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# SURGICAL MANAGEMENT VERSUS NON-SURGICAL MANAGEMENT OF RIB FRACTURES IN CHEST TRAUMA: A SYSTEMATIC REVIEW

[1,2*]Fulgensius Atin, [3]Herbert Soritua Silalahi, [2]R. Dhany Prasetyanto, [3]Fridolino Jimmy Desanto, [4]Heriberty Chindy Sulisty

*[1]Faculty of Medicine, Widya Mandala Catholic University, Surabaya, Indonesia*
*[2]St. Vincentius A Paulo Catholic Hospital, Surabaya, Indonesia*
*[3]Siloam General Hospital, Kupang, Indonesia*
*[4]dr. Ben Mboi Central General Hospital, Kupang, Indonesia*

**Corresponding Author:**
fulgensiusatin@gmail.com

## ABSTRACT

***Background:*** *Roughly ten percent of patients who visit trauma centers are estimated to have broken ribs. From a single, isolated fracture to a flail chest, rib fractures can occur in a variety of severity. Rib fractures substantially influence the rates of morbidity and mortality. There is still debate on how to treat chest injuries. Practical use varies greatly; one such example is the uneven application of surgical stabilization.*

***The aim:*** *This study aims to assess the differences between surgical management and non-surgical management of rib fractures in chest trauma.*

***Methods:*** *By comparing itself to the standards set by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, this study was able to show that it met all of the requirements. So, the experts were able to make sure that the study was as up-to-date as it was possible to be. For this search approach, publications that came out between 2013 and 2023 were taken into account. Several different online reference sources, like Pubmed and ScienceDirect, were used to do this. It was decided not to take into account review pieces, works that had already been published, or works that were only half done.*

***Results:*** *In the PubMed database, the results of our search brought up 44 articles, whereas the results of our search on ScienceDirect brought up 303 articles. The results of the search conducted by title screening yielded a total 18 articles for PubMed and 13 articles for ScienceDirect. We compiled a total of 17 papers, 12 of which came from PubMed and 5 of which came from ScienceDirect. We excluded 1 review article, 1 duplicate article, 1 non-full text article, 2 protocol study, 2 articles having ineligible subjects, and 3 articles having insufficient outcomes data. In the end, we included seven research that met the criteria.*

***Conclusion:*** *The outcomes of surgical and non-surgical methods for the management of rib fractures are comparable in terms of complications, length of hospital stay, and mortality.*

**Keywords:** *surgical, non-surgical, rib fractures, flail chest, outcomes, compare*

**SSINTRODUCTION**

In the United States (US), thoracic injuries are second only to head injuries in terms of injury-related morbidity and mortality.[1] According to estimates, 10% of patients who report to trauma centres have a rib fracture. Rib fractures can occur in a wide range of severity, from a single isolated fracture to flail chest. They are thought to be the most common injury that follows thoracic trauma.[2,3] According to a statistical report, 300,000 patients in the US were diagnosed with rib fractures in 2004 and this figure is increased to more than 350,000 in 2017.[4] Whereas the incidence rate of patients with flail chest was 1 per 100,000 person-years.[2] The most prevalent ribs fractured in trauma are ribs four to nine.[5]

According to reports, rib fractures can result in up to 20% of trauma patients dying. This makes rib fractures a major cause of mortality.[3] The mortality and morbidity rates are significantly impacted by rib fractures. Mortality and extended hospital stays have been linked to a number of factors, including the number of cracked ribs.[1] Previous studies have shown worse outcomes in the elderly with rib fractures and patients with a flail chest.[2] There is a 10%–20% increase in mortality when there is flail chest, which is defined as three or more contiguous ribs fractured at more than one position per rib. Severe pain and respiratory compromise are also present. Complications from rib fractures might include lung contusions, hemothorax, pneumothorax, and severe head, thoracic, and abdominal injuries. Most patients with rib fractures have severe pain, which can impair breathing and increase the risk of complications like pneumonia, pleural effusion, or acute respiratory distress syndrome.[6]

The management of chest injury remains controversial. There is much variation in practice: in particular, the use of surgical stabilisation is applied inconsistently. For patients with rib fractures, vigorous pulmonary hygiene, multimodal pain management, and mechanical ventilation when necessary remain the generally acknowledged standards of care. Historically, several approaches have been put out to lessen rib mobility or stabilise the broken rib segments; however, they have primarily involved external wrapping or splinting, which has been linked to higher rates of morbidity and mortality as well as pulmonary problems.[7] This study aims to assess the differences between surgical management and non-surgical management of rib fractures in chest trauma.

## METHODS

### Protocol

By following the rules provided by Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, the author of this study made certain that it was up to par with the requirements. This is done to ensure that the conclusions drawn from the inquiry are accurate.

### Criteria for Eligibility

For the purpose of this systematic review, we compare and contrast the effectiveness of surgical versus non-surgical management of rib fractures in chest trauma. It is possible to accomplish this by researching or investigating the complications, hospital stays, and mortality between surgical and non-surgical management. As the primary purpose of this piece of writing, demonstrating the relevance of the difficulties that have been identified will take place throughout its entirety.

In order for researchers to take part in the study, it was necessary for them to fulfil the following requirements: 1) The paper needs to be written in English, and it should focus on determining surgical versus non-surgical management of rib fractures in chest trauma. In order for the manuscript to be considered for publication, it needs to meet both of these requirements. 2) The studied papers include several that were published within the last 10 years. Examples of studies that are not permitted include editorials, submissions that do not have a DOI, review articles that have already been published, and entries that are essentially identical to journal papers that have already been published.

### Search Strategy

We used "surgical"; "non-surgical"; "rib fractures"; "flail chest"; "outcomes"; and "compare" as keywords. The search for studies to be included in the systematic review was carried out from December, 28th 2023 using the PubMed and ScienceDirect databases by inputting the words: "surgical procedures, operative"[MeSH Terms] OR "surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields] OR "operative surgical procedures"[All Fields] OR "surgical"[All Fields] OR "surgically"[All Fields] OR "surgicals"[All Fields] AND "non-surgical"[All Fields] AND "rib fractures"[MeSH Terms] OR "rib"[All Fields] AND "fractures"[All Fields] OR "rib fractures"[All Fields] OR "flail chest"[MeSH Terms] OR "flail"[All Fields] AND "chest"[All Fields] OR "flail chest"[All Fields] AND "outcome"[All Fields] OR "outcomes"[All Fields] AND "compare"[Journal] OR "compare"[All Fields] AND (y_10[Filter]) AND (english[Filter]) used in searching the literature.

### Data retrieval

After reading the abstract and the title of each study, the writers performed an examination to determine whether or not the study satisfied the inclusion criteria. The writers then decided which previous research they wanted to utilise as sources for their article and selected those studies. After looking at a number of different research, which all seemed to point to the same trend, this conclusion was drawn. All submissions need to be written in English and can't have been seen anywhere else.

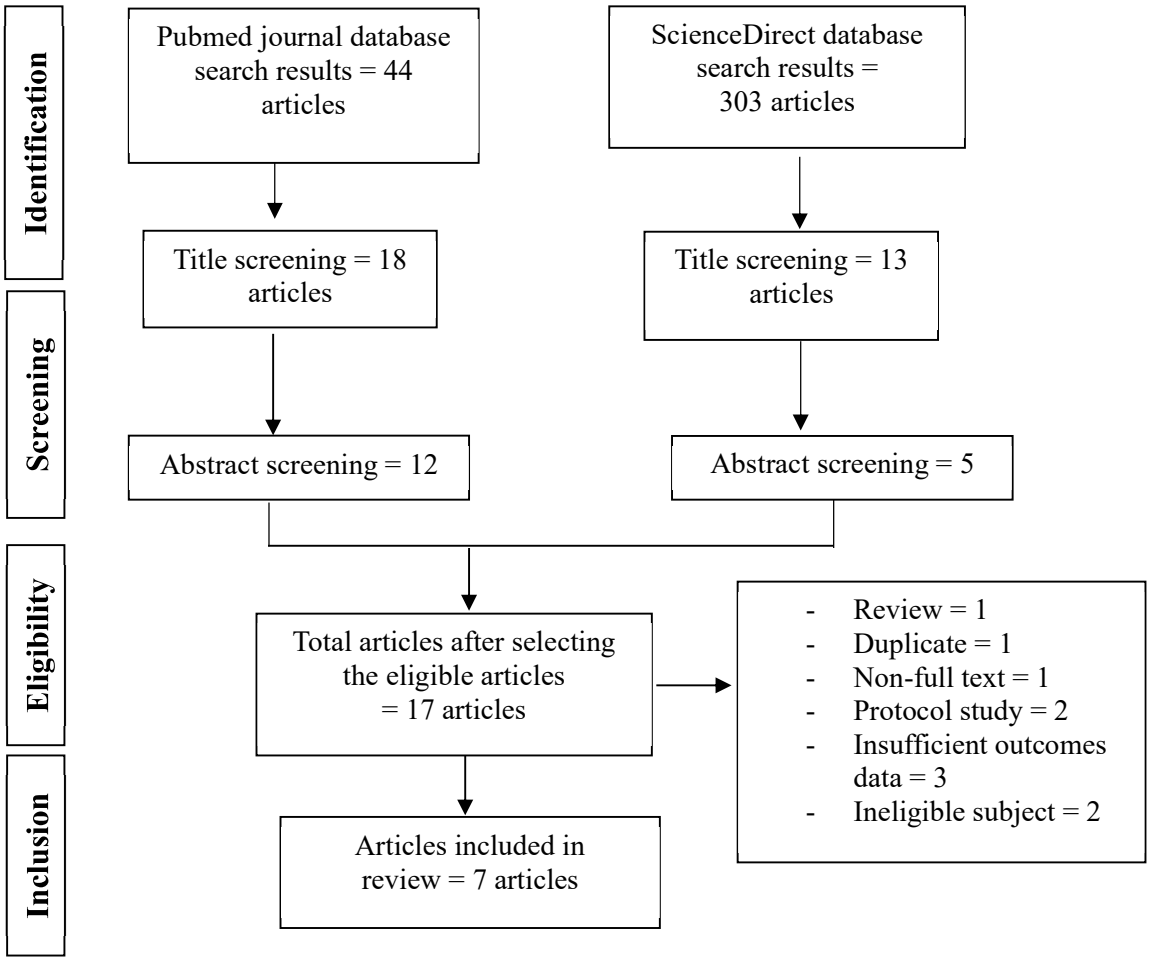


**Figure 1. Article search flowchart**

Only those papers that were able to satisfy all of the inclusion criteria were taken into consideration for the systematic review. This reduces the number of results to only those that are pertinent to the search. We do not take into consideration the conclusions of any study that does not satisfy our requirements. After this, the findings of the research will be analysed in great detail. The following pieces of information were uncovered as a result of the inquiry that was carried out for the purpose of this study: names, authors, publication dates, location, study activities, and parameters.

## Quality Assessment and Data Synthesis

Each author did their own study on the research that was included in the publication's title and abstract before making a decision about which publications to explore further. The next step will be to evaluate all of the articles that are suitable for inclusion in the review because they match the criteria set forth for that purpose in the review. After that, we'll determine which articles to include in the review depending on the findings that we've uncovered. This criteria is utilised in the process of selecting papers for further assessment in order to simplify the process as much as feasible when selecting papers to evaluate. Which earlier investigations were carried out, and what elements of those studies made it appropriate to include them in the review, are being discussed here.

## RESULT

In the PubMed database, the results of our search brought up 44 articles, whereas the results of our search on ScienceDirect brought up 303 articles. The results of the search conducted by title screening yielded a total 18 articles for PubMed and 13 articles for ScienceDirect. We compiled a total of 17 papers, 12 of which came from PubMed and 5 of which came from ScienceDirect. We excluded 1 review article, 1 duplicate article, 1 non-full text article, 2 protocol study, 2 articles having ineligible subjects, and 3 articles having insufficient outcomes data. In the end, we included seven research that met the criteria.

**Table 1. The literature include in this study**

| Author | Origin | Method | Sample Size | Result |
|---|---|---|---|---|
| Beks, 2019[8] | Netherlands | Retrospective cohort | 28 had surgery vs 212 had non-surgery in multiple rib fractures and 37 had surgery vs 55 had non-surgery in flail chest | This findings suggested that no advantage could be demonstrated for operative fixation of rib fractures.Rib fixation for a flail chest was not associated with differences in intensive care unit length of stay (ILOS) or hospital length of stay (HLOS) for rib fixation in patients with multiple rib fractures. |
| Dehghan, 2022[9] | Canada | Multicentre RCT | 111 had surgery vs 100 had non-surgery | This results showed that operative treatment of un-stable chest wall injuries provides modest benefit compared with nonoperative treatment. However, the potential advantage was primarily noted in the subgroup of patients who were ventilated at the time of randomization. No benefit to operative treatment was found in patients who were not ventilated. |

| | | | | |
|---|---|---|---|---|
| Jiang, 2019[10] | China | Retrospective study | 75 had surgery vs 92 had non-surgery | This findings suggested that surgery to treat multiple rib fractures accompanied with pulmonary contusion appear to be safe and effective. Compared with the non-surgical therapies, surgery was associated with reduced pain, shorter hospital stay, and improved physical fitness. |
| Liu, 2023[11] | Taiwan | Prospective study | 26 had surgery vs 27 had non-surgery | The results showed that surgical treatment of fractured ribs in major trauma patients without brain injury resulted in marked pain relief. Moreover, our results suggest that surgical treatment of such patients may help shorten hospital stay and decrease hospitalization costs. |
| Wijffels, 2020[12] | Netherlands | Retrospective case series | 20 had surgery vs 20 had non-surgery | This findings concluded that operative fixation of a flail chest in trauma patients results in a lower rate of pneumonia, less mechanical ventilation days, and shorter hospital stay as compared with non-operative treatment, but at the cost of surgery-related complications. |

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|---|---|---|---|---|
| Xiao, 2020[13] | China | Retrospective study | 430 had surgery vs 580 had non-surgery in multiple rib fractures and 133 had surgery vs 58 had non-surgery in flail chest | This study findings suggested that surgical rib fixation is safe and improves short-term outcome in terms of ICU length of stay in patients with a flail chest, as compared to traditional conservative therapy. For patients with multiple rib fractures, surgical rib fixation results in a comparable outcome in comparison with nonoperative treatment. |
| Zhang, 2015[14] | China | Retrospective study | 24 had surgery vs 15 had non-surgery | This results showed that surgery for flail chest with pulmonary contusion could reduce the HLOS, and early surgery could decrease the DMV and the need for tracheotomy. |

## Complications

Four of five identified studies in this systematic review suggested that the complications or adverse events, such as pneumonia, VAP, sepsis, empyema, atelectasis, delirium, and pleural effusion were similar between both groups. Dehghan, et al. (2022)[9] showed that the rates of complications such as pneumonia, VAP, sepsis, empyema were similar between surgical group and non-surgical group. However, tracheostomy rates were different (9 [8%] surgical group vs 16 [16%] non-surgical group; 95% CI, 0.83-5.73; $P = .13$). Liu, et al. (2023) showed that the incidence of pneumonia was similar between two groups, surgical group was 1 (3.7) and non-surgical group was 1 (3.8), P= 0.978. Wijffels, et al. (2020)[12] also showed that adverse events in both groups difference did not reach statistical significance ($p = 0.075$). Adverse events including pneumonia, respiratory insufficiency, empyema, and delirium occurred in 12 patients (52%) of the operative group versus 36 (77%) in the non-operative group. In matched-pairs analysis, the operatively treated group showed a statistically significantly lower pneumonia rate (35 versus 80%; $p = 0.035$). In addition, Zhang, et al. (2015)[14] showed that the incidence of pleural effusion, VAP, and tracheotomy had no significant difference between surgical and non-surgicall groups. However, Jiang, et al. (2019)[10] showed that complications including pneumonia, atelectasis, and respiratory failure were significantly lower in the surgery group than in the non-surgery group (All $p < 0.01$), whereas the incidence of heart failure was similar in the two groups.

## Hospital Stays

Four of seven identified studies showed that the length of hospital stays were similar between surgical and non-surgical groups. Beks, et al. (2019) and Xiao, et al. (2020) included two groups to be analysed, multiple rib fractures and flail chest. Beks, et al. (2019)[8] showed that in flail chest, the duration of ICU stay (days) for surgery group was 6 days, while non-operative group was 2 days (95% CI − 13.9 to 8.5; p value 0.638). The difference between these groups was not significant. In multiple rib fractures. In multiple rib fractures the duration of ICU stay (days) for surgery group was 0 day, while non-operative group was 1 day (95% CI − 3.5 to 6.7; p value 0.530). For patients with multiple rib fractures, there was no association between rib fixation and hospital length of stay (HLOS) (CI − 0.6 to 13.6, $p = 0.074$) and the secondary outcome measures. While Xiao, et al. (2020)[13] showed the hospital length of stay, was not significantly differed between surgically and conservatively managed patients with multiple rib fractures (10.3±3.6 *vs.* 10.1±4.5 days, P=0.433). In flail

chest, the ICU length of stay was significantly differed between surgery and conservative management (5.7±2.1 *vs.* 6.6±2.4 days, P=0.015).

Dehghan, et al. (2022)[9] showed that median (IQR) length of stay in the hospital was 16.5 (10.0-30.3) days for the surgery group and 16.0 (8.5-32.5) days for the non-surgical group. Mean (SD) length of ICU stay was 8.4 (9.9) days in the surgery group and 8.9 (10.4) days in the non-surgical group. In patients who were admitted to the ICU only, mean (SD) length of stay in the ICU was 10.8 (10.0) days in the surgery group and 11.3 (10.5) days in the non-surgical group. There were no differences in length of hospital or ICU stay between groups. Futhermore, Liu, et al. (2023)[11] showed that the length of hospital stay were similar in the two groups. In surgical group, the duration was 13.0 ± 6.1 , whereas in non-surgical group was 17.6 ± 15.6 (P = .165).

The other three studies showed that the length of hospital stay were shorther in surgical group than non-surgical group. Jiang, et al. (2019)[10] showed that the length of hospital stay were significantly lower in the surgery group than in the non-surgery group. In surgery group, the duration was 8.9 ± 2.2 days, in non-surgery group was 9.9 ± 2.5 ($p$ <0.01). Wijffels, et al. (2020)[12] showed that the operatively treated group showed a significantly lower median HLOS (21 versus 23 days; $p$ = 0.028) in matched-pairs analysis. Zhang, et al. (2015)[14] showed that the surgical group had slightly shorter HLOS (38 days [33, 54.25] for the surgical group vs 60 days [38, 99.75] for the non-surgical group, P = .049).

## Mortality

Four studies in this systematic review suggested there was no significant difference in mortality between both groups. Dehghan, et al. (2022)[9] showed that there were 6 in-hospital deaths during the initial hospitalization (zero in the surgical group and 6 (6.0%) in the non-surgical group ($P$ = .01). Wijffels, et al. (2020)[12] showed that six patients died in hospital; two (9%) in the surgical group versus four (9%) in the non-surgical group ($p$ = 1.000). One patient in each group deceased due to the direct effects of flail chest, i.e., pulmonary insufficiency. The other four patients deceased due to traumatic neurological injuries. Xiao, et al. (2020)[13] showed that there were not remarkably differed between surgical and non-surgical patients in hospital mortality. In multiple rib fractures, hospital mortality was (0.9% *vs.* 1.2%, P=0.767). Whereas, in flail chest, hospital mortality (3.0% *vs.* 3.4%, P=0.872). In addition, Zhang, et al. (2015)[14] showed that there was no significant difference in mortality between two groups. The 24 patients in the surgical group survived, whereas 2 patients in the nonsurgical group died (P= .142).

## DISCUSSION

The purpose of this research was to review studies published after January of 2013 and up to December of 2023 that investigated the effectiveness of surgical and non-surgical management of rib fractures in chest trauma. According to reports, the prevalence of rib fractures ranges from 10 to 26%. Patients with blunt thoracic trauma from falls or motor vehicle collisions (MVC) are more likely to experience rib fractures than those with penetrating trauma. Solid organ injuries (SOI) and traumatic brain injury (TBI) are common injuries that accompany numerous rib fractures in patients, and these injuries increase the morbidity and mortality rate of these patients.[15]

The majority of individuals with rib fractures receive nonoperative care. Early intubation, intermittent positive pressure breathing, appropriate analgesia, and pulmonary toilet are currently considered standard practices in nonoperative management. This kind of management has been in place since the 1950s, and additional research conducted by Cullen et al. into the 1970s supported the concept.[6] Adequate analgesia and pulmonary secretion clearance are cornerstones of treatment for rib fractures. It has been demonstrated that, in particular, epidural analgesia reduces the incidence of complications and the requirement for artificial ventilation following rib fractures. According to recent research, patients with rib fractures may get more pain relief and consume less oral opiates when adjuvant ketamine is administered.[16] Whereas the goal of surgical procedures is to improve respiratory and ventilatory function while reducing pain by attempting to restore the anatomy of the chest wall. Surgical rib fixation with metal implants, which entails open reduction of fractured ribs and stabilization with plates and screws, is one of the most popular methods.[17]

Because of the ribs' distinct structure and generally lesser stress tolerance when compared to the other bones in the human body, rib fractures have been linked to a number of issues. Hemothorax and pneumothorax are two examples of consequences. Fractures on ribs one and two usually indicate more severe trauma, while fractures on ribs nine through twelve are frequently linked to damage to a nearby organ, such as the kidney or spleen. Furthermore, pneumonia—a comorbidity that considerably raises the risk of death for individuals with rib fractures—can result from rib fractures.[3] Four of five identified studies in this review suggested that the complications or adverse events, such as pneumonia, VAP, sepsis, empyema, atelectasis, delirium, and pleural effusion were similar between surgical and non-surgical groups. A previous study found the patients had less pneumonia in the surgical group, although we found no significant difference between the study groups. The incidence of pneumonia was reported in the literature as 38% in fail chest cases who were not treated with surgery.[18] The other study also have demonstrated that patients who have surgical rib fixation had improved results over those who receive conservative therapy in terms of length of stay in the intensive care unit, hospital LOS, and mortality. These are different to the results of our systematic review.

Previous studies have identified age of 65 years or more and the number of rib fractures as the most important risk factors for mortality. In a 10-year retrospective study of younger (18–64) and older (> 64) cohorts of patients with comparable

injury severity scores, Bulger and her associates reported a mortality rate of 10% for younger adults, and 22% for the older patients ($p < 0.01$). More recently, the Western Trauma Association guidelines published in 2017 have reported a mortality of 10% in young adults and of at least 20% in the elderly, defined by age 65 years or older, and continue to recommend that patients with more than two rib fractures older than 65 years be admitted to a monitored unit with intensive care unit (ICU) level.[15]

With a typical hospital stay of seven days and an incidence rate of 72 per 100,000 person-years, rib fractures are extremely common and cause significant burdens to society. Of these, 45% of patients are elderly. Despite being present in only 3.9% of the patients, rib fractures should be treated differently because of the high death rate and extended hospital stay. The mortality rate for individuals with rib fractures that necessitate hospital admission is now reported to be between 10 and 22% in the literature; older patients and patients with rib fractures appear to have greater rates.[2]

## CONCLUSION

The outcomes of surgical and non-surgical methods for the management of rib fractures are comparable in terms of complications, length of hospital stay, and mortality.

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