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A Comparative Study on the Impact of Central and Other Types of Flail Chest on Outcome and Mortality in Chest Injury Patients

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Abstract **Original Research Article**

Background: Flail chest is the most serious form of blunt thoracic trauma, presenting with paradoxical chest wall motion and often complicated by high morbidity and mortality. The central flail chest may cause more profound respiratory compromise than other anatomic subtypes, but outcome comparisons among these groups have been uncommon. ***Aim of the study:*** The aim of this study was to compare the impact of central and other types of flail chest on outcome and mortality in chest injury patients. ***Methods & materials:*** The present cross-sectional study was conducted in the Department of Thoracic surgery, National Institute of Diseases of Chest & Hospital (NIDCH), Mohakhali, Dhaka from January 2010 to December 2010. Total 60 patients with chest injury were included in this study. Of them, 22 had central flail chest injury (Group-I) and 38 had other flail chest injury (Group-II). ***Result:*** Both groups were comparable in age and sex with no statistically significant difference. Road traffic accident was the main cause of injury (72.7% vs. 84.2%). Critical injuries (ISS >25) were more frequent in Group I (81.8%) than Group II (63.2%). Pneumonia (40.9% vs. 27.0%) and ARDS (18.2% vs. 2.7%) were more frequent in Group I. Mortality was significantly higher in Group I (22.7%) than Group II (2.7%, p = 0.023). ***Conclusion:*** Central flail chest is associated with more severe injury patterns, higher complication rates, and significantly greater mortality than the other subtypes.

Keywords: Central and Other Types of Flail Chest, Outcome, Mortality, and Chest Injury Patients.

INTRODUCTION

Chest trauma remains one of the most common sources of morbidity and mortality among trauma patients worldwide, causing almost a quarter of trauma-related deaths [1,2]. For thoracic injuries, flail chest is one of the more severe presentations and occurs in approximately 5–10% of serious chest trauma patients [3]. Classically defined as the fracture of three or more contiguous ribs in two or more places, flail chest results in paradoxical chest wall movement with breathing, and severe impairment in pulmonary mechanics and gas exchange [4]. The clinical importance of flail chest is considerable, and mortality varies from 10% up to as high as 60%, depending on the extent of collateral pulmonary contusion, mechanical instability, and systemic injury [5,6]. Flail chest is thus not only a diagnostic indicator of complicated trauma but a prognostic indicator of unfavorable outcomes in polytrauma settings.

Historically, flail chest has been managed as a single clinical syndrome, and little differentiation has been made between its anatomical subtypes. Current literature emphasizes that the flail segments can be classified into central, lateral, anterolateral, or posterior subtypes and that the effects in each subtype vary regarding pathophysiological and clinical aspects [7,8]. Central flail chest, further, involves the sternum and anterior costal cartilages and leads to greater destabilization of the thoracic cage and compromise of ventilatory mechanics compared to lateral or posterior types [9]. While lateral and posterior flail segments will restrict local chest expansion, central flail chest actively detracts from the stabilizing function of the sternum, inducing paradoxical motion of the sternum and, in more

severe presentations, mediastinal flutter that further detracts from venous return and cardiac output [10]. Despite these dire differences, most outcome studies continue to regard flail chest patients as a homogeneous group, thereby masking important differences in prognosis and management requirements.

The pathophysiologic impact of central flail chest is more than compromised mechanics. Studies have shown that paradoxical sternum motion reduces tidal volume, augments dead space ventilation, and predisposes patients to alveolar collapse and hypoxemia [11]. This is in contrast to the pattern of lateral flail injuries, which can be better tolerated in ventilation compromise [12]. Central flail chest de-stabilizes the anterior chest wall and renders patients prone to mediastinal instability, or mediastinal flutter, whereby recurrent paradoxical mediastinal excursion causes additional respiratory inefficiency and cardiac compromise [10,13]. These processes together explain the higher incidence of hypoxemia, pneumonia, ventilation time, and ICU stay among patients with central flail chest compared to those with lateral or posterior subtypes [14].

Clinically, the management of flail chest has undergone tremendous change. In the past, the management was more or less supportive with aggressive analgesia, mechanical ventilation, and physiotherapy [13]. However, rising rates of ventilator-associated complications stimulated growing interest in rib fracture surgical stabilization (SSRF) and literature reporting reduction of ICU stay, pneumonia, and late pulmonary disability [4]. The cartilage plating fixation techniques have actually been developed to address mechanically unstable central and anterior flail segments precisely, which makes them even more clinically relevant [9]. Yet more robust comparative data between central and non-central flail chest subtypes remain limited, with most large cohort studies merely categorizing all cases together [7]. Therefore, the present study attempts to contrast central flail chest with the other anatomical subtypes based on short-term results, ICU usage, and mortality, thereby bridging an important knowledge gap in trauma and thoracic surgery literature.

Objectives

To compare the impact of central and other types of flail chest on outcome and mortality in chest injury patients.

METHODS & MATERIALS

The present cross-sectional study was conducted in the Department of Thoracic surgery, National Institute of Diseases of Chest & Hospital (NIDCH), Mohakhali, Dhaka from January 2010 to December 2010. Total 60 chest injury patients were included consecutively in the study. These patients were divided into two groups– Group-I: 22 patients with central flail and 38 patients with others flail. Patients with pelvic and limb injuries, unconscious patients with chest injuries, extensive burn with chest injuries and those who refuse to give informed consent were exclude from this study. Patients' demographic characteristics, clinical presentation, associated conditions and the extent of chest injuries in both groups were recoded and compared. The injury severity score was computed based on clinical findings and were graded into I-V based on their severity. Based on ISS score, the injuries were classified into three categories as follows:

Category of injury	ISS score (injury severity scale)
Moderate	9 – 14
Severe	16 – 24
Critical	> 25

Informed consent of the participants was taken before data collection. The study commenced on approval of the protocol by the Committee, National Institute of Diseases of the Chest and Hospital (NIDCH), Mohakhali, Dhaka, Bangladesh to conduct this study. A structured data collection form was developed (research instrument) containing all the variables of interest which was finalized following presetting. Patient outcomes were assessed in terms of complications such as pneumonia, atelectasis, and adult respiratory distress syndrome (ARDS), as well as hospital stay duration and mortality. Follow-up evaluations included assessment of chest pain and chest radiography at 24 hours post-intervention and prior to discharge in patients undergoing tube thoracostomy or thoracotomy. Data were processed and analyzed using SPSS (Statistical Package for Social Sciences). The test statistics used to analyze the data were Chi-square (χ^2) or Fisher Exact Probability Test and Student's t-Test. For all analytical tests, the level of significance was set at 0.05 and $p < 0.05$ was considered significant.

RESULTS

Table I presents the demographic characteristics of the study groups. In Group I (central flail chest), 13.6% were ≤20 years, 22.7% were between 21–30 years, 27.3% were between 31–40 years, and 36.4% were older than 40 years, with a mean age of 38.3 ± 14.4 years. In Group II (other types of flail chest), 15.8% were ≤20 years, 13.2% were aged 21–30 years, 21.1% were between 31–40 years, and 50.0% were above 40 years, with a mean age of 41.4 ± 18.2 years. The age distribution between the groups was not statistically significant ($p = 0.471$). With respect to sex, 81.8% of patients in Group I and 65.8% in Group II were

male, while females accounted for 18.2% and 34.2% respectively, with no significant difference (p = 0.184).

Figure 1 demonstrates the causes of injury of the study groups. Road traffic accidents were the most common cause of injury in both groups (72.7% in Group I vs. 84.2% in Group II), followed by falls from height (27.3% vs. 10.5%). A small proportion of cases in Group II (5.3%) had other causes (Figure 1).

Table II highlights the comparison of injury severity score between the study groups which reveals that the majority of patients in both groups sustained critical injuries (ISS >25), accounting for 81.8% in Group I and 63.2% in Group II. Severe injuries (ISS 16–24) were seen in 18.2% and 31.6% of Group I and Group II patients, respectively. Only two patients (5.3%) in Group II had moderate injuries (ISS 9–14), while none in Group I fell into this category. The difference in injury severity distribution between the two groups was not statistically significant (p = 0.248).

Table III demonstrates the comparison of treatment modality between the study groups. Chest drainage was required in 95.5% of Group I and 92.1% of Group II, with no significant difference (p = 0.532). Tracheostomy with mechanical ventilation was performed in 9.1% of Group I but in none of the Group II patients (p = 0.131). Similarly, thoracotomy was carried out in 9.1% of Group I patients compared to none in Group II (p = 0.131). These differences, however, were not statistically significant.

Table IV illustrates the comparison of outcome between the study groups. In this study, pneumonia developed in 40.9% of Group I and 27.0% of Group II patients, though the difference was not statistically significant (p = 0.27). Adult respiratory distress syndrome (ARDS) occurred more frequently in Group I (18.2%) than in Group II (2.7%), approaching statistical significance (p = 0.059). The mean hospital stay was nearly identical between groups (12.3 ± 1.5 days in Group I vs. 12.1 ± 1.0 days in Group II; p = 0.95). Importantly, mortality was significantly higher in Group I (22.7%) compared to Group II (2.7%), with a p-value of 0.023, highlighting the greater lethality associated with central flail chest.

Table-I: Demographic characteristics of the study groups (N=60)

Characteristics	Group-I (n = 22)	Group-II (n = 38)	p-value
Age (years)			
≤ 20	3(13.6%)	6(15.8%)	
21 – 30	5(22.7%)	5(13.2%)	
31 – 40	6(27.3%)	8(21.1%)	
>40	8(36.4%)	19(50.0%)	
Mean ± SD	38.3 ± 14.4	41.4 ± 18.2	0.471
Sex			
Male	18(81.8%)	25(65.8%)	0.184
Female	4(18.2%)	13(34.2%)	

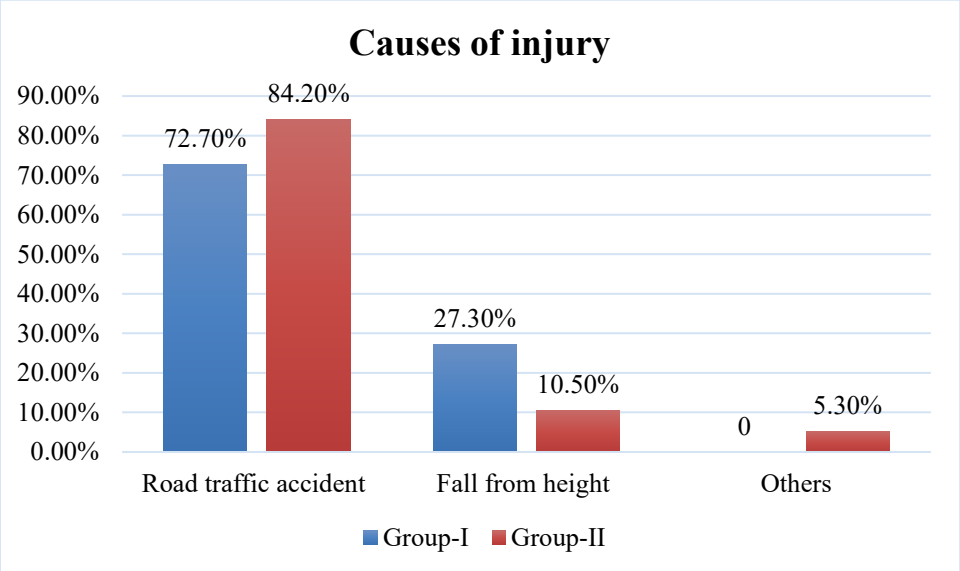

Figure 1: Comparison of causes of injury between the study groups (N=60)

Table-II: Comparison of injury severity score between the study groups (N=60)

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

***=χ^2 Test** was employed to analyze the data

Table-III: Comparison of treatment modality between the study groups (N=60)

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

#=Fisher Exact Test was employed to analyze the data

Table-IV: Comparison of outcome between study groups (N=60)

Outcome	Group-I (n = 22)	Group-II (n = 38)	p-value
Pneumonia*			
Developed	9(40.9%)	10(27.0%)	0.27
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¶			
Mean± SD	12.3 ± 1.5	12.1 ± 1.0	0.95
Mortality#			
Yes	5(22.7%)	1(2.7%)	0.023
No	17(77.3%)	37(97.3%)	

***=χ^2 Test** was employed to analyze the data.
¶=Student's t Test was employed to analyze the data.
#=Fisher Exact Test was employed to analyze the data.

DISCUSSION

The present study compared central and other anatomical subtypes of flail chest on the basis of demographics, severity of injury, modes of treatment, and outcome. Our findings establish that even though the baseline characteristics of the two groups were overall comparable, patients of central flail chest had worse outcomes defined by higher frequencies of pneumonia, adult respiratory distress syndrome (ARDS), and mortality.

In this study, the mean ages of central and other forms of flail chest patients were 38.3 and 41.4 years, respectively, with no statistically significant difference. This is lower compared with the ages reported in most foreign studies wherein the flail chest patients typically age between their fifth or sixth decade. For example, Naidoo *et al.,*[15] have quoted a mean age of 56 years in their South African series, while Zhang *et al.,*[16] have quoted a mean age of 50.2 years in a large Chinese series. The relatively young age of our series is due to the predominance of road traffic accidents (RTA) as the most frequent mechanism of injury in Bangladesh, which has accounted for more than 70% of cases in both groups. This is in conformity with the global literature, where RTAs remain the major cause of blunt chest trauma among middle- and low-income countries. [17] By sex distribution, our findings also mirrored worldwide findings, where males were predominant (81.8% in the central and 65.8% in other flail chest groups), as in

reports of 69–79% male predominance in large series. [16,18]

The severity of injury based on ISS in this study showed that a majority of patients in both groups suffered critical injuries (ISS >25), accounting for 81.8% in Group I and 63.2% in Group II. This is in agreement with other studies where mean ISS scores for flail chest patients are usually higher than 25, an indicator of the increased energy trauma. Naidoo *et al.,*[15] also had a mean ISS of 28.9, but Caragounis *et al.,*[19] reported a mean of 23.6 among rib fracture populations. Interestingly, Alanwer *et al.,*[6] had already established high ISS to be an independent predictor of mortality among patients with flail chest, and our observed distribution gains clinical relevance despite the fact that intergroup differences were not statistically significant.

As for treatment modalities, conservative management was the foundation in our series, and all patients received supportive measures. Chest drainage was required in most of the patients, in accordance with the high rate of haemothorax or haemopneumothorax with blunt chest trauma. Tracheostomy and mechanical ventilation, and thoracotomy were reserved only for the central flail chest group, albeit without statistical difference. Global data have increasingly reported the potential advantages of surgical stabilization of rib fractures (SSRF), which was not utilized in our sample. Various meta-analyses and cohort series have proven that SSRF decreases tracheostomy requirements, ventilator days, and pulmonary complications against conservative management. [20-22] The absence of SSRF in our cohort is responsible for the fact that invasive procedures such as thoracotomy and tracheostomy were needed more frequently among central flail chest patients, who are mechanically destabilizing lesions. [9]

The outcomes analysis revealed meaningful differences. Pneumonia in 40.9% of central flail chest was more prevalent than in other types at 27%, and ARDS also occurred more in the central group (18.2% vs. 2.7%), borderline significant. These rates are comparable to the previous literature describing pneumonia rates of 20–40% and ARDS rates of 14–24% in flail chest patients. [23,24] While the mean hospital stay within each cohort was nearly identical, mortality in the central flail chest cohort was significantly higher (22.7% vs. 2.7%). This is consistent with Alanwer *et al.,*[6], who reported a mortality of 19.9% in flail chest patients, and Getz *et al.,*[24], who reported mortality of about 16%. The increased deadliness of central flail chest in our study likely accounts for the pathophysiological burden of paradoxical sternal motion, impaired tidal volumes, and mediastinal instability, whose combination accounts for poorer ventilatory condition and increased risk of complications. [10,11] While central and other subtypes of flail chest have broadly comparable demographic and severity of injury profiles, central flail chest is disproportionately at risk for poor outcomes.

Limitations of the study

In our study, there was small sample size and absence of control for comparison. Study population was selected from one center in Dhaka city, so may not represent wider population. The study was conducted at a short period of time.

CONCLUSION

This study demonstrates that while demographic and injury severity profiles were broadly similar between central and other flail chest patients, central flail chest was associated with higher complication rates, including pneumonia and ARDS, and significantly greater mortality. These findings highlight central flail chest as a more lethal subtype requiring heightened clinical vigilance. Early identification and consideration of advanced management strategies, including surgical stabilization where feasible, may be essential to improving outcomes in this high-risk group.

REFERENCES

1. Veysi VT, Nikolaou VS, Paliobeis C, Efstathopoulos N, Giannoudis PV. Prevalence of chest trauma, associated injuries and mortality: a level I trauma centre experience. Int Orthop. 2009;33(5):1425–33.
2. Ekpe EE, Eyo C. Determinants of mortality in chest trauma patients. Niger J Surg. 2014;20(1):30–3.
3. Battle CE, Evans PA. Predictors of mortality in patients with flail chest: a systematic review. Emerg Med J. 2015;32(12):961–5.
4. Marasco SF, Nguyen Khuong J, Fitzgerald M. Flail chest injury—changing management and outcomes. Eur J Trauma Emerg Surg. 2023;49(4):1365–74.
5. Athanassiadi K, Gerazounis M, Theakos N. Management of 150 flail chest injuries: analysis of risk factors affecting outcome. Eur J Cardiothorac Surg. 2004;26(2):373–6.
6. Alanwer KM, Refat AM, Negm EM. Impact of flail chest injury on morbidity and outcome: Ten years' experience at a tertiary care hospital in a developing country. BMC Anesthesiol. 2023;23(1):156.
7. Groh J, Kern F, Schenderlein A, Perl M, Schulz-Drost S. Traumatic fractures of the sternum–typical distribution and need for subgroups within AO and OTA classification system? Eur J Trauma Emerg Surg. 2025;51(2):457–66.
8. Edwards JG. Taxonomy of rib fractures and blunt chest wall injury. In: StatPearls. Elsevier; 2025.
9. Schuette HB, Taylor BC, Rutkowski P, Huber G. Cartilage plating in flail chest fixation. Injury. 2021;52(7):1761–8.
10. Hurndall KH, Sullivan T, Glasgow S. Thoracic trauma. In: Trauma Care. Taylor & Francis; 2025. p. 299–318.
11. Tiwari A, Nair S, Baker A. The pathophysiology of flail chest injury. In: Thoracic Trauma. Springer; 2015. p. 25–37.

12. Schweiger JHW. The pathophysiology, diagnosis and management strategies for flail chest injury and pulmonary contusion: a review. Anesth Analg. 2001;92(3):646–50.
13. Kesieme E, Dongo A, Jebbin N, Okugbo S, Kesieme C. Flail chest: current concepts in pathophysiology and management. Int J Crit Illn Inj Sci. 2011;1(1):76–82.
14. Gilart JF, Rodríguez HH, Vallina PM. Guidelines for the diagnosis and treatment of thoracic traumatism. Med Intensiva. 2011;35(6):379–89.
15. Naidoo K, Hardcastle TC, Nicol AJ, Muckart DJ. The natural history of flail chest injuries. S Afr J Surg. 2017;55(3):49–54.
16. Zhang L, Fu S, Ma L, Ma Y, Liu X, Xu J, *et al.,* Epidemiological and clinical characteristics of road traffic crashes related thoracic trauma: A retrospective study of 5095 patients. J Cardiothorac Surg. 2021;16(1):174.
17. Benhamed S, Tourtier JP, Garbarino JL, Ausset S, Domanski L, Pons F. Road traffic accident-related thoracic trauma: epidemiology, injury patterns, and outcome. PLoS One. 2022;17(5)\:e0268202.
18. Athanassiadi K, Gerazounis M, Moustardas M, Metaxas E. Prognostic factors in flail-chest patients. Eur J Cardiothorac Surg. 2010;38(4):466–71.
19. Caragounis EC, Fagevik Olsen M, Pazooki D, Granhed H. Surgical management of multiple rib fractures and flail chest: A cohort study. Eur J Trauma Emerg Surg. 2021;47(6):1795–803.
20. Apampa B, Choi J, Campbell M, Miller A. Safety and effectiveness of surgical fixation versus non-surgical methods for the treatment of flail chest in adult populations: a systematic review and meta-analysis. Trauma Surg Acute Care Open. 2022;7(1)\:e000829.
21. Wijffels MME, Prins JTH, Perpetua Alagoa E, Verhofstad MHJ, Hietbrink F, de Jong MB. Operative vs. non-operative treatment of flail chest: a retrospective matched-pair cohort study. Eur J Trauma Emerg Surg. 2020;46(5):1041–8.
22. Hisamune T, Shimizu T, Sato N, Yamamoto T, Matsumoto K, Kawano D, *et al.,* A meta-analysis and trial sequential analysis of randomized controlled trials comparing nonoperative and operative management of chest trauma with multiple rib fractures. World J Emerg Surg. 2024;19(1):15.
23. Dogrul BN, Kiliccalan I, Asci ES, Peker SC. Blunt trauma related chest wall and pulmonary injuries: An overview. Chin J Traumatol. 2020;23(3):125–38.
24. Getz SB, Mayberry JC, Croce MA, Dossett LA. Limited influence of flail chest in patients with blunt or multiply injured chest trauma. World J Surg. 2019;43(1):254–61.