INTRODUCTION

Earthquakes are among the most destructive natural events and continue to exert a heavy toll on life and property. Ninety percent of the casualties result directly from the collapse of buildings and secondary events such as landslides, floods, fires and tsunamis account for the remainder 10 percent. More than one million earthquakes occur every year, but major earthquakes, which cause massive devastation of life and property occur once every 3 years on average worldwide. The mode of trauma plays a pivotal role and the leading causes of injuries are direct impact and crush by moving debris. Mortality increases with age, disability and degree of destruction of structure in which casualty was trapped and is mainly due to thoracoabdominal and head trauma often in conjunction with sepsis.

On the morning of October 8, 2005, a series of earthquakes measuring maximum 7.6 on the Richter scale struck Kashmir and the Northern areas of Pakistan. The epicenter was about 19 kilometers northeast of Muzaffarabad (the capital of Pakistan-administered Kashmir), and 100 kilometers north-northeast of Islamabad. The earthquake resulted in widespread damage, wiping out entire villages and flattening towns and cities.

The great magnitude of the catastrophe could not be estimated because of damage to communication and transportation equipment until the later hours of the day. According to World Bank assessment, 5.8 million people were affected, leaving 2.8 million people without shelter. An estimated 90,000 people died in the disaster.

The Armed Forces and various state and civil agencies responded promptly. The injured were taken out from the debris and transported by helicopters to all the hospitals of the twin-cities, Rawalpindi and Islamabad. Collective integration among various departments played a pivotal role. Intensive care capabilities were stretched to the maximum.

Lack of adequate experience in disaster medicine posed a challenge. It turned out to be one of the worst disasters in the century occurring in that part of the world. Such kind of catastrophic earthquakes have long-
term psychological consequences, particularly for survivors with high levels of trauma exposure.\textsuperscript{9} This paper outlines the issues involved in the screening and diagnosis of head injury in relation to the disaster victims and discusses the better ways to provide early support in disaster situations.

The aim of this study was to assess the spectrum and management of head injuries among earthquake victims, reporting to a tertiary care hospital in Rawalpindi.

**PATIENTS AND METHODS**

This was a series of three hundred cases of head injuries sustained in earthquake of October 2005. This observational study was conducted at Surgical Ward II of Combined Military Hospital, Rawalpindi, and cases of either age, gender or social strata were included in the study.

On the day of disaster, emergencies were received in the trauma center of the hospital. Cases of head injuries were examined by neurosurgeons on call. ATLS (Advance Trauma Life Support) protocol was followed and prompt resuscitation was carried out. In the primary survey, patients were assessed and their treatment priorities were established based on their vital signs and the pattern of injuries. This process constituted the ABCDEs (Airway, Breathing, Circulation, Disability, Exposures) of trauma care. A quick neurological examination was performed at the end of primary survey based on AVPU (Alertness, Voice, Pain, Unresponsive) method. Patients were divided into two categories A and B. Patients having altered levels of consciousness, focal neurological deficits and skull fractures were put in category A and rest of the patients were placed in category B. Category A patients were straightaway taken to the CT scan departments and patients of category B were shifted to the ward. There was a team of 5 neurosurgeons at the Combined Military Hospital, Rawalpindi, 2 consultants and 3 registrars. One registrar was available at trauma center round-the-clock for receiving head injuries and putting them further into the screening tunnel. The second registrar was in the CT scan department for screening patients requiring surgeries. The third registrar assisted the seniors in the operation theatre.

Secondary survey constituting a detailed head-to-toe examination of every patient was done in the ward and records were maintained. A thorough Glasgow Coma Scale assessment was done. Plain X-rays of skull, (anteroposterior, both lateral (right and left) and odontoid views) were advised in stable patients with head injuries. Local cultures were taken from wound margins, tissues, discharge or aspirate of haematoma. Superficial untidy (contaminated) wounds were debrided in the trauma centre under local anesthesia and broad spectrum antibiotics were advised before culture reports. Tidy (clean) wounds were managed by thorough debridesments only. Patients with concomitant injuries were managed in conjunction with relevant specialists.

Pro formas were maintained for every patient. Patients were followed after 6 months and one year of interval. Most of the patients maintained telephonic contacts and a few were lost to follow-up.

Glasgow Outcome Scale assessment was compared at the end of first year, since the date of incident. During this one year follow-up, 31 patients (10.3%) lost contact.

The major operations performed were, thorough wound debrimas, elevations of depressed fragments, evacuations of haematomas by craniotomies or craniectomies and repair of cerebrospinal fluid leaks. Minor operations mainly constituted wound debridesments under local anesthesia.

SPSS version 10 was applied. Age, evacuation time and Glasgow Coma Scale, hospital stay, infection, re-operations and complications were numeric variables. Gender, type of head injury, type of wound, severity of head injury, type of procedure, type of anesthesia and concomitant injuries were qualitative variables. Frequencies and percentages were calculated for categorical data, whereas mean ± Standard Deviation (SD) were calculated for numeric data.

**RESULTS**

One hundred and twenty-three (41%) patients were children under 10 years of age, adults below 55 years were 69 (23%) and above 55 years were 108 (36%). Mean age was 32.2 years with SD ± 16.7. Females were 159 (53%) and males 141(47%) and female to male ratio was 1.1:1. In the first 24 hours, only 7 patients with head injuries were received, 98 patients were received in the next 48 hours and remaining 195 cases were brought to the trauma centre after 72 hours to roughly two weeks duration.

One hundred and forty-three (47.7%) patients had wounds on their scalp and other parts of the body and only 4 (1.3%) were found to be tidy. Tidy wounds were already dressed up at the scene of accident after adequate debridements, and remaining were grossly contaminated. Pus swabs from the wounds showed growth of mixed organisms. *Staphylococcus aureus* was cultured in 67% of untidy wounds. Two patients, one in the first week and second in the third week of hospitalization, developed tetanus and both expired.

On the basis of GCS, 165 patients (55%) were of mild head injury, 103 patients (34.3%) were of moderate head injury and remaining 32 (10.7%) patients had severe head injury.

Group A comprised of 148 patients (49.3%) patients and 152 (50.7%) patients were included in group B. Eighty
seven patients (29%) from group A and 16 patients (5.3%) from group B were operated under general anesthesia.

Eighty patients (26.7%) had other associated systemic injuries, which were managed by the respective specialists.

Compound depressed fractures were seen in 58 (19.3%) patients, 39 (13%) patients had simple lacerations and 25 (8.3%) had intracranial hematomas. Among the intracranial hematoma cases, 7 (2.3%) had intracerebral hemorrhage, 14 cases (4.7%) had extradural hematomas and 4 cases (1.3%) had chronic subdural hematomas. Diffuse axonal injury was seen in 56 patients (18.7%) and 54 patients (36%) exhibited brain contusions (Table I).

One hundred and forty-six (48.7%) patients were managed conservatively. Minor surgeries requiring local anesthesia were done in 51 (17%) patients and major surgeries were performed in 103 (34.3%) patients including 8 cases of repeat surgeries. Twenty eight (9.3%) patients were managed on day-care basis in the outpatient department. One hundred and forty-four patients remained hospitalized for < a week, 87 patients for < 2 weeks and 41 patients remained admitted for > 2 weeks. The maximum hospital stay was 131 days.

The commonest postoperative complication was wound infection seen in 11 patients of compound depressed fractures.

Nineteen (6.3%) patients underwent repeat surgeries and the commonest procedure was wound debridements.

One hundred and ninety-nine (66.3%) patients were discharged as physically fit, 48 (16%) patients had focal deficits and 29 (9.7%) patients developed post-traumatic seizures. Post concussive syndrome was seen in 4 (1.3%) patients and 10 (3.3%) patients were discharged in vegetative state. After the discharge of last patient, total mortality was found to be 3.3% (n=10).

Management outcome at the discharge from the hospital and Glasgow Outcome Scale assessment calculated at interval of six months and one year from the incident was compared. Overall mortality increased from 3.3% to 7% in one year follow-up time and 31 (10.3%) patients failed to maintain contacts (Table II).

**DISCUSSION**

In an earthquake, the major danger is from collapse of buildings. Falling debris and entrapment pose the greatest threat.\(^{10}\)

During the past 20 years, natural disasters have claimed more than 3 million lives worldwide, affected at least 800 million people, and resulted in property damage exceeding US $50 billion.\(^{11}\) The highest number of casualties reported ever in the history of earthquake have been attributed to Tang Shan earthquake, which resulted in 2,42,769 deaths and 1,64,851 people injured.\(^{12}\) The Great Hanshen Awaji earthquake of the Kobe Osaka area of Japan resulted in 6,500 deaths and 34,300 people injured.\(^{13}\) An earthquake in Mexico in September 1985 with a magnitude of 9 on the Richter scale caused death of 14,000 people and loss of $4.5 billion according to the official numbers. Thirteen hospitals in this region were severely damaged or totally destroyed and a sizable number of medical staff and doctors lost their lives.\(^{14}\)

Pakistan’s earthquake, measuring 7.6 on Richter scale, proved to be the most powerful to hit the region in 100 years, prompted massive local and international aid.\(^{15}\)

Over a period of few days, Combined Military Hospital, Rawalpindi, received 3,527 casualties, out of which 8.5% (n=300) comprised of head injuries. According to one estimate, there were 282 cases of head trauma in Kobe (Japan) earthquake.\(^{16}\) Of all the emergencies arising in such kind of situations, head injuries carry the highest mortality. The earliest discussion of head injury was given by Hippocrates in the 3rd century AD as “About the head trauma” (English translation).\(^{17}\)

Experiences of disasters reveal that most lives are saved by the immediate actions of the rescuers usually within the first 24 hours.\(^{9}\) On the very first day, only 7 cases of head injuries were received, which were
3.2% of total injuries (n=198) received in the first 24 hours. In the first 72 hours, 35% (105) cases of head injuries were received. This delay in evacuation proved to be a decisive factor for such a large number of deaths seen in this earthquake. Another paramount prognosticator in head injury sequel is its severity. In this study, 21 patients expired at the end of one year and out of them 13 (65%) were having severe head injury at initial presentation. Age turned out to be another important parameter in the development of fatal scenario. Fragile age groups, children and elderly were maximum sufferers in this study. This happened because, school buildings collapsed, burying countless children and grievously hurting evacuees.

Rescue efforts and aerial searches continued for many weeks but salvageable recoveries took place in the first week only. Disaster management literature states that efforts to rescue victims should not be abandoned for at least 5 days.

Patients presented with a great diversity of injuries. Maximum number of patients (19.3%) reported with compound depressed fractures. Depressed fractures of skull are more likely, if the object has surface area less than 2 sq. inch. The patients showing diffused axonal injuries were mostly at the extremes of age. Landslide and shock waves generated acceleration and deceleration forces resulting in that kind of injuries. Wounds were contaminated and discharges were fetid and foul smelling. Some of the wounds were covered with animal excreta, some with black soot and quite a few were dressed up with old newspapers (Figure 1 and 2). This study revealed 98.6% patients had untidy wounds. Pus swabs taken from the wounds showed growth of mixed organisms predominantly of Staphylococcus aureus in 67%, Pseudomonas in 41%, Enterobacteria in 37% and Escherichia in 12% of cases developed tetanus and died of cardiopulmonary arrest. One patient is shown in (Figure 3) with external herniation of brain substance. She ultimately died of tetanus. Major surgeries were performed in 103 patients and most of them had moderate head injuries. Thirty-nine patients of compound depressed fractures were managed by debridements and elevation of depressed segment. Nineteen patients with compound depressed fractures had other intracranial injuries and they were managed by craniotomies. In toto, 47 craniotomies were performed. Burr hole evacuation of hematomas and pneumocephalus were done in 13 patients and 4 patients with wide lacerations and scalp avulsions were managed under general anesthesia. Fifty four patients (18%) exhibited cerebral contusions. They were managed conservatively and they fared fairly well.

Major surgical interventions were performed mainly in case of moderate head injuries followed by minor head injuries.

The longest hospital stay for a patient was 4 months and 11 days and after the discharge of last patient, management outcome was calculated. Majority of patients were discharged fit and 48 (16%) patients were having some kind of focal deficit, either mono- or hemi-parasis or cranial nerve palsies. Those patients with restricted capabilities were referred to the department of rehabilitation for further treatment. Early posttraumatic seizures were seen in 7 patients and 22 patients exhibited late onset posttraumatic seizures after one week of head injury. Ten patients were discharged in vegetative state and mortality was 3.3%. At the end of one year, a complete record was available for 269 patients and 31 patients (10.3%) had been lost to follow-up. Majority (57%) patients were leading a normal independent life. Out of 10 patients, who were discharged in vegetative state, 6 expired at the end of one year and mortality rose to 7% (n=21).

**Figure 1:** Patient with highly contaminated laceration right parietotemporal region. Greenish discharge, frank pus, hair and bony fragments are seen.

**Figure 2:** Contaminated wound over vertex with depressed bony fragment.

**Figure 3:** 10 years old girl with brain fungus. Child died of tetanus, three weeks after injury.
CONCLUSION

Disasters are catastrophic events that overwhelm a community’s response capabilities. Poor infrastructure, loss of communication, disruption of government and public health care systems and paucity of resources all exacerbate the calamity. A top down well-trained multi-disciplinary flexible approach is highly suggested for the provision of medical care in emergency. A comprehensive disaster management plan would incorporate, capacity building and training of doctors and paramedics with regard to triage, fragile age groups requiring top priorities in the chain of evacuation and right patient be at right place in right amount of time. Means of communications and informations must be assured and upgraded. Manuals on disaster management should be disseminated and practiced.

REFERENCES