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ORIGINAL ARTICLE

Outcomes of Patients with Blunt Chest Trauma Encountered at Emergency Department and Possible Risk Factors Affecting Mortality

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Background: Blunt chest trauma is associated with a high risk of mortality. Respiratory complications may necessitate prolonged ventilation and result in death. The present study aimed to investigate possible signs of trauma and the prognosis of trauma patients with thoracic injuries and identify risk factors for mortality. **Patients and Methods:** A retrospective study was performed to investigate the clinical characteristics and treatment outcomes of trauma patients with blunt chest injuries who underwent thoracic computed tomography on arrival in the emergency department (January 2010–December 2013). Patients with brain injuries were excluded from the study. The prognostic values of age, sex, trauma type, injury severity score, revised trauma score (RTS), ventilator requirement, days in Intensive Care Unit (ICU), associated thoracic injury, and laboratory examinations (including arterial blood gas [ABG]) were evaluated. **Results:** Fifteen of 30 analyzed patients died during their ICU stays; accordingly, we classified patients as survivors and nonsurvivors. These groups differed significantly regarding the RTS ($P = 0.002$), mechanical ventilation requirement ($P = 0.007$), total stay length ($P = 0.009$), and the presence of hemothorax ($P = 0.030$). However, no significant differences in the pneumothorax, rib fractures, and blood tests (including ABG analysis) were observed between the groups. **Conclusion:** Among hospitalized trauma patients with blunt thoracic injuries, RTS, mechanical ventilation requirement, and hemothorax were identified as risk factors for mortality. Patients with hemothorax should receive multidisciplinary care and be monitored closely to improve survival.

Key words: Blunt trauma, chest injury, mortality, revised trauma score, hemothorax

INTRODUCTION

Trauma-related mortality accounts for 9% of deaths in all age groups and most cases involve blunt injuries.[1] Multiple trauma is the main cause of emergency admission, accounting for approximately 16% of global medical expenses.[2-4] A previous study found that 20% of deaths occurred within the first few weeks after injury, 30% occurred within hours of the injury, and 50% occurred immediately.[5] Therefore, management of this difficult condition usually requires a multidisciplinary approach. Chest trauma is one of the most common injuries suffered by polytrauma patients, with an incidence of 45%–65%.[6] This type of trauma, which is usually caused by a high-energy blunt force, is associated with mortality rates as high as 60%.[7] Chest injury was found to cause death in 20%–25% of multiple trauma patients.[8,9] Thoracic trauma is, therefore, important in the overall management of multiple injury patients and may require a longer stay in the Intensive Care Unit (ICU) and use of mechanical ventilation.[7] In addition, trained multidisciplinary teams and well-equipped facilities play critical roles in reducing the rate of mortality within a few hours of trauma injury.[10,11] The present study analyzed the outcomes of blunt chest trauma in the emergency

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department (ED) and after further multidisciplinary team management at our hospital to identify possible risk factors for mortality.

PATIENTS AND METHODS

This retrospective study was conducted at a teaching hospital in Eastern Taipei City, where most trauma patients are transferred for treatment. Advanced Trauma Life Support guidelines were used for the initial evaluation. We reviewed the medical records of all patients in our trauma registry to identify those who underwent chest radiography (CXR) and computed tomography (CT) scans of the thorax for thoracic injury diagnosis on arrival at our ED from January 2010 to December 2013. We recorded demographic data, duration of hospital admission, and final outcomes. We divided patients into two groups: survivors and nonsurvivors. Data were evaluated for variables such as age, sex, injury severity score (ISS), revised trauma score (RTS), injury mechanism, ventilator support requirement, associated injuries, ICU days, total length of stay (LOS), associated thoracic injuries, arterial blood gas (ABG) data, and laboratory examinations performed on arrival at our hospital.

All CXR and CT images were reviewed by two investigators: Tsai, a thoracic surgeon and Lin. All cases were evaluated for the presence or absence of pneumothorax, hemothorax, fractured ribs, flail chest, subcutaneous emphysema, pneumomediastinum, and mediastinal hematoma. Patients were excluded from this study if they were younger than 18 years, had an accompanying intracerebral hemorrhage or other brain injury, exhibited organ dysfunction or serious disease before injury, experienced an out-of-hospital cardiac arrest, or had incomplete data. The study was approved by the authors' Institutional Review Board (IRB No. 1-105-05-021).

Statistical methods

Data analyses were performed using the Statistical Package for Social Sciences, version 18 (SPSS, Inc., Chicago, IL, USA). Student's *t*-test was used for continuous variables, and the Chi-square test or Fischer's exact test was used for categorical variables, respectively. The value of $P < 0.05$ was considered statistically significant.

RESULTS

A total of 318 cases of multiple trauma within a 4-year period were available from the trauma registry. Thirty patients (25 men, 5 women) with blunt chest trauma were included in the study. The average age was 39.13 ± 19.42 years. Twenty-eight and two patients were admitted to the ICU and general ward, respectively. Fifteen patients died during the ICU stay. The main cause of multidisciplinary trauma team involvement was multiple trauma (nine patients, 30.0%), followed by fall from a height (six patients, 20.0%), Glasgow coma scale <13 (11 patients, 36.7%), physician's decision (three patients, 10%), and systolic blood pressure <90 mmHg (one patient, 3.3%). The demographic data, ISS, RTS, cause of trauma team involvement, injury mechanism, ventilatory support requirement, associated injuries, ICU days, and total LOS are summarized in Table 1. One patient had a coexisting abdominal injury, and five patients had pelvic injuries. The

Table 1: Baseline characteristics of patients

Variables	Survivors (*n*=15)	Nonsurvivors (*n*=15)	*P**
Age	40.40±20.25	37.87±19.18	0.728
Sex (%)			
Male	12 (80.00)	13 (86.67)	0.500
Female	3 (20.00)	2 (13.33)	
ISS	26.67±11.29	33.47±8.72	0.075
Revised trauma score	6.46±1.36	4.73±1.37	0.002
Initial reason (%)			
Multiple trauma	3 (20.00)	6 (40.00)	0.658
High falling	3 (20.00)	3 (20.00)	
GCS <13	6 (40.00)	5 (33.33)	
Arterial SBP	1 (6.67)	0 (0.00)	
Physicians decision	2 (13.33)	1 (6.67)	
Injury cause (%)			
Road accident	10 (66.67)	12 (80.00)	0.563
Falling injury	3 (20.00)	3 (20.00)	
Explosion	2 (13.33)	0	
Mechanical ventilator (%)			
Present	7 (46.67)	14 (93.33)	0.007
Absent	8 (53.33)	1 (6.67)	
Abdominal injury (%)			
Present	1 (6.67)	0	0.500
Absent	14 (93.33)	15 (100.00)	
Pelvic injury (%)			
Present	2 (13.33)	3 (20.00)	0.500
Absent	13 (86.67)	12 (80.00)	
Admission (%)			
ICUs	13 (86.67)	15 (100.00)	0.135
Ward	2 (13.33)	0	
ICU stay	17.80±23.54	6.93±10.36	0.113
Total length of stay	50.80±59.92	6.93±10.36	0.009

*Significance level=*P*<0.05 (Fisher's test). SBP=Systolic blood pressure; ICUs=Intensive Care Units; ISS=Injury severity score; GCS=Glasgow coma scale

survivors and nonsurvivors differed significantly in terms of the RTS (6.46 ± 1.36 vs. 4.73 ± 1.37; $P = 0.002$), number of total LOS (50.80 ± 59.92 vs. 6.93 ± 10.36; $P = 0.009$), and mechanical ventilator usage ($P = 0.007$). However, no significant inter-group differences were observed in age, sex, and ISS ($P = 0.728$ and $P = 0.500$ for age and sex, respectively; 26.67 ± 11.29 vs. 33.47 ± 8.72, $P = 0.075$ for ISS).

The incidences of chest trauma-related complications among survivors and nonsurvivors are shown in Table 2. When patients were classified by thoracic injury type, rib fracture was the most common, followed by hemothorax, pneumothorax, subcutaneous emphysema, flail chest, pneumomediastinum, and mediastinal hematoma. A significant intergroup difference in hemothorax incidence was observed ($P = 0.030$). Laboratory examinations were performed when the trauma patients arrived at our ED. We observed no significant inter-group differences in white cell count, platelet count, mean corpuscular volume (MCV), or hemoglobin, blood urea nitrogen (BUN), creatinine, aspartate aminotransferase (AST), and ABG levels. A detailed analysis is presented in Table 3.

Table 2: Associated thoracic injuries

Variables	Survivors (n=15), n (%)	Nonsurvivors (n=15), n (%)	P*
Pneumothorax			
Present	4 (26.67)	6 (40.00)	0.350
Absent	11 (73.33)	9 (60.00)	
Hemothorax			
Present	9 (60.00)	3 (20.00)	0.030
Absent	6 (40.00)	12 (80.00)	
Fractured ribs			
Present	10 (66.67)	8 (53.33)	0.355
Absent	5 (33.33)	7 (46.67)	
Flail chest			
Present	4 (26.67)	0	0.050
Absent	11 (73.33)	15 (100.00)	
Subcutaneous emphysema			
Present	4 (26.67)	3 (20.00)	0.257
Absent	11 (73.33)	12 (80.00)	
Pneumomediastinum			
Present	2 (13.33)	2 (13.33)	0.999
Absent	13 (86.67)	13 (86.67)	
Mediastinal hematoma			
Present	1 (6.67)	0	0.500
Absent	14 (93.33)	15 (100.00)	

*Significance level: $P<0.05$ (Fisher's test)

Table 3: Laboratory examinations of patients

Variables	Survivors (n=15)	Nonsurvivors (n=15)	P*
White cell count	14360±7750	16760±4395	0.154
Hemoglobin	12.35±2.10	12.95±2.84	0.520
Platelet counts	213.67±91.07	185.33±80.07	0.373
MCV	91.93±6.39	91.08±8.91	0.765
BUN	15.97±8.87	14.60±3.74	0.587
Creatinine	1.05±0.24	1.05±0.24	0.940
AST	92.93±78.01	73.13±70.89	0.473
Arterial blood gas			
PH	7.33±0.06	7.28±0.133	0.185
PaO_2	129.09±58.76	125.60±130.81	0.926
$PaCO_2$	40.89±8.10	45.01±10.99	0.253
HCO_3	21.29±4.58	20.43±3.35	0.565
SaO_2	95.48±8.29	81.41±28.30	0.075

*Significance level: $P<0.05$ (Fisher's test). AST=Aspartate aminotransferase; BUN=Blood urea nitrogen; MCV=Mean corpuscular volume

DISCUSSION

Blunt trauma injuries predominately affect male individuals aged 30–40 years. These injuries are mainly caused by traffic accidents, as well as falls from heights.[2,3,12] Similar to other studies, in our study, the mean age at the time of injury was 39.13 ± 19.42 years, and most patients were male (83.3%). Furthermore, traffic accidents (73.3%) and falling from a height (20%) were the major causes of injury. Many studies have reported associations of ISS and RTS with mortality. Specifically, the mortality risk increases with an ISS >40 and RTS <4.5.[13-16] In the present study, we compared survivors and nonsurvivors. Although the mean ISS did not differ significantly between the groups ($P = 0.075$), a significant inter-group difference in the mean RTS was observed ($P = 0.002$).

In this study, patients with multiple trauma and associated blunt thoracic injuries had a mortality rate of 50%. In a previous report, 30%–75% of pulmonary contusions consequent to blunt thoracic trauma were caused by vehicular accidents.[17] Posttraumatic pulmonary contusion could injure the small airways and damage capillaries and epithelial cells. This condition could also cause an increase in pulmonary capillary permeability, leading to alveolar edema. Possible complications include acute oxygenation deterioration, airway obstruction, mismatch of ventilation/perfusion, and hypoxemia. In addition, increased mucus production, coupled with a decreased ability to expectorate, may also induce pulmonary alveolar edema.[18] Therefore, the patient may require a longer period of mechanical ventilator use and have a longer LOS. Our research found that nonsurvivors group had a higher frequency of mechanical ventilator usage and a lower total LOS.

Although chest film is the first tool used to evaluate trauma patients, thoracic CT remains superior.[19] However, pulmonary contusions or other chest injuries may not immediately appear on radiographs. Therefore, CXR at admission might underestimate the severity of a pulmonary contusion.[20] We thereby investigated the effects of the most common chest trauma-related complications, including pneumothorax, hemothorax, rib fractures, and flail chest. The thoracic injury is common among blunt trauma patients and may be isolated or concomitant. In general, such damage can be detected using CXR. Hemothorax/pneumothorax accompanied by rib fracture is the most common type injury. Most patients are treated through tube thoracostomy,[21,22] and mortality is directly related to the number of fractured ribs.[23,24] Pape *et al*.[25] revealed that in comparison with rib fractures, bilateral lung contusions associated with hemo/pneumothoraces were a more important factor regarding adverse outcomes. This study observed a significant difference in the incidence of hemothorax between survivors and nonsurvivors and identified this factor as more important than rib fractures with regard to adverse outcomes. Contusion-induced alveolar hemorrhage and pleural collection with hemothorax leads to a collapse of the lung parenchyma and prolong the course of hospitalization; accordingly, some studies revealed that the outcomes of patients with blunt chest trauma might be affected by the interval between trauma and further surgical intervention.[26-28]

A previous study of 144 patients with chest trauma did not observe a statistically significant difference in the PaO_2/FiO_2 ratio during hospitalization.[29] Furthermore, blood analysis did not reflect the overall degree of trauma injuries, especially thoracic trauma. Therefore, we analyzed single blood gas parameters, including pH, PaO_2, $PaCO_2$, HCO_3, and SaO_2 and collected laboratory examination data, including white blood cell and platelet counts, MCV, and hemoglobin, BUN, creatinine, and AST levels. However, we did not find any statistically significant differences.

Limitation

The study has some limitations. First, this was a retrospective single-institution study with a small sample size. Second, we only analyzed blunt trauma patients who were managed using a multidisciplinary approach in the ED. Third, it was difficult to classify patients with various types of injuries. Additional studies are needed to confirm our findings.

CONCLUSION

The RTS score, mechanical ventilator usage, and hemothorax were identified as risk factors for mortality. Most chest injuries could be treated through tube thoracostomy. However, trauma surgeons should note that early surgical intervention and multidisciplinary care would improve the outcomes of patients with initial radiographic evidence of hemothorax.

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Conflicts of interest

There are no conflicts of interest.

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