



Predictors of Mortality among Patients with Flail Chest Following Thoracic Trauma

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Abstract

Background: Flail chest is a severe form of thoracic trauma associated with significant morbidity and mortality. Early identification of factors associated with adverse outcomes is essential for improving patient management and survival. **Objective:** This study aimed to identify predictors of mortality in patients with flail chest following thoracic trauma. **Methodology:** This cross-sectional study was conducted in the Department of Thoracic Surgery at National Institute of Diseases of the Chest and Hospital (NIDCH), Dhaka, Bangladesh from January 2010 to December 2010. A total of 60 patients with flail chest were enrolled consecutively. Patients were categorized into Group I (central flail chest, n=22) and Group II (other types of flail chest, n=38). **Results:** The mean age was 38.3 ± 14.4 years in Group I and 41.4 ± 18.2 years in Group II ($p=0.471$). Haemopneumothorax was the most common associated injury, occurring in 77.3% of Group I and 68.4% of Group II patients. Lung contusion and surgical emphysema were more frequent in Group I (59.1% each) than in Group II (23.7% each). Critical injury severity was observed in 81.8% of Group I and 63.2% of Group II patients. Pneumonia developed in 40.9% and 27.0% of patients, while acute respiratory distress syndrome occurred in 18.2% and 2.7% of patients in Groups I and II, respectively. Mortality was higher in Group I than in Group II (22.7% vs. 2.7%). **Conclusion:** Higher injury severity, associated thoracic injuries and respiratory complications were associated with increased mortality in patients with flail chest following thoracic trauma. [*Journal of National Institute of Neurosciences Bangladesh, July 2025;11(2):138-143*]

Keywords: Flail chest; thoracic trauma; mortality; injury severity score; lung contusion; respiratory complications

Introduction

Flail chest is one of the most serious forms of thoracic trauma and is characterized by fractures of multiple consecutive ribs resulting in a free-floating segment of the chest wall¹. The paradoxical movement of this segment during respiration impairs ventilatory mechanics and compromises pulmonary function². Flail chest is frequently associated with significant intrathoracic injuries, including lung contusion, haemothorax, pneumothorax and pulmonary complications that contribute substantially to morbidity and mortality³.

Thoracic trauma remains an important cause of injury-related hospitalization and death worldwide. Patients with flail chest often present with severe chest pain, respiratory distress, hypoxemia and impaired gas exchange⁴. The severity of respiratory compromise

depends not only on the extent of rib fractures but also on the presence of associated injuries to the lungs and other organ systems⁵. Consequently, the clinical course of flail chest can vary from complete recovery with conservative management to respiratory failure and death⁶.

The outcome of patients with flail chest is influenced by multiple factors. Advanced age, associated thoracic injuries, severity of trauma and the development of complications have been reported as important determinants of prognosis⁷. Lung contusion is particularly significant because it can impair oxygenation and predispose patients to pneumonia and acute respiratory insufficiency⁸. Similarly, haemothorax, haemopneumothorax and surgical emphysema may worsen respiratory function and increase the complexity

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of management⁹.

Assessment of injury severity plays a crucial role in predicting clinical outcomes. The Injury Severity Score (ISS) is widely used to quantify the overall burden of trauma and has been shown to correlate with adverse outcomes in injured patients¹⁰. In addition, treatment strategies such as oxygen therapy, chest tube drainage, analgesia, ventilatory support and surgical intervention may influence survival and recovery¹¹. Identification of factors associated with mortality is therefore essential for risk stratification and timely management¹².

Despite advances in trauma care, mortality among patients with flail chest continues to be a significant concern. Early recognition of high-risk patients allows clinicians to optimize treatment decisions, allocate critical care resources appropriately and improve overall outcomes. Understanding the clinical and injury-related characteristics associated with mortality may contribute to better management protocols and enhanced patient care. The present study was undertaken to evaluate the predictors of mortality in patients with flail chest following thoracic trauma by examining demographic characteristics, associated clinical conditions, injury severity, treatment modalities and outcomes.

Methodology

Study Settings and Population: This cross-sectional study was conducted in the Department of Thoracic Surgery, National Institute of Diseases of the Chest and Hospital (NIDCH), Mohakhali, Dhaka, Bangladesh, from January 2010 to December 2010. The study population comprised patients with chest injuries presenting with flail chest who were admitted during the study period. Patients of any age and either sex with flail chest were included in the study. Patients with pelvic and limb injuries, unconscious patients with chest injuries, patients with extensive burns associated with chest injuries and those who refused to provide informed consent were excluded.

Study Procedure: A total of 60 patients fulfilling the selection criteria were enrolled consecutively. Of them, 22 patients had central flail chest injury and were assigned to Group I, while 38 patients had other types of flail chest injury and were assigned to Group II. Data were collected through interview, clinical examination, observation and review of relevant investigations using a structured data collection form. For analysis, patients were categorized according to hospital outcome into survivors and non-survivors. The variables analyzed in the present study included age, associated clinical conditions, injury severity score

(ISS), treatment modality and outcome. Associated clinical conditions evaluated were haemothorax, haemopneumothorax, lung contusion and surgical emphysema. Injury severity was assessed using the Injury Severity Score. Treatment modalities received by the patients were recorded and compared. Outcome was assessed in terms of survival or mortality during hospital stay.

Statistical Analysis: Data were processed and analyzed using the Statistical Package for Social Sciences (SPSS). Continuous variables were expressed as mean and standard deviation, while categorical variables were presented as frequency and percentage. Comparisons between survivors and non-survivors were performed using Student's t-test, Chi-square test, or Fisher's Exact Probability Test as appropriate. Factors associated with mortality were assessed by comparing the study variables between the two outcome groups. A p-value of less than 0.05 was considered statistically significant.

Ethical Consideration: Ethical approval was obtained from the appropriate authority of NIDCH before commencement of the study. Informed consent was obtained from all participants or their legal guardians after explaining the objectives and procedures of the study. Confidentiality of all collected information was maintained throughout the study.

Results

A total of 60 patients were selected to find out the factors influencing morbidity and mortality in flail chest injuries. Of them, 22 were randomly assigned to Group-I (Central Flail Chest) and 38 to Group-II (Others Flail Chest). The findings of the study obtained from data analysis are presented below. The percentage of patients with age category ≤ 20 years Group-I 3(13.6) and Group-II 6(15.8), 21 to 30 years Group-I 5(22.7) and Group-II 5(13.2), 31 to 40 years Group-I 6(27.3) Group-II 8(21.1). However, more than 40 years Group-I 8(36.4) and Group-II 19(50.0), mean age of Group-I being 38.3 ± 14.4 years Group-II 41.4 ± 18.2 years

Table 1: Comparison of age between groups

Age Group	Group		P value
	Group I	Group II	
≤ 20 Years	3(13.6%)	6(15.8%)	
21 to 30 Years	5(22.7%)	5(13.2%)	
31 to 40 Years	6(27.3%)	8(21.1%)	
More than 40 Years	8(36.4%)	19(50.0%)	
Total	22	38	
Mean $\pm$ SD	38.3 ± 14.4	41.4 ± 18.2	0.471

Data were analysed using Student's t Test and presented as Mean $\pm$ SD.

respectively. The groups were homogeneously distributed in terms of age ($p = 0.471$) (Table 1).

The haemothorax was present in group I 5(22.7%) and in Group-II 11(29.7%). Haemopneumothorax were present in group I 17(77.3%) and in group II 26(68.4%). Lung contusion were present in Group-I 13(59.1%) and in Group-II 9(23.7%) patients. Surgical emphysema was present in patients of Group-I 13(59.1%) those in Group-II 9(23.7%) (Table 2).

Table 2: Comparison of Associated Clinical Conditions Between Groups

Associated Conditions	Group		P value
	Group I	Group II	
Haemothorax			
• Present	5(22.7%)	11(29.7%)	0.559
• Absent	17(77.3%)	27(70.3%)	
Haemopneumothorax			
• Present	17(77.3%)	26(68.4%)	0.671
• Absent	5(22.7%)	12(31.6%)	
Lung contusion			
• Present	13(59.1%)	9(23.7%)	0.006
• Absent	9(40.9%)	29(76.3%)	
Surgical emphysema			
• Present	13(59.1%)	9(23.7%)	0.006
• Absent	9(40.9%)	29(76.3%)	

Chi-square Test was employed to analyse the data

In case of injury severity score in group I moderate injury was 00 where as in Group-II 2(5.3%). Severe injuries in group I was 4(18.2%) and in group II was 12 (31.6%) respectively. However, in case of critical injury group I was 18(81.8%) and in group II was 24(63.2%) (Table 3).

Table 3: Comparison of Injury Severity Score Between Groups

Injury Severity Score (ISS)*	Group		P value
	Group I	Group II	
	(n = 22)	(n = 38)	
Moderate (9 – 14)	0(0.0%)	2(5.3%)	0.248
Severe (16 – 24)	4(18.2%)	12(31.6%)	
Critical (>25)	18(81.8%)	24(63.2%)	

c2 Test was employed to analyse the data.

Table 4 shows all of the patients of both Group-I and Group-II received conservative treatment. About 21(95.5%) of patients in Group-I and 35(92.1%) in Group-II were given chest drainage ($p = 0.532$). Tracheostomy & mechanical ventilation and thoracotomy were needed 2(9.1%) of patients in Group-I, while none of the Group-II required such treatment ($p = 0.131$).

Table 4: Comparison of treatment modality between groups

Treatment modality	Group		P value
	Group I	Group II	
	(n = 22)	(n = 38)	
Conservative Treatment			
• Given	22(100.0%)	38(100.0%)	0.532
• Not given	0(0.0%)	0(0.0%)	
Chest drainage#			
• Given	21(95.5%)	35(92.1%)	0.131
• Not given	1(4.5%)	3(7.9%)	
Tracheostomy & Mechanical Ventilation#			
• Done	2(9.1%)	0(0.0%)	0.131
• Not done	20(90.9%)	38(100.0%)	
Thoracotomy #			
• Done	2(9.1%)	0(0.0%)	0.131
• Not done	20(90.9%)	38(100.0%)	

Fisher Exact Test was employed to analyze the data

The pneumonia developed in Group-I 9(40.9%) and in group-II 10(27.0%), adult respiratory distress syndrome was in Group I 4(18.2%) and in group-II 1(2.7%), the mean hospital stays in Group-I were 12.3 ± 1.5 days and in group II was 12.1 ± 1.0 days. Mortality were in Group-I 5(22.7%) and in Group-II 1(2.7%) (Table 5).

Table 5: Comparison of Outcome Between Groups

Outcomes	Group		P value
	Group I	Group II	
	(n = 22)	(n = 38)	
Pneumonia*			
• Developed	9(40.9%)	10(27.0%)	0.270
• Not developed	13(59.1%)	28(73.0%)	
Adult Respiratory Syndrome#			
• Present	4(18.2%)	1(2.7%)	0.059
• Absent	18(81.8%)	37(97.3%)	
Hospital stay¶	12.3 $\pm$ 1.5	12.1 $\pm$ 1.0	0.950
Mortality#			
• Yes	5(22.7%)	1(2.7%)	0.023
• No	17(77.3%)	37(97.3%)	

*c2 Test was employed to analyse the data; ¶Student's t Test was employed to analyse the data; #Fisher Exact Test was employed to analyse the data.

Discussion

Flail chest is a severe form of thoracic trauma associated with significant morbidity and mortality. The present study evaluated factors associated with mortality among patients with flail chest following thoracic trauma. The findings indicate that age,

Table 2. Causes of Death of Study Population (n=100)

Cause of Death	Aetiology of WS (n, total cases in each group)					
	P. asphyxia (n=46)	CMV infection (n=1)	Prematurity (n=3)	Metabolic (n=2)	N. sepsis (n=3)	N. Jaundice (n=2)
Classic hypsarrhythmia (5)	5	0	0	0	0	0
Burst suppression (18)	13	0	1	1	2	1
Interhemispheric synchronization (3)	3	0	0	0	0	0
Multifocal epileptiform discharges (22)	16	1	2	1	1	1
Asymmetrical hypsarrhythmia (9)	9	0	0	0	0	0

P. asphyxia= Perinata asphyxia; N. sepsis= Neonatal sepsis, ; N. Jaundice=Neonatal Jaundice, CMV =Cytomegalo virus.

associated thoracic injuries, injury severity, treatment requirements and subsequent complications may influence patient outcomes.

In the present study, the mean age was 38.3 ± 14.4 years in Group I and 41.4 ± 18.2 years in Group II, with no significant difference between the groups ($p=0.471$). Although age distribution was comparable, previous studies have identified increasing age as an important predictor of adverse outcomes following chest trauma. Harrington et al¹³ reported that older trauma patients experience poorer survival due to reduced physiological reserve and a higher likelihood of complications. Similarly, Battle et al¹⁴ demonstrated that age is an important component of prognostic models for predicting outcomes after blunt chest wall trauma.

Associated thoracic injuries were common in both groups. Haemopneumothorax was observed in 77.3% of Group I and 68.4% of Group II patients, while lung contusion and surgical emphysema were present in 59.1% and 59.1% of Group I patients, respectively. Lung contusion is widely recognized as a major determinant of respiratory compromise in flail chest. Majercik and Pieracci¹⁵ emphasized that pulmonary contusion substantially contributes to respiratory failure and poor outcomes following chest wall trauma. Dennis et al., also noted that associated intrathoracic injuries significantly increase morbidity and mortality in thoracic trauma patients¹⁶. The higher frequency of lung contusion among patients with central flail chest in the present study may partially explain their less favorable outcomes.

The severity of injury was another important finding. Most patients sustained critical injuries, accounting for 81.8% in Group I and 63.2% in Group II. Severe injuries were present in 18.2% and 31.6% of patients, respectively. Mommsen et al¹⁷ reported that trauma severity scores are valuable predictors of complications and mortality in chest trauma. Likewise, Grubmüller et

al¹⁸ found severe thoracic trauma to be an independent predictor of death among multiply injured patients. Ustundag et al¹⁹ also demonstrated that increasing injury severity is strongly associated with mortality in trauma patients. These observations support the importance of injury severity assessment in predicting outcomes among flail chest patients.

All patients in the present study received conservative treatment. Chest drainage was required in 95.5% of Group I and 92.1% of Group II patients. Tracheostomy and mechanical ventilation were necessary only in Group I patients (9.1%). The need for advanced respiratory support generally reflects greater injury severity and respiratory compromise. Okabe et al., identified severe chest trauma and respiratory insufficiency as major factors associated with prolonged mechanical ventilation²⁰. Cannon et al²¹ similarly observed that patients with more severe flail chest injuries often require ventilatory support and experience worse clinical outcomes.

Post-traumatic complications were frequent. Pneumonia developed in 40.9% of Group I and 27.0% of Group II patients, while acute respiratory distress syndrome (ARDS) occurred in 18.2% and 2.7%, respectively. Daurat et al²² reported that pulmonary contusion and severe thoracic injury significantly increase the risk of ARDS. Hasan²³ also highlighted pulmonary complications as major determinants of outcome in patients undergoing thoracic care. These complications prolong recovery and contribute substantially to mortality.

Mortality was considerably higher in Group I than in Group II (22.7% versus 2.7%). This finding suggests that central flail chest may be associated with more severe underlying thoracic injury and greater physiological impairment. Similar observations have been reported by Schulz-Drost et al²⁴ who noted that complex chest wall injuries are associated with increased mortality. AlEassa et al²⁵ and Yadollahi et al²⁶

also identified injury severity and associated thoracic injuries as important determinants of death among hospitalized chest trauma patients.

There are some limitations of the study. The present study was conducted in a single tertiary care center with a relatively small sample size, which may limit the generalizability of the findings. In addition, patients were followed only during their hospital stay and long-term outcomes after discharge could not be evaluated. The cross-sectional design also limited the ability to establish causal relationships between the identified factors and mortality. Despite these limitations, the study provides valuable insights into the clinical characteristics and outcome predictors of patients with flail chest following thoracic trauma.

Conclusion

Flail chest remains a serious consequence of thoracic trauma and is associated with substantial morbidity and mortality. The present study suggests that associated thoracic injuries, higher injury severity, requirement for advanced respiratory support and the development of complications such as pneumonia and acute respiratory distress syndrome are important factors influencing mortality. Early identification of high-risk patients and prompt, appropriate management may improve clinical outcomes and reduce mortality. Careful assessment of injury severity and associated chest injuries should therefore be an integral part of the management strategy for patients with flail chest.

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Data Availability

The datasets generated and analyzed during this study are not publicly available due to patient confidentiality and institutional data protection policies. However, anonymized data may be made available from the corresponding author upon reasonable request, subject to approval by the institutional ethics committee.

Ethics Approval and Consent to Participate

Ethical approval for the study was obtained from the Institutional

Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

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