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Original article

The relationship between timing of admission to a hospital and severity of injuries following 2005 Pakistan earthquake

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ABSTRACT

Purpose: The objective of this study was to establish the relationship between the timing of admission to a hospital and the severity of injuries following an earthquake.

Methods: It was a retrospective chart review of injured patients admitted to a tertiary care teaching hospital following the 2005 Pakistan earthquake. Age, gender, injury severity score, type of injuries, complications, operations, hospital stay and mortality were studied and compared at different time intervals using SPSS.

Results: Most injuries were musculoskeletal [145 (59%)] vs. all other injuries, including minor lacerations [103 (41%)], but the percentage of non-musculoskeletal injuries was higher within 24 h (67% vs. 53% respectively, $p = 0.4$). Injury severity score (25 ± 10 vs. 16 ± 9 , $p = 0.01$), multiple injuries [73% vs. 45%, $p = 0.05$] and crush syndrome [20% vs. 03%, $p = 0.02$] were significantly higher in patients admitted within 24 h. More patients with head and neck injuries were admitted within 24 h (27% vs. 18%, $p = 0.4$). Patients admitted within 24 h had higher complication rates (67% vs. 32%, $P = 0.01$) as well as mean operative procedures (2.8 ± 1.9 vs. 1.9 ± 1.9 , $p = 0.08$).

Conclusion: Our study showed that patients admitted to a hospital within 24 h following an earthquake had more severe injuries and higher complication rate than those admitted after 24 h.

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Introduction

On October 8th 2005, at 8:50 a.m. local time, a magnitude $M_w = 7.6$ earthquake struck the Himalayan region of northern Pakistan and Kashmir. The Pakistani government's official death toll as of November 2005 stood at 87,350 although it is estimated that the death toll could have reached over 100,000. Approximately 138,000 were injured and over 3.5 million were rendered homeless. According to government figures, 19,000 children died in the earthquake, mainly due to the widespread collapse of school buildings. The earthquake affected more than 500,000 families.¹

It was estimated that more than 780,000 buildings were either destroyed or damaged beyond repair, and many more were rendered unusable for extended periods of time. Out of these, approximately 17,000 school buildings and most major hospitals

close to the epicenter were destroyed or severely damaged. Lives were adversely affected, especially the numerous vital roads and highways that were closed by landslides and bridge failures. Several areas remained cut off via land routes even three months after the main event. Power, water supply and telecommunication services were down for varying lengths of time, although in most areas services were restored within a few weeks.¹

Most of the buildings in the affected area were of non-engineered, unreinforced masonry wall construction. The typical structure consisted of one or two stories of unreinforced stone, solid brick or solid concrete block masonry-bearing walls with reinforced concrete floors. Roof structures were flat or pitched, consisting of wood (non-machined) beams and straw reinforced mud slabs and, occasionally, lightly reinforced concrete slabs or galvanized iron sheets. Larger towns have buildings built of reinforced concrete slab roofs. Foundations are constructed mostly of stones or bricks, bearing on native soil about two to three feet below grade and 18–24 inches wide.¹

Previous research studies and other relevant data have also shown that in earthquake-hit areas, a majority of health care

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facilities were either completely destroyed or became functionless. Many causes have been described, including destruction of buildings, death or injuries of health care professionals and/or their families. Because of these reasons, the injured patients could not be treated in appropriate time in such disasters, which lead to increased morbidity and mortality.^{2–4}

The only available health care settings after a majority of disasters are usually the hospitals in nearby cities that escaped from the disaster. The field hospitals that are an integral part of relief efforts are usually established after 48 h or more.⁵ Such facilities have certainly played a role in reducing the complications of injuries and improving the overall outcome of injured patients; however, only a small number of seriously injured patients could reach these facilities in time. Instead, almost all studies reported that a majority of patients who reached a hospital had either musculoskeletal injuries or non-serious vital organ injuries. Mortality in such patients was not very high.^{6–11} No study has yet addressed the following question: is there any difference in the pattern and severity of injuries in relation to the timing of admission in a hospital?

The objective of this study was to establish the relationship between the timing of admission to a hospital and the severity of injuries following an earthquake.

Material and methods

This study was a retrospective chart review of injured patients admitted following the 2005 Pakistan earthquake. The study was done in a tertiary care teaching hospital, with a fully developed accident and emergency department with all surgical specialties. The study was approved by the hospital's institutional review board. All the patients with earthquake injuries admitted into the hospital were included, which was not part of the exclusion criteria. All patients with incomplete records, previous hospitalization for earthquake injuries or who were referred from other healthcare facilities after major treatments and readmitted during follow-up were excluded from the study.

The data of all patients was extracted on a predesigned form by two authors. Differences were resolved by the remaining two authors. The patients' injuries were recorded in relation to timing of hospital admission following the earthquake. Injury severity score (ISS) was calculated for each patient. Age (mean \pm SD), ISS,¹² timing of admission, hospital stay and number of operations were entered as continuous variables, whereas gender, injuries, mortality and complications were entered as categorical variables.

The data was analyzed with statistical software, SPSS version 17 (SPSS Inc., Chicago, USA). Frequencies of the above variables were reported and compared in relation to different time intervals. The difference of injuries and outcome of patients admitted within and after 24 h of the earthquake was compared and significance ($p \leq 0.05$) was calculated by either a Chi-square test, Fisher's exact test, independent sample *t*-test or Mann Whitney U test, wherever appropriate.

Results

A total of 288 patients were admitted to the hospital following the 2005 Pakistan earthquake, out of which, 148 patients were included in this study, excluding 46 wounded with incomplete records, 36 with no injuries, 30 referred to or previously treated in other hospitals, and 28 readmission. For the 148 patients, 15 were admitted within 24 h and the other 133 were admitted after 24 h. Sixty (40%) patients were male and 88 (60%) were female, with a mean age of (27 \pm 18) years.

The detailed pattern of injuries in the patients admitted following the earthquake can be seen in Table 1. The results show that a majority of injuries were musculoskeletal [145 (59%)] vs. all other injuries, including minor lacerations [103 (41%)]. The characteristics of earthquake-injured patients and the pattern of injuries at different time intervals are shown in Table 2. The comparison of injury pattern and outcome between the patients admitted within and after 24 h of the earthquake is shown in Table 3. No significant difference was seen in pattern and severity of injuries among other time intervals. Only one (0.9%) earthquake-related in-hospital mortality was recorded.

Discussion

Pakistan is situated in a region where earthquakes are common because of the geographical location of fault lines in the Himalayan region. Smaller magnitude earthquakes and floods hit this region almost every few months. Despite this fact, there is no well-established disaster management service in the region.

The hospital in which the present study was conducted was located in the nearest city of earthquake-hit areas and escaped from destruction, except for a few buildings in which a few hundred people were affected. These victims were transferred to different hospitals in the city and a majority of these victims were brought to

Table 1
Details of injuries in the patients admitted following earthquake.

Injuries	Frequency (n, %)
Head and Neck	
Scalp laceration	10 (6.8)
Skull fracture only	7 (4.7)
Skull fracture with intracranial injury	4 (2.7)
Intracranial hematoma	3 (2.0)
Diffuse brain injury	4 (2.7)
Face	
Laceration	8 (5.4)
Maxillofacial fractures	3 (2.0)
Chest	
Rib fracture	5 (3.4)
Pneumothorax	2 (1.4)
Hemothorax	1 (0.7)
Flail chest	1 (0.7)
Abdomen	
Abdominal wall injuries	4 (2.7)
Intra-abdominal injuries	2 (1.4)
Pelvis	
Stable fractures	14 (9.4)
Unstable fractures	10 (6.8)
Spine (Fracture/Subluxation)	
Cervical	1 (0.7)
Thoracic	5 (3.4)
Lumbo-sacral	11 (7.4)
Paralysis	
Quadriplegia	1 (0.7)
Paraplegia	2 (1.4)
Upper limb (Fractures)	
Shoulder joint	4 (2.7)
Humerus	7 (4.7)
Radius/Ulna	10 (6.8)
Hand	2 (1.4)
Multiple fractures of upper limb	5 (3.4)
Gangrene and amputations	3 (2.0)
Lower limb (Fractures)	
Femur	31 (21)
Tibia/Fibula	22 (15)
Foot	6 (4.1)
Multiple fractures of lower limb	7 (4.7)
Gangrene and amputations	4 (2.7)
Skin and soft tissue	
Superficial lacerations	18 (12)
Crush injuries	18 (12)
Degloving injuries	4 (2.7)

Table 2
Characteristics of injured patients and pattern of injuries admitted at different time intervals.

Characteristics	Within 24 h (n = 15)	24–48 h (n = 9)	48–72 h (n = 9)	After 72 h (n = 115)	Total (n = 148)
Age (yrs)					
(Minimum–Maximum)	3–70	10–48	10–55	2–78	2–78
Median (IQR)	28 (17–35)	27 (19–38)	22 (16–39)	22 (13–37)	25 (14–36)
Sex (n, %)					
Male	6 (40)	5 (56)	2 (22)	47 (40)	60 (40)
Female	9 (60)	4 (44)	7 (78)	68 (60)	88 (60)
ISS					
Minimum–Maximum)	9–41	9–50	09–34	4–58	4–58
Median (IQR)	25 (16–32)	16 (14–25)	25 (14–36)	16 (9–20)	16 (13–25)
Injuries (n, %)					
Single	4 (27)	3 (33)	3 (33)	68 (60)	78 (53)
Multiple	11 (73)	6 (67)	6 (66)	47 (40)	70 (47)
Head & Neck	4 (27)	2 (22)	2 (22)	20 (18)	28 (19)
Face	2 (13)	0 (0)	3 (33)	6 (5)	11 (7)
Chest	1 (6.7)	1 (11)	0 (0)	9 (10)	11 (7)
Abdomen	1 (6.7)	1 (11)	1 (11)	3 (2.5)	6 (4)
Pelvis	1 (6.7)	3 (33)	2 (22)	18 (16)	24 (16)
Spine	3 (20)	1 (11)	0 (0)	16 (14)	20 (14)
Upper limb	3 (20)	2 (22)	3 (33)	24 (21)	32 (22)
Lower Limb	7 (47)	3 (33)	5 (56)	54 (47)	69 (47)
Skin and soft tissue	6 (40)	5 (56)	3 (33)	26 (23)	40 (27)
Crush syndrome	3 (20)	1 (11)	0 (0)	3 (2.5)	7 (4.7)
Paralysis	1 (6.7)	1 (6.7)	0 (0)	07 (6)	9 (6.0)
Psychiatric illnesses	2 (13)	0 (0)	1 (11)	5 (4.3)	8 (5.4)
Mortality	0 (0)	0 (0)	0 (0)	1 (0.9)	1 (0.7)

the hospitals within 24 h after receiving injuries. In addition, some victims from major disaster areas were also transferred to hospitals by armed forces helicopters in the first 24 h; however, a large majority of injured patients were reached at least 48 h after the earthquake due to the destruction of almost all major roads and other communication systems.

The results from previous studies showed that a majority of earthquake injuries were musculoskeletal,^{8–11} whereas in the present study, non-musculoskeletal injuries were higher within 24 h than after 24 h (67% vs. 53%, respectively); however, this was not statistically significant. The ISS, presence of multiple injuries and presence of crush syndrome were significantly higher within 24 h, which indicates that patients with more severe injuries tend to present earlier. More patients with head and neck injuries were admitted within the first 24 h than in the following days (27% vs. 18%, $p = 0.4$). Additionally, the in-hospital mortality was low (0.9%).

The patients admitted within 24 h had higher complication rates (67% vs. 32%, $p = 0.01$). However, the major difference came from wound infections (47% vs. 20%, $p = 0.04$). In previous studies

including another study from the same institution, it was reported that a majority of these infections were due to multidrug resistant gram negative organisms.^{13,14} There was no significant difference in other complications (urinary tract infections, respiratory tract infections, severe sepsis, wound hematoma and seroma). Mean operative procedures were higher in patients admitted within 24 h (2.8 ± 1.9 vs. 1.9 ± 1.9 , $p = 0.08$). The one likely cause for this might be due to the higher number of multiple injuries in patients admitted within 24 h.

There was no significant difference in hospital stay between the two groups [12 (IQR 4–23)] vs. 16 (IQR 16–32), $p = 0.8$. The hospital stay is, however, a poor indicator of severity in earthquake situations, as many patients were kept in the hospital only because of the lack of shelters, disabling conditions like paralysis, complex orthopedic injuries or for the purpose of rehabilitation.

In the present study, no statistically significant difference was seen in serious injuries to the chest and abdomen between the patients within and after 24 h. The likely reason for this was due to the small number of patients who were able to reach the hospital in

Table 3
Important differences in injuries and outcomes in patients admitted following earthquake within and after 24 h. Data are expressed as number and percentage.

Characteristics	Within 24 h (n = 15)	After 24 h (n = 133)	p value
ISS [median (IQR)]	25 (16–32)	16 (16–25)	$p = 0.01$
No. of injuries			
Single	4 (27)	74 (55)	$p = 0.05$
Multiple	11 (73)	59 (45)	
Head and Neck injuries	4 (27)	24 (18)	$p = 0.4$
Chest	1 (6.7)	10 (7.5)	$p = 1.0$
Abdomen	1 (6.7)	5 (3.7)	$p = 0.4$
Crush Syndrome	3 (20)	4 (3)	$p = 0.02$
Musculoskeletal injuries	11 (73)	105 (79)	$p = 0.7$
Non musculoskeletal injuries	10 (67)	70 (53)	$p = 0.4$
Operative procedures (mean \pm SD)	2.8 ± 1.9	1.9 ± 1.9	$p = 0.08$
Complications (all)	10 (67)	43 (32)	$p = 0.01$
Wound infections	7 (47)	27 (20)	$p = 0.04$
Others ^a	4 (27)	39 (29)	$p = 1.0$
Hospital stay (d) [median (IQR)]	12 (04–23)	16 (16–32)	$p = 0.8$

^a Urinary tract infections [13 (30%)], respiratory tract infections [9 (21%)], wound hematoma and seroma [1 (2%)], systemic sepsis [6 (14%)] and others [14 (33%)].

the first 24 h, either from the same city or who were evacuated by armed forces helicopters.

The present study proved that health care facilities in the vicinity of earthquake-hit areas should be prepared for receiving more serious and life threatening injuries in the first 24 h. In addition, this study also indicates the fact that most patients with serious injuries may die before any treatment due to the non-availability of local health care facilities or evacuation services, which also justifies the higher proportion of musculoskeletal injuries, which are usually non-fatal, in a majority of studies.

This study also emphasized the importance of effective triage in an earthquake area in order to reduce the mortality and morbidity. It was noticed during the Pakistan earthquake that many patients with non-fatal injuries were evacuated earlier and others with life-threatening injuries were not. The major reason for this was the lack of effective and trained disaster and trauma management services in the region and the inability to evacuate the victims in time, who were then buried under destructed buildings.

The authors recommend that health care facilities should be strengthened and well equipped in disaster-prone areas, in order to prevent their collapse and to allow them to continue working during disasters.^{15–17} In addition, the authors also recommend the development of effective pre-hospital disaster management services and triage training for professionals working in these areas.

The data of the present study was small, but, as no study addressed this issue before, this study can be a guide for health care workers in disaster-prone areas as well as serve as an initiative for larger studies in the future. The limitation of this study was the retrospective data.

This study concludes that patients who are admitted to a hospital within 24 h following an earthquake have more severe injuries and higher complication rates as compared to patients admitted after 24 h.

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