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The natural history of flail chest injuries

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ABSTRACT

Purpose: Flail chest (FC) injuries represent a significant burden on trauma services because of its high morbidity and mortality. Current gold standard conservative management strategies for FC, are now being challenged by renewed interest in surgical rib fixation. This retrospective epidemiological study sets out to evaluate FC patients, and quantify the natural history of this injury by studying the injury patterns, epidemiology and mortality of patients sustaining FC injuries admitted to a major trauma centre (MTC). **Methods:** A retrospective cohort analysis has been conducted at an MTC with full trauma service. All patients (age > 16 years) sustaining FC were included. Patient demographics, injury characteristics and inpatient stay information were extracted.

Results: Two hundred and ninety-three patients were identified, with a mean injury severity score (ISS) of 28.9 (range 9–75), average age of 56.1 years (range of 16–100), and a male predominance (78%). Road traffic accidents accounted for 45% ($n = 132$) of injuries, whilst 44% were fall or jump from height ($n = 129$). Associated lung contusion was present in 133 patients (45%) while 76% of patients were found to have 5 or more ribs involved in the flail segment ($n = 223$) with 96% ($n = 281$) having a unilateral FC. Inpatient treatment was required 19.9 days (range 0–150 days) with 59% of patients ($n = 173$) requiring intensive care unit (ICU) level care for 8.4 days (range 1–63) with 61.8% requiring mechanical ventilation ($n = 107$) for 10.5 days (range 1–54), and 7.8% underwent rib fixation with rib plates ($n = 23$). The mortality rate was found to be 14% ($n = 42$). A non-significant trend towards improved outcomes in the conservative group was found when compared with the fixation group; ventilation days (6.94 vs 10.06, $p = 0.18$) intensive treatment unit (ITU) length of stay (LOS) (12.56 vs 15.53, $p = 0.28$) and hospital LOS (32.62 vs 35.24, $p = 0.69$).

Conclusion: This study has successfully described the natural history of flail chest injuries, and has found a nonsignificant trend towards better outcomes with conservative management. With the cohort and management challenges now defined, work on outcome improvement can be targeted. In addition the comparability of results to other studies makes collaboration with other MTCs a realistic proposal.

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Introduction

A flail chest (FC) occurs when 3 or more consecutive ribs are fractured in 2 or more places, creating an independent segment, moving paradoxically from the chest wall. This leads to acute pain, lobar atelectasis and alveolar collapse.¹ The resultant effect on ventilation and gas exchange, in addition to loss of chest wall integrity,² predisposes to acute respiratory distress syndrome,

prolonging mechanical ventilation requirements and increasing the injury burden^{1,3} of the traumatised patient. Mortality rates vary between 20^{4,5} and 42%,⁶ accounting for 25% of all blunt trauma deaths.⁴

Ten percent of blunt trauma sustains FC injuries, representing a significant burden on trauma services.⁷ The Healthcare Cost and Utilisation Project⁸ found FC patients spent on average 10 days in the intensive care unit (ICU) at a cost of \$4945 per day⁹ (£3,400) with over 30% of patients requiring ongoing hospital care. Furthermore, long term indirect costs result from chronic pain and reduced workplace productivity.⁸

The corner stone management is conservative; ICU facilitated analgesia with rescue mechanical ventilation for chest wall integrity (internal splinting).¹⁰ However, surgical management with rib

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plate fixation is becoming an increasing popular option with numerous systematic reviews finding superior outcomes.^{11–14}

With an increasing interest on this subject, and the debate continuing over surgical versus conservative management, it is important to better understand this cohort in order to improve outcomes. This retrospective epidemiological study sets out to evaluate these patients, and quantify the natural history of this injury by studying the injury patterns, epidemiology and mortality of patients sustaining FC injuries admitted to a major trauma centre (MTC). Furthermore patients surgically managed with locked rib plate fixation will be compared to those managed conservatively.

Patients and methods

Setting and data source

The study has been conducted at the Royal London Hospital, an MTC with a full trauma service, including air ambulance helipad, experienced trauma surgeons, orthopaedic surgeons and ITU physicians and facilities capable of delivering gold standard care for flail chest injuries. The in-hospital trauma service database was used to identify patients for this study from January 2014 to June 2016.

Study design

A retrospective cohort analysis has been conducted with a view to characterizing the cohort of patients sustaining FC, injury patterns, and mortality. Patients treated with operative fixation with locked rib plates were subsequently compared with those managed conservatively. Outcomes compared included ventilation days, ITU length of stay (LOS), and hospital length of stay (LOS).

Cohort

All adult patients (age > 16 years) sustaining FC were included, with the accepted definition of FC being 3 or more consecutive rib fractures in 2 or more places.¹

Characteristics

Patient characteristics extracted included age, sex, injury severity score (ISS), mechanism of injury, number of ribs fractured, unilateral or bilateral FC, management of FC (whether surgical or conservative) associated injuries, presence of lung contusion, ICU length of stay, mechanical ventilation days, hospital length of stay, and mortality.

Results

Epidemiological characteristics

This study has identified 293 patients sustaining FC injuries with a mean ISS of 28.9 (range 9–75). The average age at time of injury was 56.1 years (range of 16–100) with 78% male and 22% female patients.

A total 45.1% of patients sustained the FC through road traffic incidents ($n = 132$). Of these, 44% of patients were pedestrians ($n = 58$), 24% were motorcyclists ($n = 31$), 15% were cyclists ($n = 20$) and 17% were vehicle drivers ($n = 23$). The mechanisms of injury included 44% ($n = 129$) of falling or jumping from height, 10.2% ($n = 30$) crush injuries at work, etc (Fig. 1). For two patients (0.7%), the mechanisms of injury were unknown.

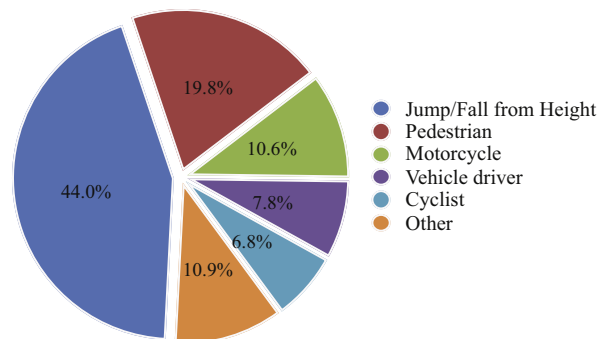


Fig. 1. Mechanism of injury.

Associated lung contusion was present in 133 patients (45%) while 76% of patients were found to have 5 or more ribs involved in the flail segment ($n = 223$) with 96% ($n = 281$) having a unilateral FC. Twelve patients (4%) were found to have bilateral flail segments. Patients required inpatient treatment for an average of 19.9 days (range 0–150 days) with 59% of patients ($n = 173$) requiring ITU level care. Patients spent on average 8.4 days in ITU (range 1–63) with 61.8% requiring mechanical ventilation ($n = 107$) for an average of 10.5 days (range 1–54).

Of the 293 patients identified, only 7.8% underwent rib fixation with rib plates ($n = 23$). The mortality rate was found to be 14% ($n = 42$). All of the surgical fixation cohort survived. These results have been summarized in Tables 1–3.

Statistical comparison

Patients operatively managed with locked rib plate fixation were compared with that receiving gold standard conservative management. Statistical analysis with T squared testing found no significant difference between the potential confounding factors of ISS and age (Table 4).

Comparison of the data using T testing found a nonsignificant trend towards improved outcomes in the conservative group compared with the fixation group (Table 4); ventilation days (6.94 vs 10.06, $p = 0.18$) ITU LOS (12.56 vs 15.53, $p = 0.28$) and hospital LOS (32.62 vs 35.24, $p = 0.69$).

Discussion

The results enable a better understanding of the epidemiology and natural history of FC. The majority of patients sustaining FC are males (78%) in the 50–60 year old age group. Furthermore, one can see that a large, inner-city MTC, such as the Royal London Hospital, is likely to see approximately 75 patients per year. This information is important, as it can aid the trauma department to plan resources

Table 1
Cohort characteristics.

Variables	<i>n</i>	Percentage (%)	Mean	Range
Age (Years)	–	–	56.1	16–100
Male	228	78	–	–
Female	65	22	–	–
ISS	–	–	28.9	9–75
Survived	251	86	–	–
Mortality	42	14	–	–

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