Bullet Wounds to the Brain among Civilians

Haider Tawfeeq Abdulhussein[2], Sadiq Fadhil hammoodi[2], Asa'ad F. Albayati[3]

[1]M.B.Ch.B, F.I.B.M.S., Neurosurgery Teaching Hospital, Baghdad, Iraq
[2]M.B.Ch.B., F.I.B.M.S., Neurosurgery Teaching Hospital, Baghdad, Iraq
[3]M.B.Ch.B., F.I.B.M.S., Pathology/Immunology, College of Medicine, Al-Iraqia University, Baghdad, Iraq

Abstract: ***579 civilian patients presented with bullet wounds to the brain treated and followed were studied retrospectively. The study was done from the first of January 2004 to the first of January 2008 in Al- Kadhimia teaching hospital. Most of the patients were in the second and third decades with high percentage of males in the study sample. Penetrating bullet injuries were the most common type of injury encountered in our study. Glasgow coma scale was the most important tool in assessing the patients on admission and also on following them up. All of the patients underwent skull X-ray and 522 had CT scan.218 patients have undergone surgery, either in the form of Craniectomy (in most of the patients) or craniotomy. There is a mortality rate of 61% (355 patients); most of them are those who had GCS score of 3-5.Other complications such as epilepsy and infections are studied and recorded.***

Keywords: Bullet wounds, Iraq

1. Introduction

Missile injuries to the head account for the majority of penetrating wounds of the brain and are responsible for a significant number of deaths. The devastating nature of these injuries is accentuated by their predilection to affect young and otherwise healthy individuals. The cost in terms of loss of productive years of live, medical expenses, and chronic care cannot be estimated accurately from the available data, but it is clearly enormous (1,2,3)50%of trauma deaths resulted from brain injury and 35%of these were caused by a gunshot wound to the head (4).There are several types of injuries, with urban conflict, terrorism, hunting accidents, creating wounds similar to those seen in combat. The neurosurgical management of all penetrating head wounds derives from the same fundamental concepts, whether the penetration involves the scalp, durra and the brain. The intention of treatment is to raise the incidence and quality of survival by:

(Preventing early and late infection, Controlling and relieving raised I.C.P., Reducing secondary damage to the affected brain tissue.)

2. Aims of the Study

1) To determine the clinical, radiological, and surgical characteristics of civilian craniocerebral bullet injury.
2) To determine factors that affect prognosis of patients with craniocerebral bullet injury.
3) To review and discuss the outcome of surgical management and other clinical predictors influencing the prognosis of cranicerebral bullet injury.
4) Demonstrate the usefulness of CT findings in the planning of brain surgery in gunshot victims.

3. Patients and Methods

During a period of four years from January 2004 to January 2008, 579 cases of missile injuries to the brain were treated at AL-KADHIMIA teaching hospital. The patient who had multiple injuries such as abdominal or thoracic wounds were excluded from this study. All patients were assessed for patency of airway, breathing pattern and circulatory status. Neurological assessment was done by the GCS scoring, pupillary size and reaction, other brainstem reflexes and limb movement. Local examination of the missile wound and examination of other systems was carried out elaborately. Resuscitative measures were initiated if the patient require respiratory support or not and whether hemodynamically stable or not. Patients having a GCS score of less than 8 were intubated and ventilated. X-ray of the skull was done in all cases and CT scan was done in 522 cases. All patients were put on Ampiclox vial (when not allergic to penicillin), cefotaxime, and metronidazole through intravenous route. Parenteral phenobarbitone and ranitidine were also started. Mannitol and furesmide were given if the features of raised ICP were seen on imaging studies.218 cases were operated at our center. Surgery is reserved for patients with:

- A GCS score of 3 to5 and a large extra-axial hematoma.
- A GCS score of 6 to 8 without transventricular, bihemispheric, or multilobar dominant hemisphere injury.
- A GCS score of 9 to 15.

No treatment is given to those patients with:
- GCS score of3 to5 without hematoma.
- GCS score of 6 to 8 with transventricular, bihemispheric, or multilobar dominant hemisphere injury.

The operative procedure comprised debridement of the scalp wound and then "Z" OR "S" extention of this wound or rising of scalp flap depending upon the requirement of the skull exposure or closure of the scalp wound. A craniotomy was performed in some cases centered over the skull penertrance, however, the majority of cases undergone a craniectomy involving only the entrance and exit (when present) wounds. The dural wound was completely exposed and it is shredded margins trimmed. Superficial necrotic brain tissue was removed with suction and the missile tract was washed with saline. No suction was introduced into the missile tract. Missile or bone fragments that presented themselves into the wound were picked up with forceps and removed. No extra maneuver was made to remove all the missile and bone fragments seen on the imaging studies. Homeostasis was achieved with monopolar coagulation and gel foam was used when needed for achievement of homeostasis. The dural defect was repaired with pericranial, temporal fascia to achieve a watertight closure. In cases of craniotomy bone flap was replaced and fixed. The wound was irrigated with gentamycin containing saline. The scalp was closed in double or single layer. Postoperatively antibiotics continued during for two weeks and antiepileptic continued even thereafter. Cerebral decongestants (mannitol and furesmide) were continued as dictated by the extent of the injury and if required postoperative ventilation was instituted. Any blood loss was replaced intraoperatively and postoperatively. Postoperative complications were evaluated and managed in detail. The result of treatment was recorded for each patient. The number on death were determined, the time of stay in hospital for each patient was recorded. A rehabilitation period was planned for the disabled patient. All of the 224 surviving patients were followed up to 6 months after injury. Complete neurological assessment, X-ray skull and CT scans of the head were done in all cases with measurement of the outcome using GOS.

4. Results

Age and sex distribution:
The ages of the patients ranges from 18 days to 80 years. The maximum age distribution was in the second decade. The youngest patient was 18 days old while the oldest one was 82 years old.

Table 1: Age (decades) and sex distribution among this study sample

Age	Female	Male	Total number	Percent
0-9 year	11	63	74	12.8%
10-19year	16	100	116	20%
20-29 year	25	151	176	30.4%
30-39 year	16	103	119	20.6%
40-49 year	8	46	54	9.4%
50-59 year	5	32	37	6.4%
60 year >	1	2	3	0.4%
total	82	497	579	100%

Male to female ratio was 6:1, in which 86% of the cases were males while only 14% of the cases were females.

Patient's assessment
Glasgow coma scale: after resuscitation, initially any patient admitted to the casualty was assessed with GCS.

Table 2: GCS scoring in the study sample

GCS	Number	Percent
3-5	335	57%
6-8	46	8%
9-12	70	12%
13-15	128	23%

Pupillary findings: Pupil were examined for reactivity to light reflex, noting there equality and symmetry of reaction in relation to the level of consciousness.

Table 3: Reveal relationship between the pupil reaction and the GCS.

	Level of consciousness			
Pupils	13-15	9-12	6-8	3-5
normal	118	42	14	67
Unequal	10	19	19	53
Fixed, dilated	0	9	13	215
total	128	70	46	335

Hypotension: It was documented in 46 (8.1%) patients on admission before resuscitation, 40 patients (87%) were of 3-5 GCS group and 5 patients (11%) of 6-8 GCS group, while 1 patient (2%) of the 9-13 GCS group.

Time interval:342 patients (59%) were transferred directly to Al-Kadhimiah hospital from the scene of accident, while 237 patients (41%) transferred to Al-Kadhimiah hospital from other hospital.

Table 4: The relation between the time of admission and mortality rate

	Number of patients	Number of deaths	Mortality rate
Direct group	342	197	57%
Transfer group	237	158	67%

Type of the injury: The wounds of the bullet injury are divided into penetrating, tangential, and perforating according to the scalp wounds and plain X-ray and brain CT.

Table 5: The distribution of the type of injury among the study sample

Type of injury	Number	Percentage
Tangential	196	34%
Penetrating	261	45%
Perforating	122	21%
total	579	100%

Radiological findings:
Skull X-ray was done in all cases and revealed skull penetrance without comminution in 336 patients (58%), in 93 patients (16%) extensive comminution of the bone was found, and missile fragments were found in 383 patients (66%).

Computed tomography (CT) scan of the head was done in 522 patients (90%) and revealed:

- Small hemorrhagic contusion with in driven bone without significant mass effects in 130 patients (25%).
- Contusion with mass effects in 313 patients (60%).
- Cortical contusion without in driven bones in 26 patients (5%).
- Distant intracranial contusion 35 patients (6.6%).
- Intraventricular hemorrhage was seen in 43patients (8.3%).
- Multilobar injury seen in 122 patients (23.3%).
- Unilobar injury was seen in 348 patients (66.6%).
- Subarachnoid hemorrhage in 407 patients (78%).
- Hemorrhage along the missile tract in 83 patients (16%).

Missile fragments were found (when present) at the distal end of the injury tract while bones at the proximal.

Surgical treatment: After stabilization of the patients' condition, and in the presence of indication of surgery, surgical intervention was done. Acute surgeries were performed in 218 patients (38%). The time interval between the time of injury and the time of surgery varied from 6 to 72 hours with an average of 36 hours, however, antibiotics were started within 6 hours of injury, in which:

- 136 patients (64%) were operated within 24 hours.
- 63 patients (29%) were operated between 24 to 48 hours.
- 15 patients (7%) were operated 48 to 72 hours after injury.

This delay was due to the delay in the evacuation from forward hospitals in most cases and in the other cases the delay was due to patient s condition in which the vital signs and GCS did not permit the operative intervention at time of admission. For exposure of the skull, the missile wound was extended with "Z" or "S" extension in 211 cases (97%), and scalp flap was raised in 7 cases (3%). Craniectomy was done in 213 cases (98%), while craniotomy was done in 5 cases (2%). Primary closure was performed in 7 cases (3.3%) Debridement of necrotic tissue and retained fragments (bone or foreign bodies) in 148 cases (68%). Duroplasty was done in 211 cases (96.7%).

The distribution of the wound site in the operated cases was as follows:

- Frontal area 94 cases (42.8%)
- Parietal area 98 cases (45%)
- Temporal area 15 cases (7.1%)
- Occipital area 11 cases (5.1%)

Surgical outcome

Mortality: In regard to the GCS the highest mortality rate was in the 3-5 GCS group, and the lowest in the 13-15 GCS group with an average mortality rate of 61%.

Table 6: The number of deaths versus the admission GCS

GCS	Number	Death	Percentage
3-5	335	315	94%
6-8	46	27	59%
9-12	70	10	15%
13-15	128	3	3%
Total	579	355	61%

These readings include all patients in the study; postoperative mortality rate was 15.4% (34 patients of the operated cases).

Complications

Table 7: Showing the incidence of complications postoperatively

Type	Number	Percentage
Brain infection, all	9	4.4%
CSF leakage	9	4.4%
Wound infection	5	2.2%
Postoperative brain hemorrhage	2	0.9%
Postdebridement brain swelling	2	0.9%
Respiratory problems	2	0.9%
Pulmonary embolism	1	0.5%
DVT	1	0.5%
Gastrointestinal bleeding	2	0.9%
Epilepsy	43	20%
Retained bone or metallic fragments	74	34%

Epilepsy was the most common complication accounting for 20% of postoperative complications. Brain infections (meningitis, cerebritis, and brain abscess) were second to epilepsy as a common postoperative complication to cranicerebral bullet injury despite the use of antibiotics.CSF leakage occur in 9 cases of which 3 from the operative site, 5 as rhinorrhea, and 1 as Ottorrhea.

Glasgow outcome scale:

These results represent the whole patients including those who kept on conservative treatment.

Table 8: Showing the Glasgow outcome scale.

Glasgow outcome scale	Number	Percentage
Good outcome	75	13%
Moderate disabled	115	20%
Severely disabled	28	5%
Persistent vegetative state	6	1%
dead	355	61%
total	579	100%

5. Discussion

Half million people in the world, each year have a gunshot injury to the head and eighty thousand of them are hospitalized (5).Missile injuries to the head are the most devastating type of injury. Usually they are caused by high-velocity missiles or by handguns fired from a very close range. There are varying degrees of cavitations in the brain along the wounding agent s path, usually several times larger than the diameter of the agent. During the agent transit, a percussion wave transmitted throughout the brain, causing explosive fractures of the skull and widespread destruction of neuronal cell membranes. Immediately after injury, the intracranial pressure rises tremendously because of the transmission of the kinetic energy to the brain. The intracranial pressure slowly declines to some extent, but rises again due to intracranial bleeding or to progressive brain edema (7).Missile induced head injuries can be influenced by the anatomical location of the injury, i.e. type of tissue and by the ballistic properties such as the design of the weapon and the mass, shape and construction of the projectile, as well as its velocity characteristics and trajectory angle (8).

Age and outcome: It's noted that 70% of patients older than 60 died, but in those 21 to 40 years of age, mortality was only 15% (6).also it's noted that increasing age was a powerful negative prognostic factor for those with a GCS score greater than 5(8). In our study most of our patients were in the second and the third decades (50%), yet the mortality rate was 61% indicating that there other factors that control the outcome of such injuries.

Glasgow coma scale: The GCS score has been found to be the main determinant of the outcome in our series. A lower GCS score predicts poor outcome and a higher one a better outcome (9, 10, 11). The patients with GCS score exceeding 8 had by far more favorable outcome in comparison to those with GCS score less than 8. Considering the extent of injury, patients suffering unihemispheric brain wounds had a more favorable outcome than those with lesions of both hemispheres, and particularly those with transventricular lesions. In our study, the mortality rate was the highest in the patients with GCS 3-5 score (94%) and lowest in the patients with GCS score 13-15 (3%).

Pupillary response: Unequal pupils were not necessarily associated with a poor outcome, but fixed and dilated or midrange pupils presaged death (12). The presence or absence of pupillary light reflexes also has been correlated with outcome. In the IDB (international data bank), 91% of patients with nonreactive pupils died or were left vegetative, compared with 39% of patients with reactive pupils (13). The trend was even more pronounced for patients older than 50 years, in whom 94% with nonreactive pupils died. Similarly, Heiden et al. (14) reported poor outcomes (dead, vegetative) in 91% of patients with nonreactive pupils versus 36% of patients with reactive pupils. Braakman et al. (15) found that patients with only one reactive pupil had 54% mortality compared with 90% mortality in patients with both pupils nonreactive and 29% mortality in patients with both pupils reactive. All the above numbers correlate with our study in which fixed dilated pupil indicate bad prognosis as it's found mostly in patients with GCS score 3-5.

Time of admission: The time between injury and hospital admission proved to be another important prognostic factor. The majority of patients admitted up to one hour of injury survived, while two thirds of those admitted between one and three hours of injury succumbed (16).The number of patients with shock was significantly larger in the transfer group than that in the direct group. The shock was considered to be developed during the transportation. The outcomes were then significantly poorer in the transfer group than those in the direct group (17). Ironically, the short transport time was associated with the mortality rate because the severely injured patients in the field were preferentially transported to our hospital. They died in a few hours. Therefore our mortality rate was higher than the literature.

Retained bodies: The presence of intracranially retained foreign bodies and bone fragments, and post injury and postoperative complications implied worse outcome in comparison with their absence. Civilian neurosurgeons in general have never addressed the late infective potential of in driven bone in a systemic way. Several authors (18, 19, 12, 20, 21) have noted postdebridement infections and, by statement or inference, retained bone fragments. The cause of these infections was either not stated or ascribed to other complications, such as cerebrospinal fluid and sinus injury, rather than to the retained bone.

Other factors: Other factors, which are associated with a poor outcome, are multilobar injuries, Intraventricular hemorrhage and dominant hemispheric injuries, as is evident from. Similar observations have been made in earlier studies (9, 22, 23, 11). Injury to the eloquent regions of the brain, commotion and contusion of the brain, intracranial hematomas, subarachnoid hemorrhage, cerebro-vascular spasm, injuries to the major vessels, liquor rhea, infections, coagulopathies and epilepsy are the most important and influential factors in the clinical status of the patient with gunshot injury to the head (5).

Hypotension: Patients with penetrating brain wounds often had an SBP less than 90 mmHg from concomitant bleeding, and 72% of these patients died (24). Hypoxia and hypotension in the head-injured patient can have a significant effect on outcome. Miller et al. (25) reported that arterial hypoxemia was present on admission in 37% of their series and was associated with poor outcomes (dead, vegetative, or severe disability) in 59% of their patients. Hypotension (systolic blood pressure <90 mm Hg) was present on admission 16% of the time and was associated with poor outcomes in 65% of these patients. Levati et al. (26) reported 58% mortality in patients with hypotension versus 37% in those without hypotension. Pietropaoli et al. (27) showed that in surgical patients intraoperative hypotension was associated with 82% mortality, compared with 25% mortality in patients without intraoperative hypotension. In the TCDB(traumatic coma data bank), Marmarou et al. (28) demonstrated that outcome was correlated strongly with the proportion of hourly blood pressure measurements less than 80 mm Hg. In that study, 80 mm Hg was shown to be a critical blood pressure, at or below which hypotension began to exert its deleterious effects. Piek et al. (29) reported that a systolic blood pressure less than or equal to 90 mm Hg at any time between injury and arrival at the hospital doubled mortality, independent of other factors. Thus, the occurrence of hypotension at any time following injury is associated with a poorer outcome. In our study, Hypotension was found in 87% of patients with GCS score 3-5 so it may give us a clue to the prognosis.

Radiological imaging: Radiographic assessment of a missile cranicerebral injury is generally more complex than imaging of closed head injury, primarily due to involvement of multiple anatomic levels in virtually every instance. Scalp, skull, and cranial vault. Although the CT scan has virtually supplanted X- ray films in trauma setting, nearly all cranicerebral injuries involve comminuted, depressed skull fractures or foreign bodies(or both), situations in which skull films are likely to be of some benefit. Since it is advent in 1972, CT has perhaps been the single most important diagnostic imaging innovation relevant to the management of traumatic head injury. All patients with cranicerebral gunshot wound injury should be studied by CT, except for the most extreme situations in which the direct surgical intervention may be clinically mandated or when the patient is clinically neurologically moribund, and there is no hope for survival (30). Emergency CT demonstrated the mechanism of the injury, the bullet path and site, the site of bone and/or metallic fragments, and damage extent. In all perforating cranioencephalic injuries intracerebral or extrathecal bone fragments were demonstrated adjacent to the bullet entrance and exit holes, respectively. In injury monitoring. CT showed injury evolution, retained fragments and complications, thus enabling damage extent assessment (31).Computed tomographic scan characteristics such as midline shift, compression or obliteration of the mesencephalic cisterns, the presence of subarachnoid blood, intraventricular hemorrhage, and the presence of hyper dense or mixed-density lesions greater than 15 mL, either bilateral or unilateral, were all associated with a poor outcome (32).The parenchymal laceration produced by the missile is generally conical in shape, with the base of the cone situated at the entrance site and a gradually decreasing diameter along the missile track. Hemorrhage from small lacerated blood vessels usually outlines the wound canal, which is then seen as a high attention conical laceration. This laceration is usually observed in many CT scans of the patients with penetrating type of bullet cranicerebral injury (33). In our series, we observed 83 patients with hemorrhage along the missile tract on CT scans. Patients with one lobe injured by a bullet had 23% mortality. If the bullet crossed the midsagittal plane, 40% of patients died, if it's crossed the midcoronal plane, 53% died, and if both midcoronal and midsagittal planes were crossed, 75% died(3). Pathophysiological alterations created missiles arise through 3 mechanisms, the predominant mechanism being dependent on the velocity of the missile:"1" direct laceration "2" shock wave transmission, and "3" cavitation. At low impact velocities, tissue damage is limited and occurs primarily by laceration. With increasing velocity, the later 2 mechanisms are increasingly prominent and, in fact become the predominant mechanism of tissue damage above 320m/sec, the speed of sound. Shock waves are violent pulsations of high pressure waves traveling at the speed of sound and emanating from the front of the advancing missile. They may reflect off the skull and summate; increasing the amount of damage (33, 30, 19, 7).Cavitation is the predominant mechanism of damage at the highest missile velocities. The advancing missile pushes away tissues through a violent centrifugal motion, creating a temporary conical cavity that pulsates several times before collapsing. A negative pressure gradient is also created within the temporary cavity, suctioning debris into the wound. With the highest velocities, cavitional motion may be so centrifugally explosive that it literally bursts the skull (34, 35).Ventricular injury may be a component of craniocerebral bullet injury. Intraventricular hemorrhage, air or foreign body is an indicator of ventricular injury that is usually found by CT scans. Intraventricular hemorrhage has poor prognostic implications and is seen on CT as high attenuation material usually layering dependently within the occipital horns of the lateral ventricles, although a large amount of cloth may form a virtual cast of ventricles (7, 36). Intraventricular hemorrhages result from direct penetration by the bullet or from transmitted shear and tensile stresses on the ventricular walls result in vessel injury. Intraventricular blood is a poor prognostic sign even if ballistic ventricular penetration has occurred because its presence in any trauma setting signifies major brain injury (100). We detected 43 cases of ventricular injury in our sample with penetrating injuries and Intraventricular air, foreign body and blood were detected on CT scans of the patients.

Management: Surgery is the main choice of treatment for the cranicerebral bullet injury. Bullet wounds, in contrast to wounds caused by a blow or impact to the viscerocranium, are characterized by an irregular path, entry and exit wounds, as well as localized demolition of bones with the associated defects (37).All cranial gunshot patients should initially receive aggressive resuscitation. Patients with stable vital signs should be examined by computed tomographic scan. If the patient's GCS score after resuscitation is 3 to 5 and no operable hematomas are present, then no further therapy should be offered. All patients with a GCS score greater than 5 should receive aggressive surgical therapy (38).No surgery should be undertaken for patients with GCS scores of 3 to 5 with unilateral multilobe injuries or with bihemispheric wounds, especially if the missile had fragmented and scattered. Comatose patients who had unilateral multilobar injuries with scattering of bone and metal fragments were also not operated on (38).Patients with post resuscitation GCS scores of 3 to 5 should undergo surgery only if they have a significant hematoma demonstrated on CT (11).Those with GCS scores of 6 to 8 should be operated on only if they have a hematoma or a unilateral nondominant hemisphere wound that does not involve the ventricle. If a GCS score 6 to 8 patient has a bihemispheric wound or a unilateral dominant hemisphere, multilobe wound with or without ventricular penetration, no surgery is advised because of the poor functional outcome expected(39).All patients with a GCS score greater than 8 deserve aggressive surgery (11). The criteria for the selection of craniotomy and Craniectomy were laid down by Rich et al (39) i.e. If the exposure required is large, the surgery is done shortly after the injury is sustained, and if there is no gross contamination of the wound and no significant comminution of bone. Suturing the dura mater during a primary surgical treatment should be regarded as a protective processTo limit antigen release, the development of immunological paralysis and autoimmunization (40).

Infection: Infection is one of the common encountered delayed complications of missile head injury. Some authors suggested that intracranial bone fragments that were not removed could cause infection (9, 41). Experimental studies reveals that the presence of bone fragments did not increase the infection rate itself, but if the fragments were combined with scalp or hairs, this rate become 10 times higher (42).Retained fragments did not increase the infection risk but high rates of infection did occur in cases with CSF fistulas (43). Among the studied factors, those increasing the infection .Rate were: coma on admission, penetrating wounds, intracerebral trajectory length over 6 cm, air sinuses Effraction, a surgical delay over 72 hours, inadequate duroplasty, cerebrospinal fluid (CSF) fistulae. The Presence of postoperative bone fragments did not increase the infection rate (47).In our study, we diagnosed infection in 4.4% of our patients. Various factors associated with the development of intracranial sepsis in missile injuries of the brain are CSF leaks, skull base injuries, extensive brain injury, prolonged coma, transportation time of > 48 hours and retained intracranial missile and bone fragments (44, 45, 46). In the absence of other factors brain abscesses do not occur in patients with retained bone or missile fragments (45, 48).

Epilepsy: Posttraumatic epilepsy is another complication associated with cranicerebral bullet injury. It reflects the extent of brain damage and is positively correlated with coma (49). Some reports have linked seizures to increased mortality and morbidity (50, 51). But others (7, 52) suggested that the post traumatic epilepsy is not associated with death. In our series, we observe epilepsy in 43 patients (20%) and the seizure were controlled with anticonvulsants.

As compared to other patients, epileptics were more commonly found to have: 1) frontoparietal lesion; 2) multiple bony defects of the vault of the skull; 3) enlargement of the Lateral ventricle of the brain on CT scans; 4) primary coma for > 2 hours and other depressed consciousness syndromes for > 1 day; 5) signs of left-handedness (53).

Mortality: The mortality rate of all admitted patients in ourMaterial was 61%; a direct relation between the severity of primary brain damage (recognizable in the degree of initial unconsciousness) and the chance of survival was found (54).Logistic regression identified the following variables as predictors of death: respiratory arrest on admission, hypotension on admission, transhemispheric and transventricular GSW (55).

Favorable outcome: The clinical characteristics that implied favorable outcome were: Glasgow Coma Scale score greater than 12, location of injury in the anterior cranial fossa, time to admission shorter than 1 hour, and absence of an intracranially retained foreign body and postoperative complications (56).

6. Conclusions

1) Missile injuries to the head are the most devastating type of injury and the penetrating variety is the one with most poor prognosis.
2) Males are affected more than females in the range of 6:1, with the most affected in the second followed by the third decade.
3) The GCS score has been found to be the main determinant of the outcome in our series. A lower GCS score predicts poor outcome and a higher one a better outcome. The patients with GCS score exceeding 8 had by far more favorable outcome in comparison to those with GCS score less than 8.
4) The time between injury and hospital admission proved to be another important prognostic factor. The majority of patients admitted up to one hour of injury survived, while two thirds of those admitted between one and three hours of injury succumbed.
5) Hypoxia and hypotension in the head-injured patient can have a significant effect on outcome.
6) All patients with cranicerebral gunshot wound injury should be studied by CT, except for the most extreme situations in which the direct surgical intervention may be clinically mandated or when the patient is clinically neurologically moribund, and there is no hope for survival.Emergency CT demonstrated the mechanism of the injury, the bullet path and site, the site of bone and/or metallic fragments, and damage extent.
7) Blood, Intraventricular hemorrhage, and the presence of hyper dense or mixed-density lesions greater than 15 mL, either bilateral or unilateral, were all associated with a poor outcome.
8) Surgery is the main choice of treatment for the cranicerebral bullet injury.
9) Patients with stable vital signs should be examined by computed tomographic scan. If the patient's GCS score after resuscitation is 3 to 5 and no operable hematomas are present, then no further therapy should be offered. All patients with a GCS score greater than 5 should receive aggressive surgical therapy
10) No surgery should be undertaken for patients with GCS scores of 3 to 5 with unilateral multilobe injuries or with bihemispheric wounds, especially if the missile had fragmented and scattered. Comatose patients who had unilateral multilobar injuries with scattering of bone and metal fragments were also not operated on. Patients with post resuscitation GCS scores of 3 to 5 should undergo surgery only if they have a significant hematoma demonstrated on CT.
11) Those with GCS scores of 6 to 8 should be operated on only if they have a hematoma or a unilateral nondominant hemisphere wound that does not involve the ventricle. If a GCS score 6 to 8 patient has a bihemispheric wound or a unilateral dominant hemisphere, multilobe wound with or without ventricular penetration, no surgery is advised because of the poor functional outcome expected.
12) All patients with a GCS score greater than 8 deserve aggressive surgery.
13) The current goals for operative management of missile craniocerebral trauma should include the following:
14) (Debridement of necrotic scalp, muscle, and brain, Removal of accessible in-driven bone and missile fragments [however, not at the expense of increased neurological deficit or loss of significant amounts of potentially viable cerebral tissue], Evacuation of all significant mass lesions, Homeostasis and repair of injured vascular structures, Meticulous dural and scalp closures)
15) Infection is one of the common encountered delayed complications of missile head injury.
16) Posttraumatic epilepsy is another complication associated with cranicerebral bullet injury. It reflects the extent of brain damage and is positively correlated with coma.
17) The clinical characteristics that implied favorable outcome were: Glasgow Coma Scale score greater than 12, location of injury in the anterior cranial fossa, time to admission shorter than 1 hour, and absence of an intracranially retained foreign body and postoperative complications.

7. Recommendations

1) This is a preliminary study aiming to obtain data that are specific to our country and compare it with the international ones. We hope that our colleagues continue this effort by gathering more cases and continue in the follow-up of the studied cases. This will make our data and statistics more accurate and more representive of the population.
2) Better training of the casualty staff on the principles of resuscitation and care of severely injured patients so that we can prevent the secondary injury to the brain aggravating his condition.
3) Every patient should undergo a CT scan, as it's the best tool that can be used in the decision of planning for surgery or not.
4) Extended follow up required for all patients underwent surgery, so one can detect the long term outcome, and

any even minor delayed complications, or consequences of surgery, aiming for improving our practice.

5) Great care should be paid for documentation as it forms the corner stone in any scientific development, more attention should be given for patients records, which should include even the least important details about the patient s disease, investigations, treatment and final outcome of the patient, which should be documented in more scientific way. These records should be reserved in more proper way.

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