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Time Is Brain; Factors Influencing The Outcome of Missile Head Injuries In Conflict Zone

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ABSTRACT

Objective: To analyze factors influencing the outcome in patients with missile head injuries sustained in the conflict zone, to help in developing a plan for treating and optimizing such patients.

Study Design: Retrospective longitudinal study

Place and Duration of Study: Neurosurgical unit Combined Military Hospital Peshawar, Pakistan from Jul 2015 to Jun 2018.

Methodology: Over a period of three years 66 male patients met the criteria with a mean age of 28 yrs. The variables identified were mechanism of injury: blast or gunshot injury, glasgow coma score (GCS) on arrival, time to reach to neurosurgical facility, location of entry wound, presence of Polytrauma, Pupils status, CT scan findings, surgical treatment, retained foreign body, seizures, hydrocephalus, cerebrospinal fluid leak and glasgow outcome scale extended (GOS E) score of 1-8.

Results: Out of 66 patients, 12 patients (18.2%) sustained bullet injuries and 54 (81.8%) sustained blast splinter injuries to head. There were 24 patients (36.4%) with GOS score of 1 (death), 4 patients (6.1%) with GOS score of 6 (moderate disability), 9 patients (13.6%) with GOS score of 7 (good recovery lower) and 29 patients (43.9%) with GOS score 8 (good recovery).

Conclusion: In time adequate triage and prompt optimisation of patients before and during the safe medical evacuation of penetrating head injuries in the austere environment of conflict zone will lead the efforts to save the survivables and will push the balance to many good outcomes

Keywords: optimization, penetrating head injuries, conflict zone

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INTRODUCTION

Missile head injuries are the unavoidable consequence of any conflict. The neurosurgical history has thoroughly documented the efforts of neurosurgeons to optimise care for such injuries since as early as 20th century beginning with Harvey Cushing's experience during World War I.[1] He advocated strongly for early and definitive debridement of necrotic tissue, removal of all in-driven debris, and meticulous dura and scalp closure, lowering the operative mortality rate from 55% to 29%. The aggressive initial debridement was advocated and was continued by the United States Army Medical Corps throughout the Vietnam conflict, the infection rate declined from 53% to 15%.and mortality rate from 25% to 4%.[2]

Since the United States Army invasion of Afghanistan in 2001, the border regions of Pakistan had witnessed an insurgency that led to the undertaking of multiple operations against terrorism. Resultantly, many neurosurgeons gained enough experience in dealing with war missile head injuries. The management of missile head injuries in the austere environment of conflict zone becomes different than civilian gunshot head injuries in cities due to variety of factors [3-5].[1] Missile calibre, velocities, and under body blasts.[2] Austerity of medical resources.[3] Ground hurdles in transfer.[4] Lack of experienced physicians for proper Triage. Therefore, due to lack of consensus in literature how much is enough has risen many management controversies such as indications of air transfer, surgical treatment including decompressive craniectomy, duroplasty and indications to remove shells/ splinters.[4,6]

The aim of this retrospective analysis of the 66 patients with missile head injuries in the low intensity conflict is to the identify the few reliable predictors of mortality and poor outcome. Collection and careful analysis of conflict zone casualty care indicators will allow the medical system to develop a plan for treating and optimizing such patients.[7,8] Additionally, the data uncovered by analysis of these statistics may also provide the impetus for the leadership of the Army Medical Corps to continue to improve upon Triage and medical evacuation system.

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METHODOLOGY

This was a retrospective longitudinal study of 66 patients with penetrating missile/IED Blast splinter injuries who were received from conflict zones in border regions of Pakistan between July 2015 and June 2018. We studied the available cohort in retrospective manner and only 66 patients met the sample criteria based on convenient sampling technique.

Inclusion Criteria: All transferred patients, regardless of age, who had penetrating missiles head injuries (including sniper, gunshots and splinters from bombs) in conflict zone were included in the study.

Exclusion Criteria: Patients with blunt mechanism of head trauma, those receiving cardiopulmonary resuscitation enroute and brought in dead were excluded from the study.

Pre-evacuation clinical status of each casualty was documented by medical evacuation team. Demographics, clinical findings, imaging findings, mechanism of injury, missile paths, and surgical data were recorded for each patient on a proforma. Glasgow Coma Scale (GCS) scores were recorded at admission and after the initial resuscitation; however, for our study, we endorsed GCS score on arrival. The clinical course of each patient was documented along with Computed Tomography (CT) scan results, and all eventualities endorsed in documents until the patient was transferred to rehabilitation facility. Glasgow Outcome Scale Extended (GOS E) were recorded at the time of transfer and subsequently during follow up. The primary outcome measure was GOS score at last available follow up and secondary outcome measures were all the recorded complications in our patients. The characteristic relevant clinical data of such patients were identified as variables with the help of literature review.[4-10] and labelled as mechanism of injury: blast or gunshot injury, GCS on arrival, time to reach to neurosurgical facility: less or more than 4 Hours, location of entry wound in head, presence of Polytrauma, Pupils status, CT scan findings of unilateral or bilateral injuries, surgical intervention :debridement / dural closure or decompressive craniotomy, absence/presence of an intracranial retained foreign body, seizures, hydrocephalus, cerebrospinal fluid leak and GOS-E scores of .[1-8]

Data was analyzed by using PASW Statistics 18 and excel 2020 software. Qualitative data including outcomes and complications were computed with descriptive statistics: of frequency, rate and percentages. Quantitative variables like age, time etc. was presented as mean±standard deviation. T test was used. The *p* value ≤ 0.05 was considered significant.

RESULTS

There were total 66 male patients with penetrating head injury, studied and followed up in this study. The mean age was 28.73 years SD ±3.936 (Table I).

Table-I. Demographics of Missile Head Injury Patients

Variable	No of Patients (%)
Age (Years)	28.73± 3.936
Bullet injury	12(18.2%)
Blast injury	54(81.8%)
GCS 3-5	22(33.3%)
GCS 6-12	19(28.8%)
GCS 13-15	25(37.9%)
Up to 4 hours' time from injury	50(75.8%)
More than 4 hours' time from injury	16(24.2%)
Received ventilated	
Yes	13(19.7%)
No	53(80.3%)
Entry wound location	
Face	10(15.2%)
Forehead	20(30.3%)
Frontal	17(25.8%)
Occipital	2(3.0%)
Parietal	11(16.7%)
Temporal	6(9.1%)
Polytrauma Y/N	
Yes	29(43.9%)
No	37(56.1%)
Reactive Pupils	44(66.7%)
Non-Reactive Pupils	22(33.3%)
Heli evacuation	
Yes	44(66.7%)
No	22(33.3%)
Unilateral Brain injury	41(62.1%)
Bilateral Brain injury	25(37.9%)
Decompressive Craniotomy	25(37.9%)
Debridement, Dural repair	41(62.1%)
GOSE score	
1	24(36.4%)
6	4(6.1%)
7	9(13.6%)
8	29(43.9%)
Follow up range in months	5-36 months

The injuries in 12 patients (18.2%) were bullet injuries and in 54(81.8%) patients were blast splinter injuries to the head. GCS at arrival facility (mean=9.5±4.418) was categorized into 3 groups for the sake of computation in which 22(33.3%) patients presented with GCS 3-5, 19 (28.8%) presented with scores of 6-12 and 25(37.9%) with scores of 13-15. Prompt evacuation did help, 50(75.8%) of patients reached neurosurgical facility within 4 hours, out of these 44(66.7%) were transferred by air and 13(19.7%) were received ventilated. Forehead was the commonest entry point in 20(30.3%) patients, while 41(62.1%) had unilateral brain injuries but additional system injuries were noted in 29(43.9%) patients, however only 25(37.9%) required decompressive craniotomy, the rest were managed with limited surgery. There were 24 patients (36.4%) with GOS-E score of 1 (death), 42 survivors including 4 patients (6.1%) with GOS-E score of 6 (moderate disability), 9 patients (13.6%) with GOS-E score of 7 (good recovery lower) and 29 patients (43.9%) with GOS-E score 8 (good recovery). The follow-up period ranged from 5 to 36 months. Of the 42 survivors, there were 3 patients (4.5%) with CSF leakage from the complicated wounds, which in 2 cases (3%) had additional underlying hydrocephalus and required CSF shunt. Ten (15.2%) patients persisted to suffer from epilepsy and were placed on long-term antiepileptic drugs (Table-II). We identified that bilateral injury, low GCS score on arrival, non-reactive pupils and the requirement for ventilated transfer were statistically significant in association with high mortality and poor outcome. Age, sex, and wound entry point were not statistically significant. Figure 1 illustrates some of the interesting cases.

Table-II. Complications in Patients

Complications	No of Patients (%)
Retained Foreign body	53 (80.3%)
CSF Leak	3 (4.5%)
Seizures	10 (15.2%)
Hydrocephalus	2 (3%)

Figure: Scans and Images of Missile Brain Injuries Patients

a. CT scan image showing parenchymal damage and haemorrhage. b. 3D scan showing fracture and entry wound in skull. c. Intra-operative the brain is tense and swollen. d. at 6 months follow-up GOS 8 but suffering from seizures.

DISCUSSION

Conflict zone missile head injuries have been studied by many investigators and identification of controllable factors influencing the outcomes will be useful in developing a comprehensive plan for adequately treating and optimizing such patients. The daunting decisions of which patients to treat or not to treat, and which to be flown back to major trauma center, is a complex triage process requiring all the expertise, resources and collaboration. The literature reviews and numerous studies have identified predictors for mortality in gunshot injuries.[4-10] however, this study only identifies conflict zone missile head injuries. Injuries are usually caused by heavy, large-calibre, high velocity bullets and usually cause more extensive injuries than handguns. Also, there are blast injuries from improvised explosive devices that are usually not seen in civilian injuries. The significance of this can be demonstrated in the study by Aarabi *et al.*[7] that elegantly identified Predictors of outcome in civilian gunshot wounds to the head.

CT scans have been instrumental in recognising fatal injury zones in the brain, have been well described in the literature. The missiles traversing these zones especially through both hemispheres as found in our analysis, were significantly associated with mortality and the fate of the injury depends on the course of the bullet or shrapnel fragment and the multi-disciplinary care.[10,11,12]

This study also highlights that other variables that were significantly related to mortality in missile head injuries were persistent bilateral dilated non-reactive pupils and low GCS score on arrival, which correlates well with many studies in literature.[10,13] Martins et al. found that low GCS scores, unilateral dilated fixed pupil, transventricular or bihemispheric trajectory, and bilobar or multilobar wounds were predictive factors of high morbidity and mortality.[14] Similar factors predicted mortality in sniper head injuries by Can *et al*.[15] Bilateral fixed pupils, a stigma and despair can also be caused by severe low brain perfusion pressures and can often be reversed if the cerebral perfusion pressure is promptly resuscitated. The presence of these findings does not preclude treatment but rather warrant urgent attention to prevent further secondary brain injury and similarly a high Injury severity score (ISS) may not be considered indicative or predictive of long-term prognosis/quality of life.[16]

Our study also found that ventilated transferred patients also had poor outcome, signifying that the combination of trauma factors which made the patient too unstable to survive the transfer and therefore the medical evacuation team led ventilatory support was initiated to support the patients.[16]

The literature also suggests that in these poor grade missile head injury patients early and aggressive surgical intervention decreased the mortality.[6-18] Our patients who were operated with decompressive craniectomy, the brain and dura were covered with an extra layer of temporalis fascia, fascia lata, or dura substitute. These patients required cranioplasty later, so these layers helped in the dissection of the scalp from the brain and dura. Decompressive craniectomy was performed in 25 patients in the study with good survival ratio but not statistically significant. Although the extent of surgical endeavour, whether to perform a decompressive craniectomy or perform triage in multiple blast victims for wound debridement and dural repair is still a moving a target, well pointed out by some authors.[19]

Khan et al. found that complications in those who survive are neuro-deficit and wound infections.[20] Of the 42 survivors in this study, there were 3 patients (4.5%) with CSF leakage from the complicated track wounds, which in 2 cases had additional underlying hydrocephalus and required CSF shunt. Ten (15.2%) patients had persistent seizures and were placed on long-term antiepileptic drugs. Literature also supports a direct connection between blast traumatic brain injury and chronic traumatic encephalopathy and indicate a primary role for blast wind–induced head acceleration in blast-related head trauma and its long term sequalae in mental health of survivors.[21]

The extraction of retained shells or splinters in patients with large-calibre missile head injuries may soon become a problem in survivors and preferably should have their bullets extracted as soon as possible as these objects tend to be heavy and migrate easily.[17]

Based on these findings we collaborated with forward treatment facilities, medical evacuation teams and utilizing the tele medicine, the triage was refined for missile head injury patients, with efforts to encourage prompt resuscitation in conflict zone and ensuring prompt but safe transfer to the neurosurgical facility.

The limitations of this study include its retrospective nature and some patients could not continue long term follow up at our hospital due to service transfer. Future prospective comparative studies are needed to answer the remaining questions and improve the standard of care for these patients.

CONCLUSION

Management of missile head injuries (including both from high velocity bullets and improvised explosives blast related splinters) sustained in a conflict zone remains a challenge. Prompt triage by experienced trauma surgeons and adequate optimisation of these patients before and during the medical evacuation from the austere environment of conflict zone will lead the effort to save the survivables and may push the balance positively for many good survivors. Further comparative studies analysing the triage on battlefield and other uncontrollable factors influencing the outcomes are required to enhance the preparedness for such casualties.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

ZH & SAQ: Data acquisition, data analysis, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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