ORIGINAL ARTICLE

Pattern of external injuries sustained during bomb blast attacks in Karachi, Pakistan from 2000 to 2007

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Abstract

Objective: To evaluate patterns of external injury resulting from bomb blasts in Karachi, and compare the injury profile resulting from explosions in open versus semi-confined blast environments.

Methods: The retrospective, cross-sectional study was conducted in Karachi and comprised relevant data from January 2000 to October 2007. Casualty medical records and medico-legal certificates of the victims presented to three large public-sector hospitals were evaluated using a self-designed proforma. SPSS 17 was used for statistical analysis.

Results: Of the 1146 victims, data of 481(42%) represented the final study sample. Of these, 306(63.6%) were injured in open spaces and 175(36.4%) in semi-confined spaces. Of the 896 recorded injuries, lacerations were encountered as external injury in 427(47.7%) cases, followed by penetrating wounds in 137(15.3%). Lower and upper extremities were injured in 348(38.8%) and 170(19%) victims respectively. Open and semi-confined blast environments produced specific injury pattern and profile ($p<0.001$).

Conclusions: External injuries sustained during bomb blast attacks in Karachi demonstrated specific injury patterns and profiles. Further studies are required to account for internal injuries and classification of injuries based on standardised scoring systems.

Keywords: Bomb blast attacks, Injury pattern, External injury, Open space, Semi-confined space, Blast environment.
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Introduction

Bomb blast attacks have become increasingly common across the world. It has become a global challenge regardless of geographical location, race, religion and ethnicity.[1] Recent Palestine-Israel conflict in the Middle East is an example of how specific groups can unfurl their terror in an attempt to achieve ideological and political motives.[2] These inhumane activities primarily target public gatherings, religious and public places, government buildings, and political processions.[3]

Bomb explosions have devastating effects both physically and psychologically.[4,5] They are associated with unique patterns of external injuries ranging from small contusions to large lacerations, deep burns and amputations. These patterns depend on several factors, including nature of blast (suicidal vs. explosive device), environment of blast (open space vs. semi-confined space settings), amount of shrapnel used and nature of explosive material.[6-8] External injuries sustained during these incidents also serve as a predictor of internal injuries and guide hospital management.[9] Understanding these injury patterns can be helpful in designing an effective emergency response system, which can decrease morbidity and mortality rates in these victims.

Over the past two decades, Pakistani citizens have been the victims of such brutal violence. Only in Karachi, during the years 2000-07, there were over 60 bomb explosions, resulting in more than 1500 causalities and over 300 deaths.[10] Despite such drastic numbers, published data pertaining to some pattern of bomb blast injuries from Pakistan is scarce.

The current study was planned to evaluate the type, description and anatomical distribution of various external injuries excluding fractures and dislocations. We also compared injury profiles resulting from explosion in open spaces (public places and gatherings) versus semi-confined blast environments (spaces with limited openings for entry and exit e.g. inside buildings and buses).

Materials and Methods

The retrospective, cross-sectional study was conducted in Karachi and comprised data from January 2000 to October 2007. After approval by the Ethical Review Board of Dow University of Health Sciences (DUHS), casualty

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medical record (CMR) and medico-legal certificate (MLC) of victims brought to the emergency department (ED) of three large public-sector, tertiary-care hospitals — Civil Hospital Karachi (CHK), Jinnah Postgraduate Medical Centre (JPMC) and Abbasi Shaheed Hospital (ASH) — were reviewed. These hospitals are designated as trauma centres and cater to the majority of causalities following bomb blast incidents.[11] The records were requested from the respective medico-legal department of each hospital which manually records, maintains and stores data of victims of all medico-legal cases, including bomb blasts.

Records of victims who were dead on arrival (DOA), those who were immediately transferred to other private-sector hospitals after presenting to ED due to unavailability of beds or exhaustion of resources, and victims whose CMR and MLC could not be extracted, read or interpreted due to inadequate record-keeping or illegible hand writing were excluded.

Pertinent information from CMR and MLC was extracted. Basic demographic information including age, gender and gross description of external injuries (such as lacerations, puncture/penetrating wounds, abrasions, contusions and burns), were recorded. Internal injuries were not taken into account due to inadequate record-keeping and unavailability of complete medical record files owing to poor storage of manual records. In order to address the location of injuries, the body was divided into eight anatomical regions (head, neck, upper limbs, thorax, abdomen, pelvis/perineum, lower limbs and back) and this was used for mapping distribution of external injuries sustained. Information regarding nature of the blast and the blast environment (open or semi-confined space) were obtained from newspaper archives and official government statements issued to the press.

Data was analysed using SPSS 17. Quantitative variables were expressed as mean ± standard deviation, and qualitative variables were expressed as frequencies and percentages. Descriptive statistics were used and cross-tabulations were performed to find out any significant relationship between the studied variables. Chi square test and Fisher's exact test (when the expected frequency was less than five) were applied for categorical data. Normality for continuous variables in groups was determined using the Shapiro Wilk test. An unpaired t test was used for comparison of variables with normal distribution and Mann-Whitney U test was applied for the comparison of continuous variables with non-normal distributions between groups. $P<0.05$ was considered statistically significant.

Results

Based on newspaper reports and online database, 63 bomb explosions took place in Karachi from January 2000 to October 2007 with a mean of 7.8±7.1 blast incidents per year (range: 1-22 per year). These incidences showed an overall decreasing trend with two peaks during the years 2002 and 2004. Out of these attacks, 20(32%) bomb explosions were carried out by suicide bombers, 33(52%) by remotely-detonated explosives devices, and 10(16%) had a combination of both. Besides, 38(60%) explosions took place in open spaces, while 25(40%) explosions took place in semi-confined settings. Bomb explosions mainly targeted religious gatherings 19(30%), government offices 16(25%), public places 9(15%), buses 6(10%) and others 13(20%). They resulted in 1592 casualties, 334(21%) of which were immediate deaths, and 1258(79%) were immediate survivors who were shifted to hospitals. Overall, 1146(72%) casualties were brought to the three public-sector hospitals that were part of the study.

Out of 1146 victims, data of 481(42%) victims meeting the

Table-1: Distribution of external injuries.

S. No.	Type of injury	Open Space n (%)	Semi-Confined Space n (%)
1	Abrasions	91(15.3)	30 (9.9)
2	Lacerations*	333 (56.1)	94 (31.1)
3	Penetrating wound*	114 (19.2)	23 (7.6)
4	1st Degree Burn*	21 (3.5)	44(14.5)
5	2nd Degree Burn*	5 (<1)	32 (10.5)
6	3rd Degree Burn	3 (<1)	5 (1.6)
5	Contusions*	24(4.0)	66(21.8)
8	Crush Injury	2 (<1)	5 (1.6)
9	Amputation	1 (<1)	3 (<1)

*Cells with significant adjusted standardized residuals.

Table-2: Mean injuries and multiple bodily regions injured.

Blast Environment	No. of victims n (%)	Dimension of Lacerated wound mean(cm)*	Diameter of punctured wound mean(cm)*	No. of injuries sustained per victim mean (S.D)	Victims with Multiple injuries+ n (%)
Open Space	306 (63.6)	2cm x 2cm	1.5cm	1.9 (1.2)	123 (40.1%)
Semi- Confined Space	175 (36.4)	4cm x 2.5cm	3.5cm	2.2 (1.2)	106 (60.6%)

*p<0.05
+p<0.001

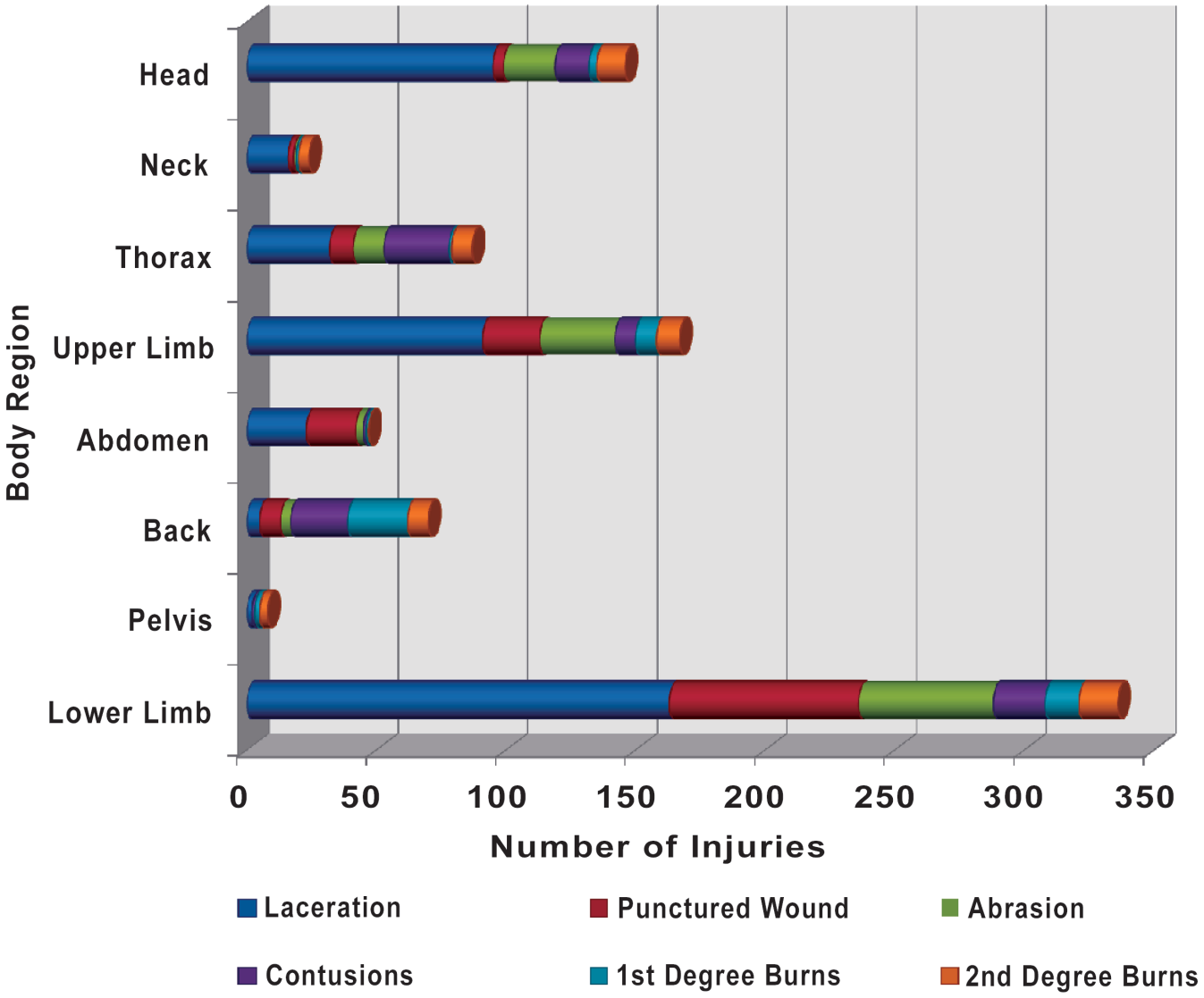

Figure-1: Anatomical distribution, frequencies and types of injuries sustained by various regions.

inclusion criteria were analysed. Of the 481 victims, 463(96%) were males and 18(4%) were females. The overall mean age was 31.4±12.3 years; 306(63.6%) victims were injured in open spaces; 175(36.4%) in semi-confined environments. CHK and JPMC received 227(47%) and 221(46%) of these casualties respectively.

There were 896 recorded injuries (1.86 injuries per victim). There were 427(47.7%) Lacerations, followed by 137(15.3%) penetrating/punctured wounds, 121(13.5%) abrasions and 121(12.3%) burns. Mean laceration length and width were 3.5±2.68cm and 2±1.49cm, respectively, and the mean diameter of penetrating wound was 2±1.31cm. Mean total body surface area (TBSA) burned was 21±12.3%.Anatomical region found to have sustained the majority of injuries were the lower limbs 348(38.6%), followed by the upper limbs 170(19%) and head 147(16.3%). Multiple injuries were found in 275(57.2%) victims (Figure).

The types of external injuries were statistically correlated with the blast environment ($p<0.001$) (Table-1).

The length and width of lacerated wounds and the diameter of penetrating wounds were statistically correlated with blast environment ($p=0.03$, $p=0.04$ and $p=0.02$, respectively) (Table-2). Multiple injuries were found in 106(60.6%) victims injured in semi-confined

space setting compared to 123(40.1%) victims who were injured in an open space environment (p<0.001). No statistically significant correlations were found between the blast environment and the anatomical distribution of the injuries sustained (p=0.49). Mean TBSA burned was not statistically correlated with the blast environment (p=0.29).

Discussion

Injuries resulting from bomb explosion have been extensively studied and described. Blast trauma is a complex chain of events. Pathophysiologically, it can be divided into primary, secondary, tertiary and quaternary blast injuries.[12,13] Different studies have shown that majority of injuries sustained by the survivors of bomb explosion are relatively minor, non-life-threatening injuries.[14,15] External injuries are mainly produced by secondary, tertiary and quaternary blast effects and are typically soft tissue and skeletal injuries.[15] According to our study, bomb explosion produced a specific pattern of external injuries. Lacerations were the commonest type of external injury, and lower limbs were the most affected anatomical region.

Males were predominantly affected in bomb explosions in Karachi, with only 4% of the injured victims being females. This can be attributed to cultural norms of Pakistani society where women are mainly indoors due to their household and family responsibilities. In addition, most of the explosions in Karachi targeted religious gatherings and government offices where females are under-represented.

Our study showed that government-run, public-sector welfare hospitals typically received most of the casualties following bomb explosions. Though private-sector, level-1 trauma centres do exist, admissions in these centres are limited due to financial constraints and space limitations.[16] In majority of blast incidents, CHK and JPMC were the closest tertiary-care, public hospitals from the blast site, and therefore catered to most of the victims.

The types of external injuries in our cohort were consistent with autopsy examination findings of the victims of Nairobi, Kenya, terrorist bombing of the US Embassy in 1998.[13] However, penetrating wounds were more common in our study compared to the Nairobi bombing. Several press releases and unpublished reports have documented use of locally-made Improvised Explosive Devices (IEDs) in various bomb explosions in Pakistan.[17] These IEDs were stuffed with ball bearings, nails like objects and pellets which could account for increased frequency of penetrating wounds observed in our study. These penetrating injuries are associated with wound infection, extensive tissue damage and orthopaedic trauma.[18] Effective management requires timely debridement and removal of contaminated tissue, prevention of sepsis, and appropriate surgical interventions.[19] Penetrating wounds in our study were commonly found on extremities and were of trivial nature. It could be explained by the inclusion criteria of our study, which only reported injuries sustained by the immediate survivors, not accounting for larger degree and central locations of these penetrating injuries, which might have resulted in immediate fatality.

We found that the extremities, especially the lower limbs, sustained a high percentage of injuries following bomb blasts. Other local and international studies have also reported similar findings.[19-21] This disproportionately higher number of injuries to the extremities can be explained by the dynamics of the blast wind, affecting extremities to a greater extent.[22] Blast extremity injuries are often horrific and distract attention from other critical, life-threatening injuries. Thus, there is a need for more vigilance, and open-minded, holistic approach while managing such victims.[14]

Our study showed that explosion in semi-confined spaces was associated with involvement of multiple regions of the body and severe nature of the injuries sustained. This has also been demonstrated in other cohorts.[8,23] Mean injuries sustained by a victim, however, did not differ significantly with blast environment. Explosion in confined spaces are also associated with higher incidence of primary blast injuries, increased TBSA burned and increased mortality.[8] Prompt multi-disciplinary and intensive management could improve outcome in such settings.

Additional injuries can also result from inadequate pre-hospital management, unskilled handling and transfer of victims to the hospital.[24] Emergency response system in Pakistan needs to be further strengthened to better respond to emergencies in the city as well as the country. Emergency Medical Service (EMS) structure and pre-hospital management of victims has been inadequate in Karachi following bomb explosion. Pre-hospital care is mainly administered by police, bystanders and well-wishers. EMS personnel generally lack adequate paramedical training and are no different from general public.[11] In a mass casualty incident, victims are usually transported to the nearby trauma centre without any triage, pre-hospital treatment and transfer protocol.[11,25] Most of the ambulance service providers do not have adequate en-route treatment facilities. The communication links between ambulance services and

trauma centres are almost non-existent.[11] These shortcomings might aggravate nature and extent of injuries sustained, and could be translated into increasing morbidities and mortalities.

A major limitation of our study was the unavailability of comprehensive clinical data due to inadequate record-keeping and poor storage. In cases of mass casualties, inadequate record-keeping is ubiquitous; recording of clinical data is done haphazardly, and victims with trivial injuries are often managed without any documentation of clinical findings and interventions.[26] Non-existent electronic medical records system, illegible handwriting in medical records and lack of proper storage system for manual records at public-sector hospitals of Karachi further limited extraction of the required clinical, pathological and radiological data.[27]

These observations and comments regarding the emergency response system and record-keeping are made pertaining to data until 2007. There is a possibility that these might have improved since then.

Other significant limitations included the retrospective nature of the study, lack of accountability of internal injuries, and exclusion of injuries sustained by the victims who were brought dead or transferred to private-sector hospitals immediately after presenting to ED. The data that we could gather was not sufficient to classify injuries and their severity according to standardised scoring systems such as the Abbreviated Injury Scale (AIS) and the Injury Severity Score (ISS), as used by other studies evaluating patterns of blast injuries.[28]

Conclusions

External injuries sustained during bomb blasts demonstrated specific injury pattern and profile. Further studies are required to account for internal injuries and injuries sustained by the victims who were brought dead or treated at private-sector hospitals. Necessary actions need to be taken by relevant bodies to encourage and ensure electronic record-keeping and proper storage of manual records. This will make extraction of such data easier, and also enable use of standardised scoring system to classify injuries and their severity. Better functioning emergency response systems should be designed to cope with mass causalities following a bomb explosion.

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