ORIGINAL ARTICLE

To Study the Factors of Favorable Clinical Outcome of Traumatic Brain Injury Due to Firearm

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ABSTRACT

Aim: *The aim of this study is to evaluate factors affecting favorable outcome of traumatic brain injuries caused by bullets and bomb blast wounds.*

Material and Methods: *This was a descriptive study conducted in the department of neurosurgery Hayatabad Medical Complex Peshawar from January 2011 to January 2012. There were 104 patients of bomb blast and bullet injuries to the head were admitted in emergency department of Hayatabad Medical Complex after initial resuscitation shifted to Head Injury Unit. Their neurological, radiological and operative findings were studied for favorable clinical outcome. Neurological assessment was done with Glasgow coma score, X-Ray skull and CT brain was done in all the patient. Emergency surgery was done for all the patients. All patients were fallowed for a period of two month. Brain injuries due to other causes were excluded from the study.*

Results: *Almost all patients (80%) were male, and the mean patient age was 22.3 years. Wounds caused by shrapnel in 70 percent of patients. The Glasgow Coma Score (GCS) score at admission was below 8 in 26 patients (25%) and above 8 in 78patients (75%). In total, 14 patients (13.4%) died despite surgical management.*

Conclusion: *Low GCS scores, ventricular injuries and bihemispheric injuries are correlated with poor prognosis. Early and less invasive surgery in conjunction with short transportation time to the hospital could decrease mortality rates.*

Key Words: *Traumatic brain injury, Gunshot wounds, GCS, Brain injury.*

INTRODUCTION

Terrorism in Pakistan has become a major and highly destructive phenomenon in recent years. The annual death toll from terrorist attacks has risen from 164 in 2003 to 3318 in 2009[1], with a total of 35,000 Pakistanis killed between September 11, 2001 and May 2011. According to the government of Pakistan, the direct and indirect economic costs of terrorism from 2000 – 2010 total $68 billion.[1] Bomb blast and bullet injuries are penetrating brain injuries and carries high morbidity and mortality rate. The ability of bullets, shrapnel, and low – velocity objects such as knives and arrows to penetrate the brain is dependent on their energy, shape, the angle of approach, and the characteristics of intervening tissues (skull, muscle, mucosa, etc.). Primary injury to the brain is determined by the ballistic properties (kinetic energy, mass, velocity, shape, etc.) of the projectile and any secondary projectiles, such as bone or metallic fragments. The kinetic energy is defined by the relationship: $E = ½mv^2$, which implies that the velocity of the projectile has a greater influence than the mass of the projectile alone. As the projectile travels through the brain parenchyma it crushes the soft brain tissue in its path, creating a permanent track of injury.[2,3] This is in addition to the secondary missiles such as bone and metal fragments created from the impact of projectile on the skull[4]. Higher velocity projectiles will also impart an additional temporary cavitation effect in their way, which is a velocity – related phenomenon. This results from the transmission of the kinetic energy of the projectile to the surrounding tissue, thus rapidly compressing it tange-

ntially from the primary track. This temporary cavity then collapses upon itself only to re-expand in progressively smaller undulating wave – like patterns. Every cycle of temporary expansion and collapse creates significant surrounding tissue injury to the brain. This can result in shear – like injury of the neurons or can result in epidural hematomas, subdural hematomas, or parenchymal contusions.[5] Projectiles traveling at higher velocities carries more kinetic energy, and thus causes more damage. Wounds can be classified as tangential, perforating, or penetrating. The latter are the most devastating type of missile injury to the head. Penetrating missile, especially those that cross the coronal or midline sagittal planes, are usually fatal. TBI is classified according to the extent of brain damage as mild, moderate or severe. A low Glasgow Coma Scale (GCS) score at admission and a lateral penetrating injury is usually correlated with severe traumatic brain injuries.[6,7] The outcome of which can be anything from complete recovery to permanent disability or death. Mild and moderate TBI may also cause a host of temporary or permanent physical, cognitive, emotional and social problems. Severe TBI resulting from a gunshot wound is usually treated surgically. Data on morbidity and mortality may be helpful in determining which patients are likely to benefit from surgical intervention. This paper presents clinical, radiological and surgical assessments of 104 patients with TBI caused by gunshot wounds and bomb blasts, and it evaluates the possible predictive factors for the outcome of surgical intervention.

MATERIAL AND METHODS

This was a descriptive study conducted in the department of Neurosurgery at Hayatabad Medical Complex Peshawar from January 2011 to January 2012. There were total of 104 patients (84 male, 20 female mean age 22.3 years; age range 15 – 54 years) with penetrating brain injuries caused by bomb blast and bullets who were brought in emergency department of Hayatabad Medical complex Peshawar after initial resuscitation were admitted in the Head Injury unit and ICU. Individuals who had gunshot wounds other than head injury that did not penetrate the cranium were excluded from the study and also who were brought dead due to gunshot or bomb blast injury to head and who had penetrating head injury other than bomb blast or bullets. Most of the patient arrived in the hospital emergency with the mean time – lapse between injury and arrival was 2 to, 3 hours. Neurological assessments of all the patient were done with the help of Glasgow Coma Score. Pre-operative skull x-rays and CT scan was taken in all patients. X-rays showed the fractures, bullet, and bomb pieces and CT scans revealed both Hematomas and intracranial bone fragments; foreign bodies, including metal, stone and blood-filled bullet trajectories. Data was collected with the help of Performa and was analyzed with help of software Microsoft Excel. All patients were treated surgically in the emergency. During surgery intracranial bone and metal fragments that were superficial were removed, necrotic brain tissue was debrided and active hemorrhages were stopped. Bone and metal fragments of deep or eloquent locations were left in place. In most cases, the Dura was closed with primary suturing; however, in cases with large gaps between the dural edges, duraplasty was performed using pericranium, temporalis muscle fascia or tensor fascia lata tissue. All patients received a standard medication protocol that included third – generation cephalosporin for one moth postoperatively together with antiedema, anticonvulsant and analgesic agents. All patients were followed by CT scans, postoperatively. Patients with CT scans showing extensive brain edema and GCS below eight were intubated and ventilated. For patients with deep bone and metal fragments, treatment was conservative. Secondary surgery was performed on patients with large cranial defects, intracranial infections such as intracerebral abscess or empyema, cerebrospinal fluid (CSF) leakage and hydrocephalus. The number and causes of death were recorded. The factors for the favorable outcome were divided into three groups. First group included time of arrival to the hospital and the post resuscitative conscious level of the patient which was assessed through Glasgow Coma Score that is GCS below8 severe head injury. 9 to12 moderate head injury and 13 to 15 mild head injury of the patient. Second group included the radiological findings like number of lobe involved, intra-cereble bleed and preoperative finding like skin and scalp loss dural loss brain damage ,bone, bullet pieces involving the brain areas and postoperative complication like infection, fits, hydrocephalus. Outcome was assessed on the basis of Glasgow Coma Outcome scale i.e. Good (Grade V), Moderate Disability (Grade IV), Sever Disability (Grade III), Vegetative (Grade II), and Death (Grade I). Patients suffering from neurological impairment following surgery underwent rehabilitation. Follow up for all patients consisted of neurological examination including CT scans at 2 – month intervals after discharge.

RESULTS

In our study majority of the head injuries were due to bomb blasts shrapnel's (70%) and the remaining injuries are caused by bullets (30%). The most common site of injuries to the brain on the basis of CT was frontal lobe and number of patients were (33), followed by the temporal and parietal lobes (20, 18) respectively, where as Parietal lobe (18), Occipital lobe (10), Brain stem (5) ,Orbito cranial region (9) and multiple injury sites were seen in (9) patients. Mortality rates were highest for Brain stem injuries and multiple site injuries, lowest for Orbito cranial region. The relationship between the GCS score and the mortality is a very important factor which was divided into three Groups depending upon the severity of head injury. Group I Sever injury with GCS 3 to 8 number of patients were 10, number of deaths were 8 (80%). Group II Moderate head injury with GCS 9 to 12 number of patient were 26, deaths were 5 (19%). Group III Mild head injury with GCS 13 to 15 number of patient were 68, death were 1 (1.7%). The Dura was closed primarily in 15 cases (14.1%). With pericranium, temporal muscle fascia and tensor fascia lata in 59 cases (56%). Retained bone and or metal fragments were detected in 33 (32%) patients after the primary surgery. Fragments lodged in deep locations and eloquent brain areas were left in place. Ventricular injuries were detected in 17 (16.3%) patients. The overall mortality rate among the patients in this study was 13.4% (n = 14), and the most common cause of death was diffuse brain injury (50%; n = 7), followed by brain stem injury (28%; n = 4), infection (21%; n = 3). Outcome of the 104 patients in this study was assessed on the basis of Glasgow Coma Outcome Score, 73 (70%) patient were in Grade 5. 10 patient (9.6 %) had the moderate disability for self – care, while 5 (4.8%) had sever disability Grade III, 2 (1.9%) patient were in vegetative state Grade II and Death 14 (13.4%) Grade I.

DISCUSSION

All cranial gunshot victims were aggressively resuscitated upon initial arrival at the hospital. If a patient's blood pressure and oxygenation can be maintained, an urgent CT scan of the brain is obtained. The decision to proceed with surgical management of the gunshot wound is based on three factors. The level of consciousness (GCS), the degree of neurological brainstem function, and the findings on CT scan. In our study the most common site of injuries to the brain on the basis of CT was frontal lobe and the number of patients were (33), followed by the temporal and parietal lobes (20, 18) respectively, where as Parietal lobe (18), Occipital lobe (10), Brain stem (5), Orbito cranial region (9) and multiple injury sites were seen in (9) patients. Mortality rates were highest for Brain stem injuries and multiple site injuries, similar are results in the study conducted in Turkey by Dr Silah Yaralanmalar. Also the study conducted by Dr Abrar ahad wani the outcome also depended on the extent of brain damage since the wounds associated with a high mortality rate were predominantly bihemispheric.[8,9] The relationship between the GCS score and the mortality is a very important factor which was divided into three Groups depending upon the severity of head injury. Group I Sever injury with GCS 3 to 8 number of patients were 10, number of deaths were 8 (80%) similar are the results of the study of Ansari and Panezai published in the British journal of Neurosurgery where the patient with low GCS had the high mortality rate, 52 patients died out of hundred patients.[10] Group II Moderate head injury with GCS 9 to 12 number of patient were 26 deaths were 5 (19%). Group III Mild head injury with GCS 13 to 15 number of patient were 68 death were 1 (1.7%). GCS is the strong predictor of the outcome in all head injuries irrespective of the etiology.[11] The patients who present in a comatose state invariably have a poor outcome. In a study by Kaufman *et al*., there was a mortality rate of 97% (83 of 86 patients) in patients with a GCS score of 3 – 5.[12] They found that the outcome improved as the GCS score increased, and concluded that the patients with an admission GCS score of 3 – 5 after resuscitation (without an operable hematoma) should not be operated. Levy *et al*[13] evaluated the outcome of patients who had a low GCS (5 or less) score, they had 60 patients in the series, and out of them only two patients had Survived, the variables most predictive of mortality in their study included admission GCS score. In another study by Splavski *et al*. the state of consciousness on admission was the most sensitive criterion as far as the prognosis was concerned. The outcome also depended on the extent of brain damage since the wounds associated with a high mortality rate were predominantly bihemispheric Ansari and Panezai.[10] In our study all patients underwent primary surgery. That included necrotic tissue debridement, hemorrhage control, removal of superficial foreign bodies and dural repair. The Dura was closed primarily in 15 cases (14.1%). Retained bone and or metal fragments were detected in 33 (32%) patients after the primary surgery. Fragments lodged in deep locations and eloquent

brain areas were left in place. Ventricular injuries were detected in 17 (16.3%) patients. The most common complication of primary surgery was infection, which was observed in 15 (14.2%) patients. The infection was either systemic or local, but required long – term and broad-spectrum antibiotic regimen. Other surgical complications included intracranial hematomas, hydrocephalus, wound – healing problems and CSF fistulae. CSF leakage is a common complication Aredall and Meriowsly reported a 28% incidence leading to infection. In another study it is documented 4% to 11% in military injuries while in civilian injuries it is 1% to 5%.[14] The most common cause of death was diffuse brain injury (50%; n = 7), followed by brain stem injury (28%; n = 4), infection (21%; n = 3). The follow-up period for all patients was up to 2 month. All patients required extended hospital stays, mainly due to the length of post-operative rehabilitation. Outcome of the 104 patients in this study was assessed on the basis of Glasgow Coma Outcome Score, 73 (70%) patient were in Grade 5. 10 patient (9.6%) had the moderate disability for self – care, while 5 (4.8%) had sever disability Grade III, 2 (1.9%) patient were in vegetative state. In a study conducted by Zang X, Xi patients were fallowed for three months, their outcome 45% had good recovery, Moderate disability, Sever disability and Vegetative state in their series was 29%, 14% and 2% respectively.[15]

CONCLUSION

Glasgow Coma Score at admission seem to be the most significant predictor of outcome in penetrating craniocerebral gunshot wounds or bomb blast injuries. Computed tomography scans, bi- or multilobar injury, and intraventricular hemorrhage were correlated with poor outcome. Less aggressive debridement of deep seated fragments and a more aggressive antibiotic prophylaxis in an effort to improve outcomes. The surgeon should not be discouraged by a low GCS score at admission or ventricular involvement. Moreover, recent advances particularly in neuroimaging and surgical techniques could save more lives than medical advances.

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