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Original article

Effect of Rib Fixation *versus* Conservative Management on Clinical Outcomes in Patients with Flail Chest

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Abstract
Flail chest is a critical consequence of blunt thoracic trauma, defined by multiple rib fractures leading to a segment of the chest wall that moves independently and paradoxically during respiration. This mechanical instability significantly compromises pulmonary function and is frequently associated with increased morbidity and mortality. The present study aimed to assess the impact of surgical rib fixation compared with non-operative management on key clinical outcomes in patients with flail chest. A retrospective cohort study was performed, including seventy-two patients admitted to the intensive care unit between March 2019 and April 2023 with confirmed flail chest. Patients were allocated into two groups based on the treatment approach. Outcome measures included duration of mechanical ventilation, length of ICU stay, incidence of pneumonia, and mortality rate. The analysis revealed that patients undergoing surgical stabilization experienced improved outcomes, including shorter ventilatory support duration and reduced ICU stay. Additionally, lower rates of pulmonary complications and a slight reduction in mortality were observed in the surgical group. These findings support the potential role of rib fixation in optimizing recovery among selected patients. However, further prospective investigations are necessary to establish definitive clinical recommendations.
Keywords. *Flail Chest, Rib Fixation, Blunt Chest Trauma, Mechanical Ventilation, ICU Stay.*

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Introduction

Flail chest remains one of the most severe presentations of blunt chest trauma and continues to represent a major therapeutic challenge. It occurs when a segment of the thoracic cage loses continuity with the rest of the chest wall due to multiple rib fractures, resulting in paradoxical motion during the respiratory cycle. This abnormal biomechanics leads to ineffective ventilation, decreased tidal volume, and impaired gas exchange, often progressing to respiratory failure if not adequately managed [1].

In clinical practice, flail chest is rarely an isolated injury and is commonly associated with pulmonary contusions and other thoracic complications such as pneumothorax and hemothorax. These associated injuries significantly worsen patient outcomes and contribute to prolonged hospitalization and increased mortality [2]. Elderly patients are particularly vulnerable due to diminished physiological reserve and preexisting comorbidities [9]. Conventional management has long relied on supportive strategies, including mechanical ventilation, aggressive pain control, and respiratory physiotherapy. While these measures are essential, prolonged ventilatory support is associated with complications such as ventilator-associated pneumonia and muscle weakness [10].

In response to these limitations, surgical rib fixation has gained increasing attention as a method to restore chest wall stability and improve respiratory efficiency. Despite growing evidence supporting its use, debate persists regarding its indications and overall benefit [8]. This study was designed to compare surgical rib fixation with conservative management in patients with flail chest, with particular emphasis on respiratory outcomes, complication rates, and mortality.

Methods

Study Design and Setting

A retrospective cohort design was adopted for this study, conducted at Abusleem Hospital and several private healthcare facilities in Tripoli, Libya, over a four-year period from March 2019 to April 2023.

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Study Population
During this timeframe, 246 patients with rib fractures resulting from blunt thoracic trauma were admitted. Of these, seventy-two patients fulfilled the diagnostic criteria for flail chest and were included in the analysis.

Diagnostic Criteria and Eligibility
The diagnosis of flail chest was established through clinical findings, particularly paradoxical chest wall movement, and radiological confirmation of fractures involving at least three ribs in two or more locations. Additional inclusion criteria required a chest Abbreviated Injury Score (AIS) of three or higher and an Injury Severity Score (ISS) of at least sixteen.
Patients with severe traumatic brain injury (Glasgow Coma Scale ≤ 8 or head AIS ≥ 3) were excluded to minimize confounding effects on outcomes. Similarly, individuals with significant chronic illnesses that could independently influence prognosis were not included.

Treatment Groups
Participants were categorized into two groups based on the management approach:

- **Surgical group:** Patients underwent rib fixation using internal stabilization techniques.
- **Conservative group:** Patients received non-operative management consisting of ventilatory support, analgesia, and standard supportive care.

Data Collection
Clinical data were collected retrospectively from hospital records. Pneumonia was defined as the presence of new or progressive infiltrates on chest imaging associated with clinical features such as fever, leukocytosis, purulent secretions, and compatible microbiological findings when available, in accordance with standard clinical criteria.

Statistical Analysis
Data were analyzed using SPSS version 16. Continuous variables were expressed as mean ± standard deviation. Categorical variables were presented as frequencies and percentages, with comparisons performed using the chi-square test or Fisher's exact test where appropriate.

Ethical Approval and Patient Consent
This study was approved by the Institutional Review Board (IRB) of Abusleem Hospital, Tripoli, Libya. Written informed consent was obtained from all patients or their legal guardians prior to inclusion in the study, in accordance with the Declaration of Helsinki.

Results
The mean age of the study population was thirty-nine years, with a standard deviation of 7.6 years, and males represented the majority of cases. The average Injury Severity Score was twenty-nine, indicating a high level of trauma severity, while the mean number of fractured ribs was six. Patients who underwent surgical rib fixation demonstrated notably better clinical outcomes compared with those managed conservatively.
The duration of mechanical ventilation was reduced to an average of three days in the surgical group, compared with seven days in the conservative group. Likewise, the length of ICU stay was shorter in patients who received surgical treatment, with an average of seven days versus twelve days in the non-operative group. In terms of complications, the incidence of pneumonia was lower among surgically treated patients, affecting nine percent compared with twenty-two percent in the conservative group.
Mortality rates were also slightly reduced in the surgical group, with seven percent compared to ten percent in the conservative cohort. These findings indicate a consistent advantage associated with surgical stabilization.

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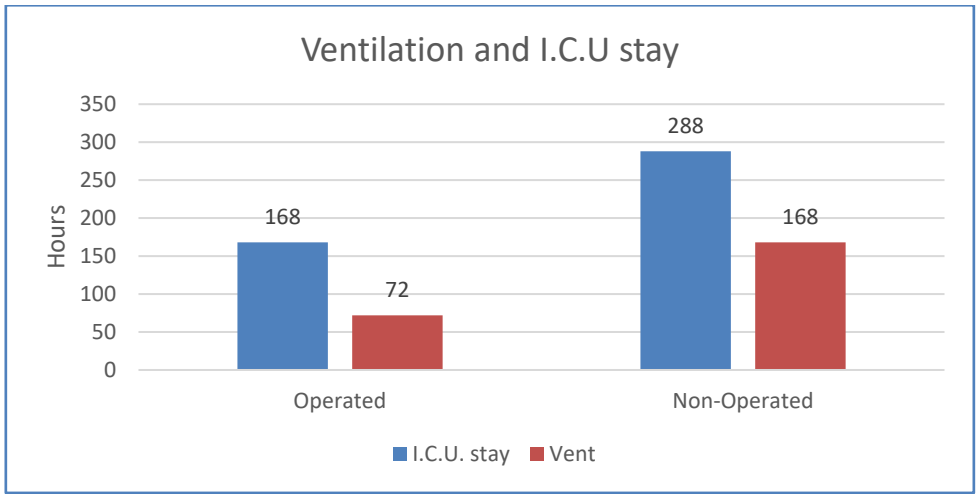

Figure 1. Ventilation and I.C.U stay.

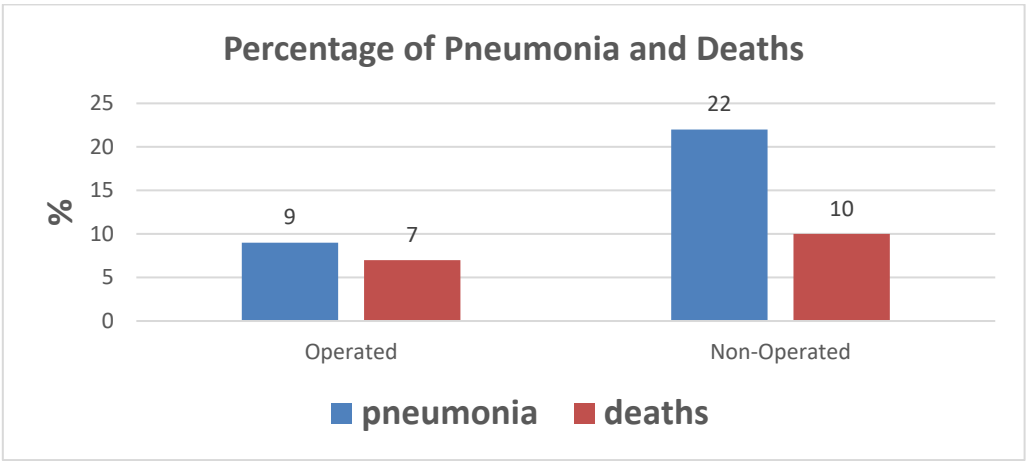

Figure 2. Percentage of Pneumonia and Deaths

Discussion

The findings of this study contribute to the expanding body of evidence supporting surgical stabilization of rib fractures in patients with flail chest. Unlike conservative approaches, which primarily address symptoms, surgical fixation directly corrects the underlying mechanical instability of the chest wall, thereby improving respiratory mechanics and gas exchange. Improved chest wall stability facilitates more effective ventilation and reduces the need for prolonged mechanical support, which in turn decreases the risk of ventilator-associated complications. This mechanism likely explains the observed reductions in ICU stay and pneumonia rates in the surgical group.

Similar outcomes have been reported in previous studies, which have demonstrated enhanced pulmonary function and faster recovery following rib fixation [7]. Although the reduction in mortality observed in this study was relatively small, it remains clinically relevant when interpreted alongside improvements in morbidity. It is also consistent with prior reports suggesting that flail chest may be less lethal than previously believed when managed appropriately [3].

Statistical comparisons confirmed that both ventilation duration and ICU stay were significantly shorter in the operated group compared with the non-operated group ($p < 0.05$). Likewise, pneumonia incidence was significantly lower in the surgical group ($p < 0.05$). Mortality reduction did not reach statistical significance, but the trend supports the clinical advantage of surgical stabilization.

Despite these encouraging findings, the limitations of the study must be considered. The retrospective design inherently carries a risk of selection bias, particularly in determining which patients were selected for surgical intervention. Additionally, the relatively small sample size limits the statistical robustness of the conclusions, and the single-region setting may restrict generalizability. Furthermore, the absence of randomization prevents definitive causal inference.

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Future prospective multicenter studies with larger cohorts are warranted to validate these findings and to further clarify the role of surgical stabilization in reducing both morbidity and mortality among patients with flail chest.

Conclusion

Surgical stabilization of rib fractures in patients with flail chest was associated with shorter ventilation duration, reduced ICU stay, and lower rates of pneumonia compared with conservative management. Although the reduction in mortality was modest and not statistically significant, the improvements in morbidity highlight the clinical value of surgical fixation. These results support the growing evidence that operative management enhances recovery and reduces complications in flail chest, while underscoring the need for larger prospective studies to confirm these benefits and strengthen generalizability.

Conflict of interest. Nil

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