Gender:		
	Frequency	**Percentage**
Male	21	70%
Female	9	30%

Modes of trauma

The different modes of trauma affected the cases in this study are shown in table (3). The most common cause of trauma was RTA (12 cases) followed by struck by hard objects (7 cases). Other causes of trauma were FFH, falling on stairs, falling on the floor and bullet that were found in 6, 2, 2 and 1 cases respectively.

Table (3)**:** Modes of trauma of cases included in the study.

Mode of trauma	**Frequency**	**Percent**
RTA	12	40%
FFH	6	20%
Struck by hard object	7	23.3%
Falling on stairs	2	6.7%
Falling on floor	2	6.7%
Bullet	1	3.3%

Type of hemorrhage

Regarding the site of haemorrhage, 7 cases had SDH, 8 cases had EDH and 8 cases had ICH. These data are shown in table (4).

Table (4)**:** Type of hemorrhage of cases included in the study.

Type of hemorrhage	**Frequency**	**Percent**
SDH	7	23.3%
EDH	8	26.7%
ICH	8	26.7

Type of skull fracture

Regarding the type of depressed fracture was present in 17 cases, fissure fracture in 7 cases, skull base fracture in 2 cases, diastatic fracture in 1 case and bevelling (bullet inlet and exit) in 1case. These data are shown in table (5).

Table (5)**:** Fracture type in the study cases.

Type of fracture	**Frequency**	**Percent**
Depressed	17	56.6%
Fissure fracture	7	23.3%
Skull base fracture	2	6.7%
Diastatic fracture	1	3.3%
Beveling (bullet inlet and exit)	1	3.3%

GOS analysis

The analysis of the GOS in the cases included in the study is shown in table (6). 9 cases (30%) had GOS I, 3 cases (10%) had GOS III, 3 cases (10%) had GOS IV and 15 cases (50%) had GOS V.

Table (6)**:** GOS of the cases included in the study.

GOS	Frequency	Percent
I	9	30%
III	3	10%
IV	3	10%
V	15	50%
Total	30	100%

Late complications

In the cases included in the study, chest infections were detected in 4 cases, diffuse axonal injury in 1 case, frontal manifestation in 1 case, grade 4 lt sided weakness in 1 case, stable GCS at 14 in 2 cases, reoperation in 1 case, paraplegia in 1 case and right hemiparesis in 1 case. These data are shown in table (7).

Table (7)**:** Late complications.

	Frequency	Percent
No	18	16%
Chest infection	4	13.3%
Diffuse axonal injury	1	3.3%
Frontal manifestation	1	3.3%
G4 Lt weakness	1	3.3%
GCS stable at 14	1	3.3%
Opened twice	1	3.3%
Paraplegic	1	3.3%
Rt hemiparetic	1	3.3%
Totoal	30	100%

DISCUSSION

The study included 30 patients with traumatic open head injuries who were presented to the Department of Neurosurgery, Al-Azhar University Hospitals and Nasr City Health Insurance Hospital.

Initial resuscitation occurs concurrently with primary assessment. When a life-threatening condition is found, immediate corrective actions must be taken, and its effects evaluated before moving on to the next step. The primary assessment should proceed with using the "ABCDE" approach.

Clinical examination of the patients at the trauma Room included general examination and local examination of the head and neck region. Radiological investigations included X-ray skull (AP - LAT), non-contrast CT Brain.

In this study, the mean age of the cases included in the study is 26.41 ± 21.16 years, the minimum age was 8 months and the maximum age was 76 years. 21 cases (70%) of the cases were males and 9 cases were females (30%).

This came in agreement with the results reported by Vasconcelos and Ribeiro who revealed that most of traumatic head injuries victims were males due to their challenging behavior, with more involvement in high-risk activities [(7)].

Regarding the age, The possible explanation for this is that the people in this age group take part in dangerous exercise and sports, drive motor vehicles carelessly and are more likely to be involved in violence [(8)].

This also came in accordance with the study conducted by **Macciocchi *et al.*** [(9)] where the participants' mean age ± SD was 28.7± 10.1 years. The majority of participants were men (79%).

We also agreed with **Nnadi *et al.*** [(10)] who included one hundred and seventy-seven head injury patients were seen over the two- and half-year period. Males constituted 76.8% (136) and females 23.2% (41) with a ratio of 3.3:1. Their ages ranged from one month to 71 years with mean of 23.3 years.

In this study, the most common cause of trauma was RTA (12 cases) followed by struck by hard objects (7 cases). Other causes of trauma were FFH, falling on stairs, falling on the floor and bullet that were found in 6, 2, 2 and 1 case respectively.

This came in agreement with the results reported by **Melo Neto *et al.*** [(11)]. They reported that car accident (58%) was the most frequent etiology of TBI.

Similar results were reported in another study where RTA patients formed 73.4% (130) and majority were motorcycle related (73). Ninety-nine patients had mild head injury [(10)].

Elbiah *et al.* [(12)] showed that the majority of the studied patient had motor car accident (53.30%), while falling from height was in the second mechanism of trauma (30%) and assault was the third mechanism (16.7%). They conducted the study on 90 polytrauma patients with head traumas presented at Suez Canal University Hospitals.

Macciocchi *et al.* [(9)] reported the same results as in this study where the injuries were reported as the following ; MVCs (63%), violence (15%), sporting injuries (13%), and falls (10%) of the cases included in their study.

All the previous studies, including the results of this current study, came opposite to the results reported by **Nemetz *et al.*** [(13)]**,** where Falling from a height was the most common 'traumatic' cause of TBI in their study (76 patients, 43%, and RTA 18%).

Vahldiek *et al.* [14] reported from a total of 1160 patients (86.5%) suffered blunt minor trauma defined as falls from low height or syncope- related falls. Only 182 patients presented to the emergency room (ER) because of a low-speed trauma following a car accident (n¼109, 8.1%) or a bicycle accident (n¼73, 5.4%).

Heskestad *et al.* [15] have reported that frequency of head injuries were 51% fall, 21% RTA and 14% assault, whereas the current study has showed that falls contribute 53.1% RTA 43.1% and assaults are 3.8%.

In our study, more than 50% patients present with therapeutic challenges like threatened airway, difficult other system evaluation and inability to assess underlying co morbidities. The mean time between injury and operation in the cases included in the study was 7.11 ± 4.45 hours, the minimum duration was 2 hours and the maximum duration was 24 hours. In this study, the GCS of most of the cases indicated good condition of the cases as follows; 21 cases (70%) had GCS above 8 while the remaining 9 cases (30%) had scores less than 8.

This came in agreement with the results of another study conducted by **Macciocchi *et al.*** [9] where GCS total scores ranged from 3 to 15, with the most common scores being 13 to 15 (47%). GCS total scores were unknown or not administered in a high number of cases (42%)

Opposite results were reported by Ahuja and his colleagues where 71% of the cases had GCS less than 8 and 27% had GCS between 8 and 13 [16].

In this study, depressed fracture was present in 17 cases, fissure fracture in 7 cases, skull base fracture in 2 cases, diastatic fracture in 1 case and bevelling (bullet inlet and exit) in 1case.

In another study, Characteristics of TBI cases were illustrated as follows; 44% had MVT and 32% had fall-related injuries and the mean GCS was 12.7 and mean ISS was 14.3. Among these TBI patients, 31% had skull/face fractures. Nearly, 12% had other spine fracture/dislocation, 17% had upper limb injury, 12% had lower limb injury, 7% had pelvic injury, and 17% had thorax injury. Among them 3.6% had hypotension and 9.2% had respiratory distress [17].

Regarding the overall mortality, death occurred in 9 cases (30%) while the rest of the cases survived.

This came in agreement with Nnadi and his colleagues as the mortality among severe head injury patients was 37%, while prior to provision of functional intensive care unit (ICU) the mortality among them was 45.83% (11/24) [10].

Also, in this study, 9 cases (30%) had GOS I, 3 cases (10%) had GOS III, 3 cases (10%) had GOS IV and 15 cases (50%) had GOS V.

This disagreed with **Liew *et al.*** [18] who showed in their study that 61(85%) patients were discharged from hospital, with only 29(40%) having good outcome (GOS 4 and 5). Also this was opposite to another study where only 40 (37.4%) of patients in the study had a Glasgow outcome score of 4 and 5 [16].

Finally, as regards the overall complications in our study, chest infections were detected in 4 cases, frontal manifestation in 1 case, grade 4 Lt. sided weakness in 1 case, stable GCS at 14 in 2 cases, reoperation in 1 case and right hemiparesis in 1 case.

In another study, the most common set of post-TBI complications was pneumonia with acute respiratory failure (ARF) and urinary tract infection (UTI) (0.055%); other combinations were also highly related to pneumonia [19].

Corral et al. reported the complications in their study as follows; sepsis occurred in 75% of patients, respiratory infections in 68%, hypotension in 44%, severe respiratory failure (arterial oxygen pressure/oxygen inspired fraction ratio (PaO_2/FiO_2) < 200) in 41% and acute kidney injury (AKI) in 8% [20].

Respiratory problems were also frequently observed in patients with severe TBI in this study. Pneumonia was common (42%), as in other studies, but was not associated with increased mortality [21, 22].

Few limitations of the study were observed. There was no comparison group, and the sample size was relatively small. The study, therefore, cannot be generalized to all patients with brain injury.

CONCLUSION

It could be concluded that surgical intervention is the ideal solution for the management of acute TBI with persistent increased ICP when the other medical management fail under the good circumstances of early intervention and the other factors.

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