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Management of Flail Chest: Outcome of Surgical Fixation versus Traditional Conservative Management

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ABSTRACT

Background: High-impact chest trauma frequently results in rib fractures. It may cause severe respiratory compromise. Surgical management of flail chest has been used for a long time, but till now there is debate regarding its wide use and the optimal management remains controversial.

Objective: This study aimed to compare the outcome of conservative versus surgical management of flail chest cases.

Patients and methods: prospective multicenter cohort study included 48 patients with flail chest through the period from June 2020 to June 2023. Patients were divided into 2 groups: Group one (conservative management) included 27 patients and group two (surgical fixation) included 21 patients. Demographic and clinical data for all patients were collected and their outcome was compared.

Results: Road traffic accident (RTA) was the most common cause of flail chest in both groups (51.85% in group one and 52.38% in group two) with no significant difference between both groups. There was a significantly shorter duration of mechanical ventilation (MV) in group two (P=0.044). ICU and hospital stay were also significantly less (P= 0.027and 0.013 respectively). Again, complications and chronic pain were less. Surgical correction was satisfactory with restored chest wall symmetry in 20 patients (95.24%) which was significantly higher than 16 patients in the conservative group (59.26%).

Conclusion: Surgical fixation of flail chest was safe, effective and had better outcome than conservative management. Also, it was associated with shorter ventilation duration and ICU and hospital stay with less morbidity, pulmonary complications and postoperative chronic pain. This study can be considered as added evidence to the body of knowledge regarding management of flail chest.

Keywords: Conservative management, External fixation, Flail chest, Outcome, Surgical fixation.

INTRODUCTION

Trauma has different and variable outcomes according to its mode, pattern and the injured parts of the body. One of the most serious and deadly injuries, thoracic trauma is extremely common, particularly in underdeveloped nations [1]. Thoracic trauma has a very high rate of morbidity and death [2, 3].

With the exception of a small number of patients who have numerous severe fractured ribs, most thoracic traumas do not require surgical intervention [4]. Normally the chest wall moves as one unit during respiratory cycle. In presence of 3 or more ribs fractures at 2 or more levels (flail segment) this mechanism is lost and the fractured segment starts to move separately and in a reverse direction to the other part of the chest wall which is called paradoxical movement [5].

Chronic chest wall discomfort and a number of morbidities and impairments can result from flail chest. Paradoxical chest wall motion can cause severe respiratory distress [6].

The main aim in management of these patients is to control pain, avoid respiratory distress by minimizing the paradoxical movement and regaining the chest wall stability. Different treatment options for rib stabilization have been reported in literatures, of them, surgical stabilization of the chest wall and conservative management by internal fixation using positive pressure ventilation are the main lines of management [7].

The optimal way to treat rib fractures is still up for debate, and there is still no clear consensus on how to manage flail chest [8, 9].

Compared to surgery, conservative therapy is less expensive. Although, it is not always possible, surgical fixation can better and more quickly rectify the thoracic deformity [10, 11].

The study** objective was to compare the outcome of conservative versus surgical management of flail chest according to our experience.

PATIENTS AND METHODS

Prospective cohort study included 48 patients presented to us with flail chest between June 2020 and June 2023 in two trauma centers (Khamis Mushait General Hospital and New Najran General Hospital). All patients had multiple severe ribs fractures at 3 or more consecutive ribs in 2 or more locations, we enrolled patients with mainly chest trauma and excluded patients who died from associated other injuries. The two centers' ethical committees gave their approval to the study.

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Patients were divided into 2 groups according to the treatment received: Group one (conservative management) included 27 patients that were managed conservatively by external fixation of the flail part by Elastoplast and dressing with good chest physiotherapy, close monitoring and management of the hemodynamics. Mechanical ventilation (MV) was used in 14 patients who presented with respiratory failure and it also helped in internal fixation of the flail segment.

Group two (surgical fixation) included 21 patients who had surgical fixation, four of them were operated in the first 24 hours of admission because of associated injuries (one patient had tracheal injury and three patients were operated for massive haemothorax) and the other seventeen patients were operated within the first week. Titanium fixator plates were used in all patients (Figure 1).

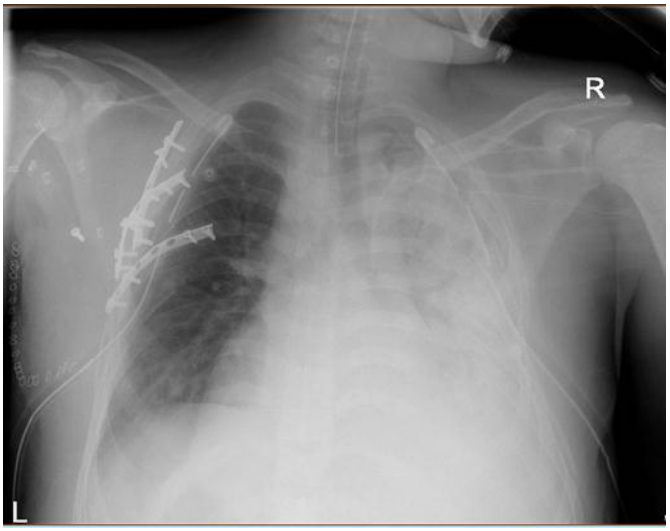

Figure (1): Surgical fixation.

All patient data, including the mechanism of injury, related injuries, and therapeutic approach, were meticulously gathered. In terms of postoperative discomfort, the frequency of respiratory problems, chest deformity, other morbidities, mortality, and the length of MV, intensive care unit stay, and overall hospital stay, we compared the outcomes of the two groups.

On arrival to the hospital, CXR and CT chest with 3D chest wall reconstruction was done for all patients to diagnose the site and number of fractured ribs (Figure 2) and to diagnose any other associated intrathoracic injuries, other investigations were done according to associated injuries by other specialties in order to diagnose and manage other systems injuries according to their priority. All patients had proper analgesics including thoracic epidural if required, pain was assessed using the visual analogue scale, anti-inflammatories, prophylactic antibiotics plus treatment according to their condition or associated lesions. The decision of surgical fixation or conservative management was according to the admitting consultant preference and patient acceptance.

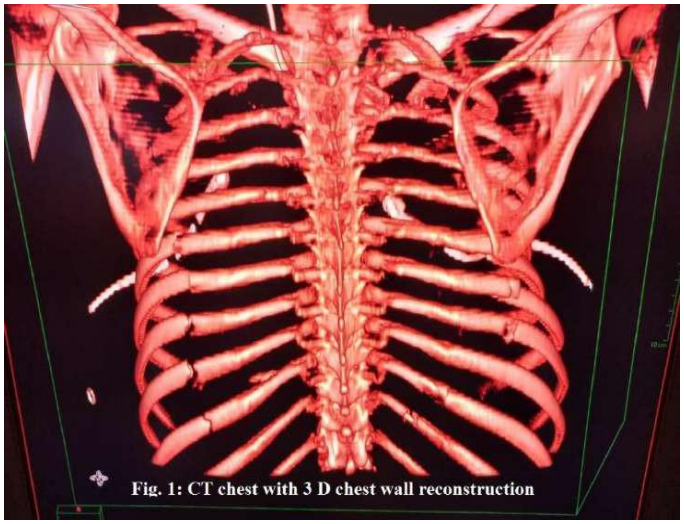

Figure (2): 3D reconstruction for a case of flail chest.

Ethical approval: Khamis Mushait General Hospital and New Najran General Hospital Ethics Committee accepted this study, and after receiving all information, each participant signed a permission form. The study followed the Helsinki Declaration throughout its implementation.

Statistical analysis:

Microsoft Excel software was used to gather, tabulate, and statistically analyze the results. SPSS version 20.0 was then used to analyze the data. For continuous variables, the data were presented as mean and SD. For categorical variables, it was presented as percentages. To determine significance, the Chi-squared test (χ^2) was employed, and a p-value ≤ 0.05 was deemed significant. Continuous variables were subjected to the Student's t test.

RESULTS

Patients' demographic and baseline clinical data were collected for each group. Both groups' demographic and baseline clinical data did not differ statistically significantly (Table 1).

Table (1): Demographic and baseline clinical data of both groups.

Variable	Group 1: Conservative Management	Group 2: Surgical Management	P value
Age: Range (years) Mean ± SD	18-65 30.925± 12.06	23-61 34.38± 11.21	0.39
Sex: Male Female	23 (85.19%) 4 (14.81%)	19 (90.48%) 2 (9.52%)	0.26
Weight: Range (kg) Mean ± SD	68-112 90.96± 10.005	69-114 84.19 ±10.39	0.47
Height: Range (cm) Mean ± SD	167-185 174.15± 4.8	165-187 175.19± 5.85	0.43
BMI (kg/m^2): Range Mean ± SD	24.1-34.7 29.97± 3.27	23.9-34.3 27.82± 2.62	0.41
Smoking	12 (44.44%)	11 (52.38%)	0.55
Chronic Obstructive Pulmonary Dis. (COPD)	5 (18.52%)	4 (19.05%)	0.27
Diabetes Mellitus (DM)	6 (22.22%)	5 (23.81%)	0.12
Hypertension (HTN)	4 (14.81%)	4 (19.05%)	0.24
Ischemic Heart Disease (IHD)	1 (3.7%)	1 (4.76%)	0.42
Chronic Kidney Disease (CKD)	2 (7.41%)	1 (4.76%))	0.31
Liver impairment	1 (3.7%)	1 (4.76%	0.18

All patients presented with severe dyspnea and chest discomfort. There was no statistically significant difference in the trauma mechanism between the two groups (Table 2).

Table (2): Mechanism of trauma

Mechanism of trauma	Conservative Group (Group 1)	Surgical Group (Group 2)	P- value
RTA: No. %	14 51.85%	11 52.38%	 0.16
Bomb blast: No. %	10 37.04	8 38.1%	 0.25
FFH: No. %	3 11.11%	2 9.52%	0.09

RTA; Road Traffic Accident, FFH; Falling from Height

Table (3) showed that there was no statistically significant difference in the number or side of cracked ribs between the two groups.

Table (3): Number and side of fractured ribs

Variable		Conservative Group (Group 1)	Surgical Group (Group 2)	P-value
Number of fracture ribs	Range mean± SD	3-9. 5.67± 1.7	3-10 6.05± 2.03	0.35
Rt. side	No. %	12 44.45%	9 42.86%	0.21
Lt. side	No. %	11 40.74	7 33.33%	0.19
Bilateral	No. %	4 14.81%	5 (operated on both sides). 23.81%	0.23

Thirty-three patients in our study group had associated intrathoracic injuries: Eighteen patients in the conservative group (66.67%) and they were managed by chest tube insertion (five for haemothorax, eight for pneumothorax and five for hemopneumothorax and lung contusion). In the surgical group fifteen patients (71.43%) had associated intrathoracic injuries that were managed primarily by chest tube insertion (four for haemothorax, six for pneumothorax, four for hemopneumothorax and lung contusions and one for tracheal injury with pneumothorax that was operated for early within the first 24 hours), the difference between both groups was statistically non-significant (p=0.31). There were associated extra-thoracic injuries in fifteen patients (55.56%) in the conservative group and thirteen patients (61.9%) in the surgical group and the difference between both groups was statistically non-significant (p=0.67). MV was used in 14 patients in the conservative group (51.85%) because of severe lung injury and/or respiratory failure (it helped as internal fixator of the flail segment), and in 11 patients in the surgical group (52.38%), the difference between both groups was statistically non-significant (p=0.16). The duration of MV, ICU and hospital stay were shown in table (4) and all were significantly less in the surgical group. The need of tracheostomy was significantly less in the surgical group (p=0.007) (Table 4).

Table (4): Inpatient outcome and morbidity

Variable		Conservative Group	Surgical Group	P- value
Need of MV	No. %	14 (51.85%)	11 (52.38%)	0.16
Need of tracheostomy	No. %	6 22.22%	1 4.7%	0.007*
ventilation time(days)	Range mean± SD	11-18 14.5/±2.23	4-6 5.09 ±0.79	0.044*
ICU stay (days)	Range mean± SD	12-21 16.59±3.456	5-8 6.14/±1.08	0.027*
hospital stay (days)	Range mean± SD	16-26 21.48±3.99	9-12 10.19± 1.22	0.013*
Pain score (follow up period)	Range mean± SD	3-8 4.1±1.2	4-10 6.3±1.5	0.022*

* Significant

In group 2, the average time of surgery was 100 minutes, and the post-operative course was smooth regarding early extubation, tolerable postoperative pain, early discharge from the ICU and shorter hospital stay than in conservative group.

All patients were followed up for six months (155±23 days) by CXR and CT chest to confirm fracture healing, chest wall stability and deformity occurrence. Surgical correction group showed more satisfactory outcome with restored chest wall symmetry in 20 patients (95.24%) which was significantly higher than in the conservative group (16 patients-59.26%), (P=0.04)

Regarding chronic chest pain, it was present only in one patient (4.76%) in the surgical group that was significantly less than in the conservative group which happened in ten patients (37.04%), (P=0.009). In both groups there was no delayed hemopneumothorax or mortality.

DISCUSSION

Flail chest can cause severe chest wall instability and paradoxical movement that can cause a lot of complications if not managed properly and the way of management can affect the outcome.

In our study, the surgical group had less MV duration; ICU and hospital stay mostly because of rapid stabilization of the flail segment contrary to the conservative group. The surgical group showed a substantial decrease in total ventilator days compared to the non-surgical group (4.5 [0-30] vs. 16.0 [4-40] days) in a study by **Doben *et al.*** [5] comparing 2 groups of surgical and non-surgical therapy of flail chest. Additionally, operatively fixing fractured ribs lowered the need for ventilation and the length of stay in intensive care for a group of multi-trauma patients with severe flail chest injury, according to a study by **Marasco *et al.*** [12] that contrasted this procedure with the best practices for mechanical ventilator management at the moment.

We found that, pulmonary complications and need for tracheostomy was significantly higher in the conservative group and this can be attributed to the fact that conservative management of flail chest can impair the normal respiratory mechanism and decreases the volume of the thoracic cavity. The same was documented in a study by **Carver *et al.*** [13] who demonstrated that higher vital capacity (VC) is linked to a decreased risk of pulmonary complications, while individuals with broken ribs and VC of less than 30% have a strong connection with pulmonary complications. Hence the importance of restoring VC to as close to normal which was found to be more achievable with surgical fixation.

Compared to the conservative group, the surgical group had pain that was noticeably less severe and lasted for a shorter period of time. The surgical group also showed a lower incidence of morbidities, which is consistent with the findings of **Swart *et al.*** [14] in their study of rib fractures.

Chest wall stability and symmetry was obviously better in the surgical group. In a research by **Granetzny *et al.*** [15] who randomized their patients of flail chest into surgical and conservative groups, stability of the chest wall occurred in 85% of the patients in the surgical group, whereas in the conservative group, fifty percent of their patients experienced stability. Nine patients in the conservatively-treated group had apparent chest wall deformity, such as a stove-in chest and rib crowding, whereas just one patient in the surgical group experienced this condition.

Conservative management had a higher rate of mal-union and non-union that may cause chronic pain or chest deformity. Elastoplast and dressing were used aiming to cause external fixation of the flail part to improve the respiration, decrease pain and complications and accelerate the healing process but the outcome was not always satisfactory, **Hoepelman *et al*.** [4].

A study done by **Majercik *et al.*** [16] was concerned about comparing the cost of management of both approaches suggested that the expense of the hospital is the same. The higher expenses of the acute care period for surgical fixation are outweighed by the better quality of life and the sooner return to meaningful activities.

Surgery has been shown to be more dependable and successful in treating severe rib fractures in recent years. A comprehensive analysis by **Kasotakis and colleagues** [17] found and analyzed 22 trials with 986 patients with flail chest, 334 of whom had rib ORIF. Lower mortality, shorter MV, hospital LOS, and ICU LOS, as well as a decreased incidence of pneumonia and tracheostomy requirement, were all benefits of rib ORIF. As demonstrated by **Qiu *et al.* [18],** surgical fixation should be utilized in cases of numerous rib fractures in order to enhance the patients' respiratory and circulatory function.

CONCLUSION

Surgical fixation of flail chest is safe, effective and has better outcome than conservative management and is associated with shorter ventilation duration, ICU and hospital stay, less morbidity, pulmonary complications and postoperative chronic pain. This study can be considered as added evidence to the body of knowledge regarding management of flail chest.

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REFERENCES

1. **Lema M, Phillipo L, Joseph B *et al.* (2011):** Pattern and outcome of chest injuries at Bugando Medical Centre in Northwestern Tanzania. J Cardiothorac Surg., 18: 6-7.
2. **Farag G, Al-Awadi M (2017):** Surgical Fixation Compared with Conservative Treatment of Flail Chest Injuries. The Egyptian Journal of Hospital Medicine, 66(1): 140-145.
3. **Pettiford B, Luketich J, Landreneau R (2007):** The management of flail chest. Thorac Surg Clin., 17: 25-33.
4. **Hoepelman R, Minervini F, Beeres F *et al.* (2023):** NEXT study group. Quality of life and clinical outcomes of operatively treated patients with flail chest injuries: A multicentre prospective cohort study. Front Surg., 10: 1156489.
5. **Doben A, Eriksson E, Denlinger C *et al.* (2014):** Surgical rib fixation for flail chest deformity improves liberation from mechanical ventilation. J Crit Care, 29 (1): 139-43.
6. **Cannon R, Smith J, Franklin G *et al.* (2012):** Flail chest injury: are we making any progress? Am Surg., 78 (4): 398-402.
7. **Nirula R, Mayberry J (2010):** Rib Fracture Fixation: Controversies and Technical Challenges. Am Surg., 76: 793-802.
8. **Lafferty P, Anavian J, Will R *et al.* (2011):** Operative Treatment of Chest Wall Injuries: Indications, Technique, and Outcomes. J Bone Joint Surg Am., 93 (1): 97-110.
9. **Muhm M, Härter J, Weiss C *et al.* (2013):** Severe trauma of the chest wall: surgical rib stabilisation versus non-operative treatment. Eur J Trauma Emerg Surg., 39 (3): 257-65.
10. **Witt C, Bulger E (2017):** Comprehensive approach to the management of the patient with multiple rib fractures: a review and introduction of a bundled rib fracture management protocol. Trauma Surg. Acute Care Open, 2 (1): e000064. doi: 10.1136/tsaco-2016-000064.
11. **Chan E, Stefancin E, Cunha J (2016):** Rib Fixation Following Trauma: A Cardiothoracic Surgeon's Perspective. J Trauma Treat., 5: 339. DOI:10.4172/2167-1222.1000339
12. **Marasco S, Davies A, Cooper J *et al.* (2013):** Prospective randomized controlled trial of operative rib fixation in traumatic flail chest. J Am Coll Surg., 216 (5): 924-32.
13. **Carver T, Milia D, Somberg C *et al.* (2015):** Vital capacity helps predict pulmonary complications after rib fractures. J Trauma Acute Care Surg., 79 (3): 413-6.
14. **Swart E, Laratta J, Slobogean G *et al.* (2017):** Operative Treatment of Rib Fractures in Flail Chest Injuries: A Meta-analysis and Cost-Effectiveness Analysis. J Orthop Trauma, 31 (2): 64-70.
15. **Granetzny A, Abd El-Aal M, Emam E *et al.* (2005):** Surgical versus conservative treatment of flail chest. Evaluation of the pulmonary status. Interact Cardiovasc Thorac Surg., 4 (6): 583-7.
16. **Majercik S, Wilson E, Gardner S *et al.* (2015):** In-hospital outcomes and costs of surgical stabilization versus nonoperative management of severe rib fractures. J Trauma Acute Care Surg., 79 (4): 533-8.
17. **Kasotakis G, Hasenboehler E, Streib E *et al.* (2017):** Operative fixation of rib fractures after blunt trauma: A practice management guideline from the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg., 82 (3): 618-26.
18. **Qiu M, Shi Z, Xiao J *et al.* (2016):** Potential Benefits of Rib Fracture Fixation in Patients with Flail Chest and Multiple Non-Flail Rib Fractures. Indian J Surg., 78 (6): 458-63.