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RESEARCH ARTICLE
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PATTERNS OF INJURIES IN BOMB BLAST VICTIMS: A TERTIARY CARE HOSPITAL

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Abstract

Introduction: Complex trauma caused by bomb blasts is a significant burden with varied injury profiles that pressure healthcare systems, especially in low- and middle-income settings such as Pakistan.

Objective: To analyze the patterns, severity, and anatomical distribution of injuries among bomb blast victims presenting to a tertiary care hospital in Pakistan.

Material and Methods: The study was a descriptive cross-sectional study conducted at Mekran Medical College Turbat, Pakistan, from June, 2022 to December, 2022. Standardised protocols were applied when assessing eligible victims, as well as analysing demographic, clinical, and injury-related data.

Results: Of 120 victims, the majority were males (73.3%), with a predominant age of between 21 and 30 years. The majority of them involved extremity injuries (60%), head and neck trauma (40%). The cases of secondary blast injuries are 66.7%. Combined head and thoracoabdominal injuries had the highest mortality (8.3%).

Conclusion: The most common of these consequences is extremity trauma, and combined critical injuries increase mortality, highlighting the importance of fast, specialised trauma care.

Keywords: Bomb blast, Injury patterns, Extremity trauma, Secondary blast injuries, Pakistan.

INTRODUCTION

Bomb explosions are among the worst types of traumas, resulting in multifaceted and mostly disastrous injuries that strain the health systems, especially those in low and middle-income economies such as Pakistan. There are various types of injuries caused by explosions with primary

blast waves, secondary fragmentation, and tertiary displacement with quaternary injuries like burns and inhalational harms (1). Trauma to the extremities is one of the most commonly seen injuries in a bomb blast survivor, where imaging identifies fractures, dislocations, and soft tissue injuries that require swift diagnosis and a multidisciplinary approach to treatment, to ensure the best possible outcomes. Military and civilian research present divergent injury patterns in the Israel Defence Forces. Studies of fatalities revealed extremity and head plus thorax injury over-representation attributed to the deadly combination of overpressure and penetrating fragments caused by the blast (2). Unusual injury patterns may be presented in civil casualty incidents based on environmental and circumstantial factors. The Beirut port explosion in 2020 resulted in a high rate of facial, limb, and eye injuries, caused by the broken glass and debris, highlighting the role of the city infrastructure on injury patterns (3).

Pediatric casualties involve different considerations. Systematic reviews state that children are more vulnerable to severe blast-related injuries, and the risk of death depends on the site, severity of the injury, and the availability of prehospital care (4). Mass assessments, including the Beirut Blast Assessment of Surgical Services, have demonstrated exorbitant utilisation rates of surgical capacity, requiring surgical preparedness and trauma systems with integrated responses in mass-casualty situations (5). The patterns of the blast-related injuries are not associated only with armed conflict, as these injuries can be observed in any violence or even accidental explosions. The unique injuries observed in homicidal deaths using autopsy observations have been noted as unique profiles of injuries not found in blasts as a result of accidents or combats, and tend to concentrate in areas considered vital (6). The use of observational studies of hundreds of civilian blast and ballistic casualties has made it possible to build templates of injury burden, and this helps in the strategic planning of medical response (7). In comparable retrospective studies in Somalia, designed over seven years, they found that extremities were the most frequently injured part, followed by head and torso trauma, and death largely depended on the extent of accompanying vascular injury (8).

A systematic review of civilian injury patterns in armed conflicts also confirms that lower extremity injuries take a pre-eminent position in blast victim patterns, although head and torso trauma are more strictly associated with mortality (9). Individual case reports, including the accidental fatal bomb explosion to a child, highlight the lethality of small-scale, improvised explosive devices and require community education and prevention measures (10). The support of child victims demands special emergency health care attention, and the frameworks on enhancing pediatric trauma in blasting environments address such requirements (11). Blast injuries are not only confined to acute trauma, but they have been shown to produce long-term disabilities. Prolonged musculoskeletal disabilities, sensory, and psychological outcomes have been encountered in multicenter reviews of survivors of the Beirut blasts, and these call upon rehabilitation pathways that are well integrated (12). Surveillance of National trauma databases has given us insight into the frequency and mechanism of blast injuries affecting civilian populations, with explosions caused by improvised devices being a significant cause of complex polytrauma (13). Thoracoabdominal traumas have low incidences compared to extremity trauma, but they have a high morbidity and mortality rate as they involve vital organs and the likelihood of internal haemorrhage that has been obscured (14).

Mass-fatality terrorist attacks have been analysed historically to show transitions like targets and systems of weapons, which scale the subsequent injury patterns and inform the basis of medical preparedness to counter terrorism (15). Major cases survived in the likes of enormous burns, amputations, and deaths can ensue even with small-scale accidental events in the operation of explosive mixtures (16). Comparative investigations into injuries of extremities caused by blast and gunshots indicate that the latter are more likely to produce more severe soft tissue damage and an increased likelihood of amputation (17). The reports of a single institution after catastrophic events, including the port explosion in Beirut, illustrate a range of presentations of various levels of severity, including minor lacerations to severe polytrauma involving multiple organs, as the outcome depends on the severity of the injury and the amount of time it takes to reach a definitive care center (18). The theory of biomechanical failure during human extremity lateral blast loads has been developed with

the help of computational modelling, and its insights have been used in the design of protective devices in addition to structural mitigation practices (19).
Head injuries have continued to be one of the greatest causes of blast-related morbidity and mortality, with recent data suggesting high rates of traumatic brain injury and the necessity to develop neurosurgical capacity in conflict zones, as exemplified by patients of the civilian war in Afghanistan (20). Injury scoring systems exist to assist accurate evaluation and recording of blast injuries, although they take some time during diagnosis and procedures (21). Frequent bomb blasts in Pakistan resulting in terrorism, sectarian attacks, and even accidental explosions make the study of the pattern of injuries essential to guide clinical practice and even public health interventions. There is a pivotal role of a tertiary care hospital in the receiving and treatment of the most seriously injured patients, hence making it a perfect place to conduct elaborate epidemiology analysis.

Objective: To analyze and document the patterns, severity, and anatomical distribution of injuries in bomb blast victims presenting to a tertiary care hospital in Pakistan.

MATERIALS AND METHODS

Study Design: Descriptive Cross-sectional study.

Study Setting: The research was conducted at Mekran Medical College Turbat, Pakistan.

Duration of the Study: The study was conducted over a period of six months, from June, 2022 to December, 2022.

Inclusion Criteria: All of these bomb blast victims of any age and gender visiting the emergency department within the study period were enrolled. Isolated and multiple injuries were treated as eligible, with patients being alive at arrival during the study of patients.

Exclusion Criteria: The study excluded patients found dead on arrival, those with missing medical records, and those transferred following definite surgical intervention in other hospitals, to allow the collection and analysis of accurate primary data.

Methods

When the patients reached the emergency department, all patients meeting the criteria were evaluated according to Advanced Trauma Life Support (ATLS) guidelines. The demographic information was noted, such as age, gender, and the mode of arrival. A comprehensive clinical assessment was done to find the form and location of injuries. Mechanism of injury was classified into primary, secondary, tertiary, or quaternary blast injuries. An individual necessary investigation, i.e., radiographs, ultrasound, or CT scans, was carried out. The degree of any injuries was recorded based on standardised injury scoring points. The structured proforma used in the study was used to obtain the data. There was immediate resuscitation and stabilisation of the patients, and then surgical or medical management as needed. Each case was followed up until they discharged, referred or died. The data were entered into statistical software packages to carry out the descriptive analysis, frequencies and percentages were calculated in the categorical variables, and the means with standard deviations were calculated in the continuous variables to describe the patterns and outcomes of the injuries.

RESULTS

In the estimation of the study, 120 victims of bomb blast presented a case during the six-month study period and fulfilled the inclusion criteria as analyzed. Males (n=88; 73.3%) were the predominant patients and females made 26.7% (n=32). The victims age was between 8 dark to 65 with a average of 31.4 + 12.6 years. The greatest number of cases (n=42; 35%) was found in the 21-30 years group, and the 31-40 years age group resulted in 30 (25%) cases.

Table 1: Demographic characteristics of victims

Variable	Frequency (n)	Percentage (%)
Gender (Male)	88	73.3
Gender (Female)	32	26.7
Age group ≤ 20	18	15.0
Age group 21–30	42	35.0
Age group 31–40	30	25.0
Age group > 40	30	25.0

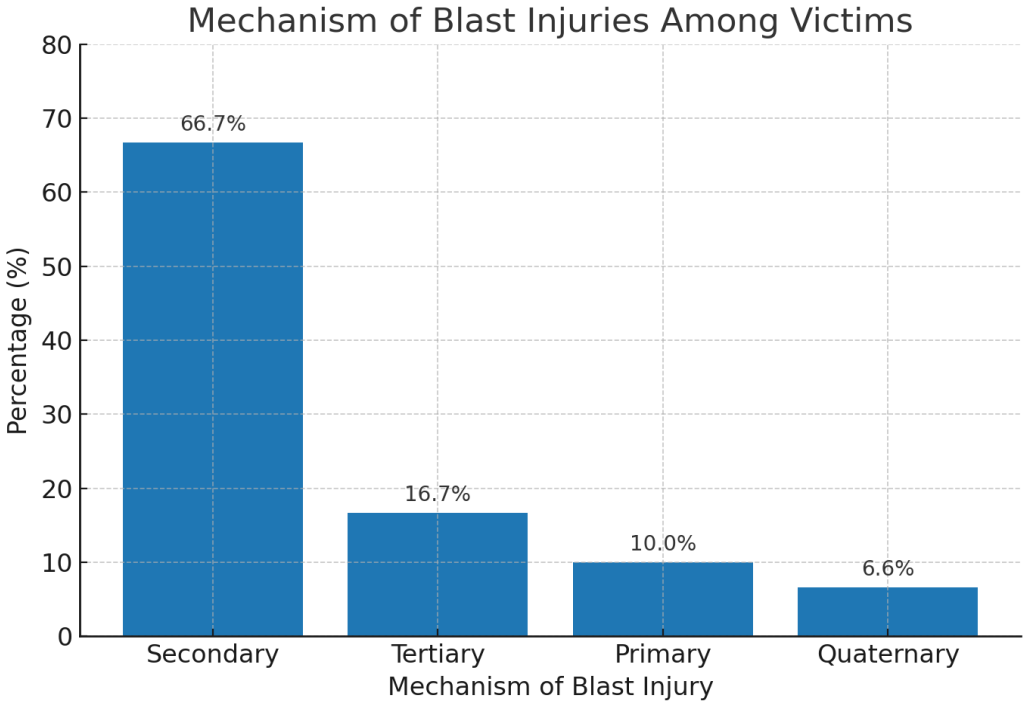
Majority of the victims came in through ambulance services (n=94; 78.3%), but others came through personal transport. Most of them were presented within two hours of the explosion (n=85; 70.8%). The distribution of anatomical injuries showed that the most common were extremity injuries (n=72; 60%), the next, in order, were head and neck injuries (n=48; 40%), thoracoabdominal traumas (n=36; 30%), and facial injuries (n=24; 20%). There were 54 patients (45%) with multiple injuries.

Table 2: Anatomical distribution of injuries

Site of Injury	Frequency (n)	Percentage (%)
Extremities	72	60.0
Head & Neck	48	40.0
Thoracoabdominal	36	30.0
Face	24	20.0
Multiple regions	54	45.0

The injury classification mechanism revealed that the most frequent mechanism of injury was secondary blast injuries caused by flying debris (n=80; 66.7%), followed by tertiary injuries as a result of body displacement (n=20; 16.7%), primary blast wave injuries (n=12; 10%), and quaternary injuries that included burns and smoke inhalation (n=8; 6.6%).

Graph 1: Mechanism of blast injuries among victims



The results of injury severity scoring revealed 40 patients (33.3%) with mild, 50 patients (41.7%) with moderate, and 30 patients (25%) with severe injuries that needed immediate surgical intervention. Extremity traumas involved primarily fractures, amputations, and severe lacerations. Head injuries included open skull fractures and intracranial haemorrhage.

Table 3: Injury severity distribution

Severity Level	Frequency (n)	Percentage (%)
Mild	40	33.3
Moderate	50	41.7
Severe	30	25.0

In outcomes, 95 had recovered to be discharged (79.2%), 15 had to be referred to specialised centres such as neurosurgical or reconstructive surgery (12.5%), and 10 of them had died during hospital stay as a result of critical head injury or excessive internal bleeding. Among the injured, there was high mortality among those who had combined head and thoracoabdominal injuries ($p<0.05$). The length of stay in the hospital was 1 day to 25 days, with a mean of 7.3 +/ - 4.8 days. The patients with several other injuries were found to stay longer in comparison to those with isolated injury.

Discussion

Incidents of bomb blasts are important sources of morbidity and mortality in the world, and cause very complicated patterns of injuries, which pose a challenge to the trauma systems. This current study was carried out in a tertiary care hospital in Pakistan, and it reveals how most injuries affect the extremities and how many injuries involve secondary blast evidence. These results coincide with international literature, which has reported extremity trauma as one of the most frequently occurring results of explosive incidents, owing to the exposure of extremities to the flying debris and shrapnel (1). The fact that we had predominantly male victims holds true to the social and occupational exposure patterns because men are still more likely to be part of the population in a situation of a criminal occurrence or a gathering in an open space. Equivalent gender proportions have been reported in the military context, in which blast victims are mainly men who are combatants, in civilian contexts, men are predominant because of the sociocultural roles available (2). There was an age distribution in this study, where the highest was in the men, respectively, the 21-30 group, in agreement with the demographic most engaged in social, economic and political activities, putting them at a risk of exposure.

Urban blast events are likely to result in injury patterns unique to that type of event, as observed in the 2020 Beirut port explosion, where the explosion of countless pieces of glass in nearby buildings resulted in an unprecedented rate of facial and ocular injuries (3). In our research, the percentage of facial injury was 20 %, which confirms the assumption that environmental influences have a crucial role in the variability of injury patterns. The second most vulnerable area included the head and neck part of the body, which indicates the sensitivity of the region to both primary blast and secondary blast. Children constitute one of the most vulnerable groups during blast incidents because they have smaller bodies and are less able to protect themselves. Reviews of past studies have indicated that blast-related injuries in the pediatric population can span across more areas, and the risk of death is very high in the event of a head injury (4). Children comprised a minor part of our cohort, but their injuries were often found to be severe, and this fact once again promotes the point of pediatric trauma protocols in such circumstances.

Large-scale incidents like the Beirut port blast have reported the immense strain on surgical services when hospitals are suddenly overwhelmed with numbers of critically wounded patients during mass-casualty incidents (5). The setting of the research, which is a tertiary trauma centre, implied that most of the admitted patients exhibited moderate and severe injuries that needed operative treatment. This underscores the importance of the strong plans of mass-casualty preparedness in Pakistan. Other studies on injury patterns through forensic and autopsy indicate that in cases of homicidal injury, the injury pattern can be different in comparison with the injury pattern in an accident, and there are specific and targeted traumatic injuries due to the important areas of the body being targeted (6). Although our study reflected no post-mortem examination, the high lethality of patients with combined head and thoracoabdominal injuries agrees with this fatal concurrence. To inform resources, templates of injury burden as established in the major observational civilian research might be customised locally (7).

The data collected in Somalia proves a close prevalence of extremities injuries, but also points out that the risk of mortality is the greatest in the case of involving major vascular structures (8). This observation is consistent with our results, in which highly traumatic injuries involving extremities were often amputated, and the mortality was higher in cases of uncontrolled bleeding. By using systematic reviews, the importance of extremity trauma has been noted, although the traumas affecting the head and the torso are more closely linked with death (9). In our series, the majority of deaths were reported in patients with a combined head and torso injury, further proving the importance of the above injury locations. There are case reports of how the small-scale devices can be catastrophic, including the accounts of deaths of children due to the simple bombs made of crude materials in rural or unregulated locations (10). Enhancement of prehospital emergency response and awareness may translate into fewer deaths that could be avoided (11).

The issue of long-term disability should also be considered, and survivors can be faced with permanent physical and psychological disability. Evidence reported in multicentric reviews on survivors of blasts shows that musculoskeletal disabilities and sensory deficits are prevalent (12). Our study represented acute injuries, but with such a high preponderance of severe extremity injury, long-term disability among the survivors must involve a significant level of long-term disability. The national trauma databases have established that the bomb blasts using improvised devices contribute to the high volume of such cases of complex polytrauma (13). This corresponds to the fact that in almost half of the attending patients, there were multiple injuries that made the management and hospital stay difficult. Less common, but difficult to diagnose and to treat, are the thoracoabdominal injuries, which are characterised by obscured blood loss, as well as by organ damage (14).

According to historical patterns, the nature of blast injuries has changed, as the demographic type of targets and the weapons of attack have changed, causing changes in the injury patterns (15). Accidental explosions by handling of explosives, even at a small scale, are capable of disastrous trauma, and this issue has been highlighted in past reports (16). The literature on comparative studies shows that blast trauma to extremities is more likely to result in a greater area of soft tissue damage and amputation rates than firearm injuries (17), a trend reflected in our results. The specificity of the experiences at the institutions, like those shared in the case of the Beirut port blast, provides high variance in terms of outcomes, and outcomes seem greatly aligned with the extent of trauma and the quickness of treatment (18). Traumatic brain injury (TBI) is one of the key causes of morbidity and mortality due to a blast. The civilian war statistics in Afghanistan demonstrate that an elevated proportion of TBI is evident in blast injury victims and, therefore, neurosurgical capacity is required even in civilian hospitals (20). In our study, a similar finding was that head injuries showed the highest mortality. Lastly, specialised systems of injury scoring improve the consistency and comparability of research on blast injury (21). The usage of these types of standardised assessment tools in Pakistan would act to increase clinical treatment as well as the strength of research, which would lead to new successes in policy and preparedness planning.

Conclusion

This research paper is an attempt to outline typical trends of injuries, which are incurred with bomb blasts, and to admit patients to the tertiary care hospital in Pakistan. The most frequent type of injury was extremity trauma, mostly due to the secondary blast effect of the shrapnel and debris, and combined thoracoabdominal and head injuries were very strongly correlated with mortality. Most victims were male young adults, as indicated by sociocultural exposure patterns. A majority of the patients came to the hospital in less than two hours, which indicates that speedy prehospital transportation seems significant to increase survival. The results support the necessity of specific preparedness measures that should entail augmented trauma preparation, surgical-resource accessibility, and the coordination of targeted treatment of severe injuries such as traumatic brain and thoracoabdominal trauma. Also, the post-disaster care strategies needs to be brought into line with long-term rehabilitation and psychosocial assistance to overcome the long-term consequences of blast injuries. The findings can guide the disaster measures in hospitals, placement of resources and also policies by national governments on the reduction of morbidity and death.

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