

Clinical Presentation and Time-Based Mortality in Patients With Chest Injuries Associated With Road Traffic Accidents

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Abstract

Background: Blunt chest trauma (BCT) poses significant morbidity and mortality worldwide.

Objectives: We investigated the clinical presentation and outcome of BCT related to road traffic accidents (RTA).

Patients and Methods: A retrospective observational analysis for patients who sustained BCT secondary to RTA in terms of motor vehicle crash (MVC) and pedestrian-motor vehicle accidents (PMVA) who were admitted to the trauma center at Hamad general hospital, Doha, Qatar, between 2008 and 2011.

Results: Of 5118 traumatic injury cases, 1004 (20%) were found to have BCT secondary to RTA (77% MVC and 23% PMVA). The majority were males (92%), and expatriates (72%). Among MVCs, 84% reported they did not use protective devices. There was a correlation between chest abbreviated injury score (AIS) and injury severity scoring (ISS) ($r = 0.35$, $r^2 = 0.12$, $P < 0.001$). Regardless of mechanism of injury (MOI), multivariate analysis showed that the head injury associated with chest AIS and ISS was a predictor of mortality in BCT. Overall mortality was 15%, and the highest rate was observed within the first 24 hours post-trauma.

Conclusions: Blunt chest trauma from RTA represents one-fifth of the total trauma admissions in Qatar, with a high overall mortality. Pedestrians are likely to have more severe injuries and higher fatality rates than MVC victims. Specific injury prevention programs focusing on road safety should be implemented to minimize the incidence of such preventable injuries.

Keywords: Chest Trauma, Road Traffic Accidents, Injury, Pedestrians, Motor Vehicle Crashes

1. Background

Blunt chest trauma (BCT) represents 10 - 15% of all traumatic injuries and around 25% of all trauma-related deaths worldwide (1, 2). The etiology and pattern of BCT vary according to the mechanism of injury and socio-economic factors (3, 4). Motor vehicle crashes (MVCs) account for 60 - 70% of all thoracic traumas (5, 6). The mortality rate in BCT patients depends mainly upon the severity of injury and the presence of associated injuries to the other organ systems (3, 6). Unfortunately, developing countries have a greater proportion of road traffic-related deaths (6, 7). Notably, the rapidly developing Middle Eastern countries have a higher incidence of RTA-related fatalities, which is mainly attributed to the high motorization rate (7). Moreover, pedestrians are the most vulnerable road users and sustain significant injuries during RTAs (8, 9). In Qatar, RTAs constitute a higher proportion of BCTs; however, there is a lack of information on the pattern, severity, and outcome of BCT secondary to RTA in terms of MVC vs. pedestrian-motor vehicle accidents.

2. Objectives

This study aimed to evaluate the clinical presentation, severity, and time-based mortality of BCT according to types

of RTA (MVC vs. pedestrian motor vehicle accident [PMVA]) in Qatar, a rapidly developing Middle Eastern country.

3. Patients and Methods

This is an observational retrospective analysis of all BCT patients secondary to RTA who required admission to the section of trauma surgery at Hamad general hospital (HGH) between January 2008 and June 2011. Hamad general hospital is the only tertiary hospital with a Level I trauma centre in the state of Qatar. Patients who died at the scene or were declared dead in the trauma resuscitation unit (TRU) were excluded because of incomplete data. The diagnosis of chest injury was made after obtaining the clinical history, a physical examination, and radiologic imaging. Thoracic injuries are defined as injury to the chest wall and/or the contents of the thorax, for example, the pleura, lungs, lower respiratory tract, heart, and great vessels. On arrival, all patients underwent thorough clinical assessment and resuscitation according to advanced TRAUMA life support (ATLS) guidelines. Collected data included age, sex, nationality, mechanism of injury, protective measures, radiological imaging, injury severity score (ISS) calculation using the ab-

breviated injury scale (AIS), chest AIS value, thoracic trauma (i.e. rib fractures, diaphragmatic injury, pneumothorax, hemothorax, pulmonary contusion, cardiac and major vessels injury), and associated non-thoracic injuries (head and solid organ injuries). Acute interventions (intubation, chest tubes, thoracotomy, tracheostomy, and non-thoracic interventions), hospital length of stay, development of pneumonia, and acute respiratory distress syndrome (ARDS) during hospitalization were also reported. The primary outcome was in-hospital mortality after the initial traumatic event. Data were analyzed according to the type of accident (MVC vs. PMVA), ISS (≤ 15 vs. > 15), and time of death after hospital admission (< 24 hours, 2nd - 7th day, and > 1 week).

3.1. Statistical Analysis

Data were presented as proportions, medians (range), or mean \pm standard deviation, as appropriate. Differences in categorical and continuous variables were analyzed using χ^2 , student's t-test, and one-way analysis of variance (ANOVA), as appropriate. For the correlation

between chest AIS and ISS, a linear regression analysis was performed. Predictors of mortality among BCTs were assessed using multivariate logistic regression analysis including all relevant and significant univariate variables. Two tailed P values of < 0.05 were considered to be significant. All data were analyzed using the statistical package for the social sciences version 18 (SPSS, Inc. Chicago, Illinois, USA).

4. Results

Out of the 5118 trauma patients admitted to HGH, 1004 (19.6 %) were found to have BCT. The mean age of BCT patients was 33 ± 15 years. Males and expatriates represented 92% and 72%, respectively. Demographics, clinical presentation, and outcome of BCT are presented in Table 1. The MOI of BCT comprised of MVC (77%) and PMVA (23%). Among MVC occupants, chest injuries were predominantly observed in drivers (62%), followed by front-seat (13.4%) and back-seat (12.4%) passengers. Most of the MVC victims (84%) did not use protective devices during crashes.

Table 1. Patients Demographics, Clinical Presentations and Outcomes Based on the Mechanism of Injury^a

	Overall	MVC	PMVA	P Value
Patients, No. (%)	1004 (100)	771 (77)	233 (23)	
Mean age, y	32.7 \pm 15	32.5 \pm 14.3	33 \pm 16.2	0.60
Male	92	92	93	0.55
Prior lung diseases^b	2	2.7	0.4	0.04
Hospital stay (median)	7 (1-262)	7 (1-262)	9 (1-249)	0.12
Overall mortality	15	12.3	23.2	0.001
Thoracic injuries				
Lung contusion	74	73	76	0.63
Rib fracture	57.4	59	53	0.14
Pneumothorax	29	28	34	0.10
Hemothorax	23	22.9	23.3	0.88
Cardiac injury	2	2.1	1.3	0.43
Diaphragmatic injury		1.4	3.9	0.02
Associated injuries				
Spleen injury	12.4	11	16	0.10
Liver injury	15	14	19	0.06
Kidney injury	6	5	8	0.12
Head injury	44	41	54	0.001
Interventions				
Exploratory laparotomy	7.7	7	11	0.02
Tracheostomy	4.4	4.7	3.4	0.42
Thoracic tube	19.4	19	20	0.83
Craniotomy	3.4	2.9	5.2	0.08
ORIF	16	16	15.5	0.82
Intubation	32	30	39	0.009
Thoracotomy	4.4	1.8	1.7	0.92
Chest AIS	3(1-9)	2.8 \pm 0.9	2.8 \pm 0.8	0.74
ISS	19 \pm 10.7	18.6 \pm 10.3	20.6 \pm 11.9	0.02
Pneumonia	4.8	4.7	5.0	0.76

Abbreviations: AIS, abbreviated injury scale; ARDS, acute respiratory distress syndrome; CT, computed tomography; MVC, motor vehicle crash; ORIF, open reduction internal fixation; PMVA, pedestrian-motor vehicle accidents; SD, standard deviation.

^aValues are presented as mean \pm SD or %.

^bPrior lung diseases, history of asthma or chronic obstructive pulmonary disease.

The pattern of BCT was predominated by lung contusions (74%), followed by rib fracture (57%), pneumothorax (29%), and hemothorax (23%). Head injuries were reported in 44% of cases. The overall mean ISS was 19 ± 11 . Complications such as pneumonia and ARDS were observed in 4.8% and 0.4% cases, respectively.

Table 1 also demonstrates the injury pattern and outcome according to the type of RTA.

There was no significant difference in the pattern of chest injuries between the two groups regarding lung contusions or rib fractures. Patients in the PMVA group had a higher rate of head injury ($P = 0.001$). Intubation ($P = 0.009$), injury severity score ($P = 0.02$) and mortality ($P = 0.001$) were higher in the PMVA than the MVC group. Tables 2 and 3 show the characteristics of the MVC and PMVA groups according to ISS. Moreover, there was a cor-

relation between chest AIS and ISS ($r = 0.35$, $R^2 = 0.125$, and adjusted $R^2 = 0.124$; $P < 0.001$).

Table 4 and Figure 1 demonstrate BCT in vehicle occupants and pedestrians according to the time of death. The overall mortality was 15% ($n = 149$), and the highest proportion of mortalities (64%) was observed within the first day post-trauma. A significantly higher proportion of vehicle occupants who died after 7 days had complications such as pneumonia and ARDS ($P = 0.001$). On the other hand, pedestrians who died between 2 and 7 days post-injury had higher rates of lung contusion and pneumonia.

Multivariate logistic regression analysis (Table 5) revealed that associated head injury (odds ratio [OR] 2.7; 95% confidence interval (CI) 1.516 - 4.684) and chest AIS (OR 2.0; 95% CI 1.506 - 2.570) and ISS (OR 1.1; 95% CI 1.084 - 1.137) were independent predictors of in-hospital mortality.

Table 2. Patients Demographics, Clinical Presentations and Outcomes in the MVC Group According to Injury Severity Score^a

	ISS ≤ 15	ISS > 15	P Value
Patients, No. (%)	341 (44.8)	421 (55.2)	
Mean age, y	33.4 ± 14.7	31.6 ± 14	0.09
Male	87.7	95.5	0.001
Overall mortality	2.1	19.5	0.001
Lung injury	63	83	0.001
Rib fracture	67	53	0.001
Pneumothorax	26	30	0.28
Hemothorax	16	29	0.001
Cardiac injury	1.5	2.6	0.27
Protective measures used			0.001
Seatbelt only	24.1	10.4	
Airbag + Seatbelt	3.2	1.2	
Airbag Only	2.1	1.2	
Position in vehicle			0.03
Driver	64.6	60.5	
Front passenger	12.9	13.8	
Back passenger	14.8	10.7	
Unknown	7.7	15	
Associated injuries			
Head injury	17.3	60.5	0.001
Spleen injury	5.3	16.6	0.001
Liver injury	6	20	0.001
Kidney injury	2.1	7.6	0.001
Interventions			
Exploratory Laparotomy	1.5	10.9	0.001
Tracheostomy	0.6	8	0.001
Thoracic tube	8.5	28.6	0.001
Craniotomy	0	5.2	0.001
ORIF	9	22	0.001
Intubation	9.4	46.6	0.001
Thoracotomy	0.6	2.9	0.02
Hospital stay (median)	4 (1 - 64)	13 (1 - 186)	0.001
Chest AIS	2.5 ± 0.9	3 ± 0.8	0.001
Pneumonia	0.9	7.8	0.001

Abbreviations: ARDS, acute respiratory distress syndrome; AIS, abbreviated injury scale; CT, computed tomography; ISS, injury severity score; ORIF, open reduction internal fixation; SD, standard deviation.

^aValues are expressed as mean \pm SD or %.

Table 3. Patients Demographics, Clinical Presentations and Outcomes in the PMVA Group According to Injury Severity Score^a

	ISS ≤ 15	ISS > 15	P Value
Patients	86 (38.2)	139 (61.8)	
Mean age	30.5 ± 17.6	34.7 ± 15	.06
Male	92	94	.63
Hospital stay	6 (1- 61)	12 (1- 168)	.004
Chest AIS	2.4 ± 1	3 ± 0.6	.001
Pneumonia	1.2	7.9	.02
Overall mortality	9.3	29.5	.001
Associated injuries			
Head injury	32.6	68.3	.001
Lung injury	71	81	.07
Rib fracture	49	55	.33
Hemothorax	20	27	.21
Pneumothorax	33	35	.75
Cardiac injury	1.2	1.4	.86
Spleen injury	6	22	.001
Liver injury	14	22	.12
Kidney injury	5.8	9.4	.34
Interventions			
Exploratory laparotomy	9.3	12.2	.49
Tracheostomy	0	6	.02
Thoracic tube	11	26	.007
Craniotomy	3.5	6.5	.33
ORIF	11.6	18	.20
Intubation	16.3	51.8	.001
Thoracotomy	1.2	2.2	.58

Abbreviations: AIS, abbreviated injury scale; CT, computed tomography; ISS, injury severity score; ORIF, open reduction internal fixation; SD, standard deviation.

^aValues are presented as mean ± SD or No. (%).

Table 4. Clinical Presentations and Complications in the MVC and PMVA Group, Stratified by Time of Death^a

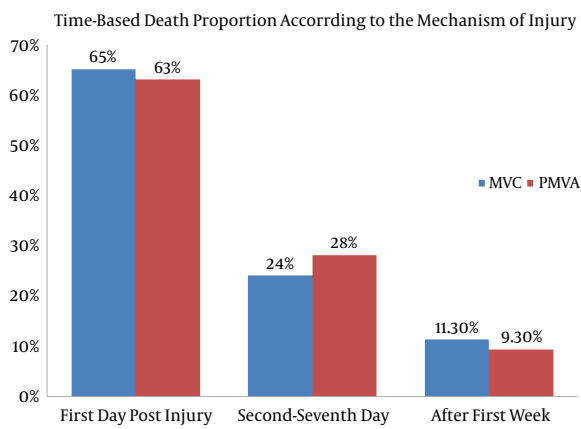
	MVC				PMVA			
	1 st Day	2 nd - 7 th Day	> 1 Week	P Value	1 st Day	2 nd - 7 th Day	> 1 Week	P Value
Age, y	31.8 ± 11	30.2 ± 13	37.6 ± 17.5	0.38	39.8 ± 21.5	34.1 ± 13.3	40.4 ± 19.5	0.65
Males	92.3	94.7	100	0.66	94	100	100	0.54
Head injury	71	84	89	0.33	71	87	60	0.37
Lung contusion	69	84	78	0.42	47	93	100	0.002
Rib fractures	46	37	78	0.12	41	27	80	0.10
Spleen injury	5.8	15.8	22.2	0.19	18	27	20	0.77
Liver injury	9.6	10.5	22.2	0.53	11.8	13.3	40	0.24
Kidney injury	5.8	0	0	0.43	2.9	6.7	0	0.73
Cardiac injury	3.8	0	0	0.57	NA	NA	NA	NA
Hemothorax	25	31.6	33.3	0.78	15	20	40	0.39
Pneumothorax	19	37	22	0.30	12	40	80	0.002
ISS	30.6 ± 13.5	31.9 ± 8	32.8 ± 11.5	0.84	25.9 ± 16.6	36.5 ± 14.8	34.4 ± 9.6	0.09
Chest AIS	4.1 ± 2.2	3.3 ± 1.6	2.9 ± 0.6	0.14	3.1 ± 1.4	2.9 ± 0.7	3.2 ± 0.4	0.87
Pneumonia	0	0	22.2	0.001	2.9	20	0	0.08

Abbreviations: ARDS, acute respiratory distress syndrome; AIS, abbreviated injury scale; ISS, injury severity score; NA, not available; SD, standard deviation.

^aValues are expressed as mean ± SD or No (%).

Table 5. Predictors of Mortality in Patients with Blunt Chest Injury

Variable	P Value	Odds Ratio	95% Confidence Interval
Age, y	0.105	1.013	0.997 - 1.029
Head injury	0.001	2.665	1.516 - 4.684
Diaphragmatic injury	0.092	0.217	0.037 - 1.280
Injury severity scoring	0.001	1.110	1.084 - 1.137
Chest AIS	0.001	1.967	1.506 - 2.570
Pneumonia	0.275	0.614	0.256 - 1.473
MVC vs. pedestrian injury	0.082	1.577	0.943 - 2.636
Thoracotomy	0.185	2.398	0.658 - 8.748

**Figure 1.** Time-Based Mortality Among Blunt Chest Traumas Based on the Mechanism of Injury; Motor Vehicle Crash vs. Pedestrian Injury

5. Discussion

This is a unique study from a single center in the Arab Middle East that assesses the clinical presentation and time-based mortality of BCT based on the mode of injury. The majority of RTA victims were young males. In this analysis, lung contusion was the most common type of BCT, followed by rib fracture, which is consistent with other studies (10-12). Earlier studies have reported hemothorax and pneumothorax as the most frequent lesions in BCT (13). Similarly, around one-third of our chest injury cases presented with pneumothorax and one-fourth had hemothorax.

Although seatbelt compliance is the most appropriate mode of minimizing RTA traumatic injuries (11), we have observed a low rate of seatbelt use in our cohort. Studies from Saudi Arabia and UAE have reported consistently lower seatbelt compliance rates among drivers and front-seat passengers (14, 15). Similar to earlier reports (4, 6, 16), the present study observed a higher proportion of extrathoracic injuries among BCT patients, which possibly increased the risk of complications. The presence of associated head injury is considered a significant predictor of mortality in BCT patients (4, 6). Moreover, injuries of the liver and spleen also increase the risk of mortality by three times (17). In our study, hepatic and splenic injuries

accounted for 15% and 12%, respectively.

In our cohort, pedestrians had higher ISS, associated head injury, intubation, and mortality rates than occupants of motor vehicles. Demetriades et al. (18) also observed a significant association of PMVA with higher injury severity and higher incidence of head injury and mortality when compared to other road users. In the present study, the severity of injury was stratified according to the ISS to correlate its impact on the overall outcome. There are few studies that have attempted to correlate the BCT injury severity and outcomes (19, 20). Veysi et al. (21) reviewed 1164 BCT patients and observed that high chest AIS was associated with high overall ISS and mortality. Consistently, in our cohort, both vehicle occupants and pedestrians with severe injuries (ISS > 15) required more acute interventions and prolonged hospital stays, and had higher rates of extra-thoracic injuries, complications, and mortality. Moreover, the present analysis showed a correlation between ISS and chest AIS.

Despite a sharp decline in the rate of pneumonia and ARDS mortality in recent years, these complications still account for a mortality rate of 20% - 43% (22). In our study, pneumonia and ARDS were significantly more common among motor vehicle occupants, particularly among those who died late in the hospital. It is also important to note that the most frequent intrathoracic injury associated with mortality in both MVC and PMVA patients was pulmonary contusion, while head injury constituted the most frequent extrathoracic injury that was closely associated with mortality in both groups of patients. In the multivariate analysis, associated head injury and chest injury AIS in addition to ISS were independent predictors of mortality in MVCs and PMVAs. Also, our findings showed that regardless of the mechanism of RTA, peak mortality was seen within the first day post-trauma, which reflects the severity of injury and prehospital care.

One of the limitations of our study is the retrospective observational design. Alcohol use and the use of seatbelts in motor vehicles were not reported for the entire cohort. Also, we do not have data on the circumstances of the PMVAs, road conditions such as lighting, distance from pedestrian crosswalks, pedestrian overpasses, type of vehicle, or information on the drivers. The rate of seat-

belt use could be underestimated, as its documentation was not validated with police data and other sources. The number of deaths may be underestimated, as those who died at the scene were not included in the study. The exact cause of death is also lacking, as no routine post-mortem analysis was feasible. To improve the prediction of outcomes in BCT patients, a validated severity score such as thoracic trauma severity score (TTSS) is required; our data were not complete enough to comply with that. However, TTSS is not the final word in BCT evaluation (23).

In conclusion, chest injuries secondary to RTAs represent one-fifth of the total trauma admissions in Qatar, with a high overall mortality. However, pedestrians are likely to have more severe injuries and higher fatality rates than MVC victims. Specific injury prevention programs focusing on safe driving practices and the safety of road users should be implemented to minimize the incidence of traffic-related chest injuries.

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Footnote

Authors' Contribution:All authors contributed to and approved the manuscript.

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