



Management of Advanced Aged Patients with Rib Fractures: Current Evidence and Review of the Literature

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Abstract: Elderly patients (age > 60 years old) represent the majority of the victims of major trauma, and rib fractures account for 10% of all trauma admissions. Due to the growing interest in surgical rib fixation and the lack of evidence on the best treatment available, we aimed to compare the conservative and operative approaches among the elderly population with multiple rib fractures. The systematic review identified seven eligible studies from over 321 papers collected through the database screening process. The mortality rate, considered the primary outcome, was higher in the conservative-treated group than the operatively-treated patients (8.3% vs. 3%). Considering the secondary outcomes investigated, the overall intensive care unit stay and in-hospital length of stay were longer in the operatively-treated patients (6.3 and 13.3 vs. 4.7 and 7.7, respectively). Conversely, the operative treatment showed favorable results regarding the pneumonia complication rate (5.8% vs. 9.6%), while the duration of mechanical ventilation was similar for both treatments. Surgical stabilization of rib fractures in the elderly population appears to be associated with a survival advantage and avoiding pulmonary complications. However, the individual contribution of operative and conservative treatment in reducing morbidity and mortality in the elderly with multiple rib fractures remains unclear.

Keywords: conservative treatment; ribs fractures; flail chest; elderly population; rib fixation



Citation: Ferrari, P.A.; Zappadu, S.; Santoru, M.; Riva, L.; Cherchi, R. Management of Advanced Aged Patients with Rib Fractures: Current Evidence and Review of the Literature. *Trauma Care* **2022**, *2*, 87–94. <https://doi.org/10.3390/traumacare2020008>

Received: 28 February 2022

Accepted: 21 March 2022

Published: 22 March 2022

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1. Introduction

Rib fractures are painful and disabling injuries found in chest trauma patients. Simple rib fractures typically heal with minimal intervention or consequence, but as the number of fractured ribs increases, the morbidity and mortality rates increase exponentially, particularly among elderly patients [1,2].

Rib fracture management includes operative and non-operative approaches. Conservative treatment generally consists of satisfactory pain control, respiratory assistance, cough strategies, and deep breathing exercises [3]. Patients receiving conservative treatment have fewer complications, a more significant length of hospital stay, and worse functional status after hospitalization [4].

Despite the favorable results emerging from multiple studies reported in the literature, surgical fixation of rib fractures and fluctuating chest injuries has not been used to its full potential [5,6]. Furthermore, it is controversial whether older age patients benefit from surgical fixation, and the few studies reported in the literature are relatively small and lack the power to provide concrete conclusions [7].

Because it is difficult to retrieve clinical evidence comparing operative versus conservative treatment in 60-year-olds with multiple rib fractures, we performed a systematic review of the literature. Thus, this study aims to answer this question by delineating

conclusive evidence in the literature and providing a reliable basis to enhance the protocols to achieve optimal clinical outcomes.

2. Materials and Methods

This systematic review adheres to the protocol recommended by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines to enhance the comprehensiveness and accuracy of this study [8].

2.1. Literature Search

After scoping searches, we investigated four electronic databases (Cochrane Library, Ovid MEDLINE, EMBASE, Google Scholar) for relevant literature from the inception to February 2022. The PICO strategy (Table 1) was adopted to identify the following keywords: “elderly”, “older”, “fracture”, “ribs”, “flail chest”, and “treatment”. These terms were searched with different combinations in the title and abstract and against the exclusion criteria. Furthermore, we also examined the reference lists of all the literature to be as inclusive as possible.

Table 1. PICO strategy used for the study.

| | |
|---------------------|---|
| Patient | Hospitalized elderly patients over 60 years old with ribs fractures |
| Intervention | Operative treatment with surgical rib fixation |
| Comparison | Conservative treatment without surgical rib fixation |
| Outcome | Reduced mortality rate |

2.2. Data Collection

Four researchers (P.A.F., S.Z., M.S., and L.R.) performed the literature search and independently screened the title and abstract for eligibility, according to the inclusion and the exclusion criteria (Table 2).

Table 2. Inclusion and exclusion criteria.

| Inclusion Criteria | Exclusion Criteria |
|--|--|
| The study design was a randomized clinical trial or an observational study | No availability of a full-text |
| Subjects were adult patients over 60 years old age | Conference reports, letters, meeting proceedings, case series with fewer than ten patients |
| Conservative vs. operative treatment of two rib fractures or more was compared | The study was still ongoing |
| Study reporting on mortality rate and secondary outcomes | The study was not written in English |

2.3. Data Extraction and Quality Assessment

Relevant data from the included studies were extracted and presented in a table for cross-checking and agreement by the four reviewers (P.A.F., S.Z., M.S. and L.R.). The following baseline characteristics were extracted: first author, year of publication, study design, number of included patients, gender, age, number of fractured ribs, flail chest percentage, and injury severity score (ISS). In cases of studies that comprised data on the target population of this review as part of subgroup analysis, only data from that analysis was included in the present systematic review. Four reviewers (P.A.F., S.Z., M.S. and L.R.) independently assessed the methodological quality of the included studies using the Methodological Index for Non-Randomized Studies (MINORS) [9]. Disagreements were resolved by consensus.

2.4. Outcome Measures

The mortality rate was used as the primary outcome. Secondary outcomes investigated included pneumonia rate, mechanical ventilation length (MVL), intensive care unit length of stay (ICU-LOS), and in-hospital length of stay (IH-LOS). Since none of the studies included in this systematic review reported uniform definitions in describing complications, such as pneumonia, the rates were taken as reported.

2.5. Statistical Analysis

The studies included in this review were retrospective descriptive studies where the clinical data (interventions, inclusion and exclusion criteria, outcome measures), methodology (quality), and statistical significance were heterogeneous. This limited our ability to combine and integrate the extracted data, and the lack of statistical homogeneity did not allow for a meta-analysis. Therefore, only a narrative synthesis could be performed.

Information about the continuous variables was presented as means with standard deviation (SD) or range, or information was converted to the mean and SD. Dichotomous variables were presented as counts and percentages. For all outcomes, the weighted mean or percentage was calculated according to the size of each study population.

3. Results

3.1. Study Selection

A total of 321 articles were identified in Cochrane Library, Ovid MEDLINE, EMBASE, and Google Scholar. After de-duplication, the reviewers were left with 254 studies to screen and they examined the titles and abstracts for eligibility. Twenty-two potential studies were retained for a full-text assessment. Two studies met all the inclusion criteria [10,11] except for the inappropriate mean age of the patient subgroups requested by PICO (>60 years old). As a result, this systematic review included seven articles, as shown in the PRISMA flow diagram (Figure 1).

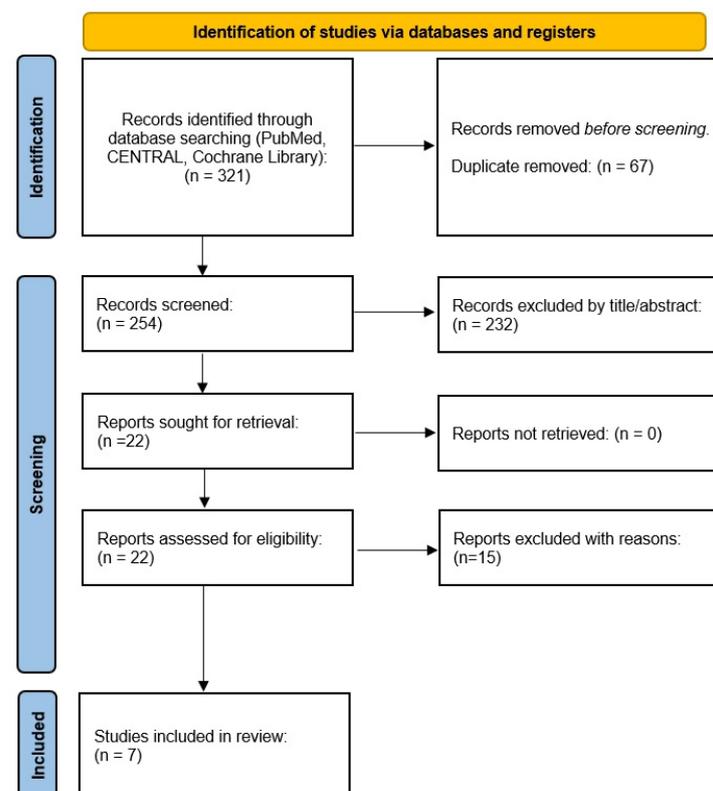


Figure 1. PRISMA flow diagram. From Page et al. [8].

3.2. Study Characteristics

All seven studies were carried out in two countries (the United States and Australia) and published between 2017 and 2021 as retrospective observational studies [12–18]. Out of 3135 enrolled patients, 2014 received conservative treatment and 1121 received operative treatment. The conservative approach was prevalent in the older patients' group (76.1 vs. 73.7 years). Moreover, the ISS scores were notably lower (14.5 vs. 18.4) in the non-operative group, as well as the median number of rib fractures (4.6 vs. 8) and the percentage of flail chest (25.7% vs. 51%), compared to the patients who were operatively treated. No stratification was possible due to the absence of a separate report for these characteristics in the two subgroups. The studies included multi-trauma patients and single rib fractures, but only four reported stratified ISS [13,15,17,18].

3.3. Main Findings

The data concerning the mortality rate, as reported in Table 3, showed a lower overall weighted mean in the operatively-treated group (3%) compared to conservative-treated patients (8.3%).

Table 3. Studies comparing conservative and operative treatment of rib fractures.

| Outcomes | | Authors (Year, Country) | | | | | | |
|------------------------|----|------------------------------------|-----------------------------------|------------------------------|----------------------------------|----------------------------------|--------------------------------------|----------------------------------|
| | | Fitzgerald et al. (2017, USA) [12] | Ali-Osman et al. (2018, USA) [12] | Kane et al. (2018, USA) [13] | Chen Zhu et al. (2020, USA) [15] | Pieracci et al. (2021, USA) [16] | Cooper et al. (2021, Australia) [17] | Christie et al. (2021, USA) [18] |
| Subjects (number) | CT | 50 | 135 | 392 | 758 | 227 | 280 | 172 |
| | OT | 23 | 64 | 43 | 758 | 133 | 15 | 85 |
| Male (%) | CT | nr | 73 (54) | nr | 518 (68) | 116 (51) | † 185 (63) | nr nr |
| | OT | nr | 41 (61) | nr | 530 (70) | 81 (61) | | nr |
| Age (IQR/SD) | CT | 75 (65–97) | 72 (66–81) | 75.4 ± 6.8 | 72 (68–79) | 86 (80–90) | 77 (73–84) | 75 (65–100) |
| | OT | 68 (63–89) | 69 (63–74) | 71.3 ± 6.0 | 72 (68–78) | 84 (80–100) | 78 (75–83) | 74 (65–69) |
| Rib fractures (IQR/SD) | CT | nr | 5 (3–7) | nr | nr | 5 (1–7) | 4 (3–6) | nr |
| | OT | nr | 7 (5–9) | nr | nr | 9 (1–30) | 8 (6–12) | nr |
| Flail chest (IQR/SD) | CT | nr | nr | nr | 348 (46) | 36 (16) | 42 (15) | nr |
| | OT | nr | nr | nr | 345 (46) | 76 (57) | 7 (50) | nr |
| ISS (IQR/SD) | CT | 19 (14–23) | 14 (8–24) | 14.1 ± 10.3 | nr | 13 (4–34) | 14 (10–19) | 13 (1–38) |
| | OT | 21 (16–26) | 17.5 (9–25) | 20.1 ± 8.5 | nr | 14 (4–57) | 17 (13–29) | 20 (9–59) |
| Mortality (%) | CT | 2 (4) | 13 (10) | 33 (8) | 55 (7) | 21 (9) | 27 (10) | 18 (10) |
| | OT | 0 (0) | 1 (2) | 1 (2) | 32 (4) | 10 (8) | 0 (0) | 4 (5) |
| Pneumonia (%) | CT | 7 (14) | 16 (12) | 54 (14) | 8 (1) | 9 (4) | 25 (10) | 20 (12) |
| | OT | 0 (0) | 5 (8) | 2 (5) | 23 (3) | 16 (12) | 2 (13) | 0 (0) |
| MVL (IQR/SD) | CT | nr | 4 (1–10) | nr | 7 (3–14) | nr | 5 (2–12) | nr |
| | OT | nr | 3 (1–15) | nr | 6 (2–13) | nr | 12 (3–30) | nr |
| ICU-LOS (IQR/SD) | CT | 12 (7–17) | 4 (3–7) | 0 (0–3) | 4 (2–8) | 0 | 3 (1–6) | 10 (1–32) |
| | OT | 8 (5–11) | 6 (3–10) | 5 (0–8) | 7 (4–13) | 4.5 | 6 (2–13) | 8 (1–11) |
| IH-LOS (IQR/SD) | CT | 17 (10–23) | 4.8 (3–8) | 5 (3–9) | 7 (4–12) | 6 | 6.5 (3–13) | 8 (1–39) |
| | OT | 18 (14–23) | 12 (9–16) | 12 (10–16) | 13 (9–18) | 11 | 12 (9–15) | 15 (3–49) |

† Overall male distribution; IQR: interquartile range; SD: standard deviation; nr: not reported; CT: conservative treatment; OT: operative treatment; ISS: Injury Severity Score; MVL: mechanical ventilation length; ICU-LOS: intensive care unit-length of stay; IH-LOS: in hospital-length of stay.

Secondary outcomes, such as pneumonia, were reported at a reasonably higher rate in the non-operative patients' group (9.6% vs. 5.8%). The IH-LOS and ICU-LOS was 13.3 and 6.3 days for operatively-treated patients, respectively, and 7.7 and 4.7 days for conservatively-treated patients. We compared the average MVL between the two groups, and found that the duration in the conservative group was 5.3 days, while 7 days was the average length of mechanical ventilation for the operatively-treated patients' group.

3.4. Global Complications Report

Fitzgerald et al. reported 7 (14%) cases of pleural effusion and 19 (38%) cases of recurrent pneumothorax versus zero for either complication in the surgically-treated group [12].

The study conducted by Ali-Osman and colleagues reported 7 (3.5%) versus 6 (3%) cases of pleural effusion, 7 (3.5%) cases versus 1 (0.5%) case of atrial fibrillation for conservative and operative treatment, respectively [13]. There was 1 (0.5%) case of abscess and 1 (0.5%) case of pneumothorax for operatively-treated patients. Finally, there were two cases of arrhythmia, one in both study groups.

Chen Zhu et al. reported 10 (1.3%) versus 13 (1.7%) cases of acute respiratory distress syndrome (ARDS), 6 (0.8%) versus 12 (1.6%) cases of decubitus ulcer, 10 (1.3%) versus 13 (1.7%) cases of sepsis and 16 (2.1%) versus 30 (4%) cases of venous thromboembolism (VTE) in patients treated conservatively and operatively, respectively [15].

A recent study described 6 (3.5%) cases versus 1 (1.2%) case of recurrent pneumothorax, 2 (1.2%) versus 2 (2.3%) cases of pleural effusion for conservative and operative treatment, respectively [18]. In addition, twenty-six (15%) conservatively-treated patients were readmitted during the 60 day follow-up, compared with 4 (%) readmissions reported in the operative group.

Due to the heterogeneity of the reports, no analysis or adequate comparison could be performed on the complications data reported by the studies included in this investigation.

4. Discussion

In this systematic review of non-randomized observational studies, rib fixation in elderly patients with thoracic trauma resulted in lower mortality and complications related to respiratory distresses and pneumonia. The prevalence of multiple rib fractures and flail chest in subjects undergoing operative treatment and the higher mean ISS score in this group could partly justify the higher mean IH-LOS and ICU-LOS values compared with the conservative cohort of patients. Based on the results of this study, it is not easy to assess which treatment is superior. A multidisciplinary approach is advisable since it remains unknown as to which patients benefit from operative treatment, especially for elderly patients [19]. The clinical outcome appears to be affected by multiple factors, including the severity of the trauma and concomitant injuries, the number of rib fractures, the variety and timing of treatment, and the adequacy of polytrauma care [20]. All of these elements should be considered in future studies and analyses to identify the specific contribution of conservative and operative treatments in this polynomial causal relationship [7].

Historically, the standard of care for rib fractures has been nonoperative management. The choice of nonoperative management may have resulted from a lack of knowledge about fracture fixation techniques among those managing the chest wall injuries in this set of patients. As rib fracture fixation has gained popularity and fixation techniques and implant devices have been refined, the clinical results are encouraging [21]. Operative techniques for rib fixation include rigid devices such as plates, struts, intramedullary nails, malleable Kirschner wires, and sutures. These surgical approaches differ in their safety and efficacy, and the optimal approach has not been determined so far [10]. The evidence supporting rib fracture fixation to improve patient survival statistics and accelerate patient's recovery to a normal functional state is increasing. Several studies have shown that rib fracture fixation results in reductions in narcotic use, avoidance of tracheostomy, and better quality of life [12,22,23].

Rib fractures are a known threat to the survival of geriatric trauma patients and can adversely affect the recovery and rehabilitation of other injuries. Functional and lifestyle limitations relative to the patient's baseline are crucial endpoints after chest wall trauma in the elderly population. Along with the age-associated deterioration in global pulmonary function, pain from rib fractures, and subsequent respiratory impairment, rib fractures can alter the survival potential and quality of recovery. Rib plating procedures appear to enhance these outcome measures and should be strongly considered as an adjunct, if not a first-line therapeutic alternative for rib fractures in the geriatric patient population [24].

Elderly trauma patients with rib fractures are currently understudied with few published studies and data defining best practices. With the evolution of plating systems for fixation and chest wall stabilization, the practical paradigm for rib fracture management is shifting as a viable operative intervention now exists [18,24–27]. The clinical outcomes in this group of patients may be ameliorated by the systematic use of thoracic trauma protocols, anesthetic techniques, and rib-stabilization interventions. A tailored rehabilitation nursing care program has also significantly improved the functional status and quality of life in patients with severe rib fractures at discharge and six-month follow-up, improving the quality of nursing care itself [28]. However, few of these studies have included elderly subjects to date. Therefore, it is unclear whether the results of these studies can be extrapolated to the geriatric trauma population [29].

5. Limitations

The limitations that affected our study are attributable to the analysis of retrospective descriptive studies in which clinical data, methods, and statistical significance were heterogeneous. The results obtained relate only to elderly patients with rib fractures, and the inhomogeneity of the data did not make it possible to perform a meta-analysis. Moreover, the studies included in this review originate from only two countries, which limits the generalizability of the findings.

6. Conclusions

Considering the available results, surgical fixation in elderly patients seems to result in better outcomes than conservative treatment in terms of shorter hospitalization time, more favorable pain feedback and reduced associated morbidity. Robust research in this area with well-performed comparative observational studies or randomized control trials is urgently needed.

Author Contributions: Conceptualization: P.A.F. and S.Z.; methodology, P.A.F., S.Z., M.S. and L.R.; validation, P.A.F., S.Z., M.S., L.R. and R.C.; formal analysis, P.A.F. and S.Z.; investigation, P.A.F., S.Z., M.S., L.R. and R.C.; data curation, P.A.F., S.Z., M.S., L.R. and R.C.; writing—original draft preparation, P.A.F. and S.Z.; writing—review and editing, P.A.F., S.Z., M.S. and L.R.; visualization, P.A.F., S.Z., M.S. and L.R.; supervision, P.A.F. and R.C.; project administration, P.A.F. and R.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study since it is a systematic review of published literature.

Informed Consent Statement: Patient consent was waived because no patients or members of the public were involved in the design, conduct of this study, or reporting of this research.

Data Availability Statement: All data generated as part of this study are included in the article.

Conflicts of Interest: The authors declare no conflict of interest.

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