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Surgical stabilization of traumatic flail chest is superior to conservative management

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ABSTRACT A critical appraisal and clinical application of Marasco SF, Davies AR, Cooper J, et al. Prospective Randomized Controlled Trial of Operative Rib Fixation in Traumatic Flail Chest. *Journal of the American College of Surgeons*. 2013;216(5):924-932. doi: 10.1016/j.jamcollsurg.2012.12.024.

Keywords: *traumatic flail chest, rib fixation, conservative management*

Clinical Context

John Smythe [pseudonym], a 41-year-old Caucasian male presented to the emergency department (ED) after sustaining blunt trauma injury in a motor vehicle collision (MVC). His past medical history was unremarkable. Chest X-ray revealed the presence of a flail segment (i.e. three or more consecutive ribs fractured in more than 1 place producing a free-floating segment of chest wall5) with multiple rib fractures on the right of ribs 3 through 6; this was confirmed with computed tomography imaging. There was no evidence of severe traumatic brain injury (TBI), pneumothorax, spinal injury, liver or spleen lacerations, or cardiac contusions. The patient was admitted to the intensive care unit and mechanical ventilation was started. Conservative treatment for traumatic flail chest often involves mechanical ventilator management while the non-displaced fractures are allowed to heal on their own accord. This non-operative option versus surgical treatment was discussed with the Mr. Smythe and his wife. Given their Canadian citizenship, they were eager to minimize his ICU hospitalization time and expedite transfer of care due to lack of health insurance, while still having good health outcomes. Although non-operative measures are considered standard management, the team managing his care wondered what differences conservative versus surgical treatment would have on the patient's health outcomes.

Clinical Question

Is there a difference in outcomes between conservative versus surgical treatment of traumatic flail chest?

Research Article

Marasco SF, Davies AR, Cooper J, et al. Prospective Randomized Controlled Trial of Operative Rib Fixation in Traumatic Flail Chest. *Journal of the American College of Surgeons*. 2013;216(5):924-932. doi: 10.1016/j.jamcollsurg.2012.12.024.

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Related Literature

A literature review was conducted using PubMed Advanced Search with the search keywords “surgical”, “conservative”, and “flail” sorted by best match. This returned 31 results which were reviewed for relevance to the clinical question. References were also reviewed in articles on treatment of traumatic rib fractures on UpToDate and in a systemic review and meta-analysis on the topic to identify additional cited studies. 4 Overall, 5 retrospective cohort studies, 1 case-control study, and 3 prospective trial studies of interest were identified.

Of the retrospective cohort studies, Xu et al. examined 32 patients with severe flail chest who were treated with either surgical internal rib fixation or conservative treatments. They found that patients in the surgical group had shorter total mechanical ventilation time, decreased ICU stay, and decreased pulmonary infection rate.[8] Conversely, Naidoo et al. evaluated 293 flail chest patients and found a non-significant benefit to conservative management, however, this study suffered from some relatively significant limitations, including retrospective design and lack of case controls.[6] Additional studies by Granhed & Pazooki, Zhang et. al, and Gerakopoulos et al. supported the findings of Xu et al. with better outcomes favoring flail chest patients treated with surgical versus non-surgical intervention.[1,3,9]

Tanaka et al. was the first prospective controlled trial to evaluate operative versus non-operative treatment of severe flail chest patients. They randomly sorted 37 patients to surgical or internal pneumatic stabilization. Their results supported previous retrospective studies that surgical management has better short-term outcomes versus non-surgical treatment. They also found that patients with surgical stabilization could return to their prior employment quicker than those with non-operative treatment.[7] The second prospective trial by Granetzny et al. enrolled 40 flail chest patients. They concluded that stability could be achieved via surgical treatment without deformity of the chest wall, and that these patients have less restriction of pulmonary functions.[2] The trials by Tanaka et al. and Granetzny et al. were not chosen for this critical appraisal as they were more dated and had smaller sample sizes than the study that was ultimately selected.

This critical appraisal focuses on the prospective study by Marasco et al. which examined 46 patients on mechanical ventilation with traumatic flail chest. Patients who underwent surgical rib fixation experienced shorter ICU stay and decreased duration of noninvasive ventilation following extubation compared to patients treated with non-operative management.[5] It was ultimately selected for analysis because it was the most recent of the three prospective randomized studies, had the largest sample size, and was the most relevant to our clinical question and patient concerns.

Critical Appraisal

This prospective randomized controlled clinical trial was conducted at a single institute, The Alfred Hospital located in Victoria, Australia. Given the relatively rare frequency of these injuries, the recruitment process extended over four years to achieve the twenty-three patients required to be enrolled in each group to achieve a study power = 0.8. Forty-six patients with traumatic flail chest were enrolled in the study, with informed consent being obtained from next of kin initially and then from the patient once adequately recovered. Inclusion criteria were 1) ventilator dependency with no prospect of weaning within the next 48 hours; 2) presence of flail segment defined as ≥3 consecutive ribs fractured in ≥1 location. Patients were excluded if they were older than 80 years, had spinal injuries, open rib fractures with soiling or infection, sepsis, severe TBI, and/or uncorrected coagulopathy. Patients were randomized via a computer-generated code to either operative rib fixation or non-operative management. Power analysis showed that 23 patients per group were needed in each treatment group to detect a difference of 120 hours in duration of mechanical ventilation (providing a significance level of 0.05 and a power of 0.8). Blinding of neither the healthcare provider nor the patient was possible due to the nature of the treatment plans, although it is unclear if the research personnel were blinded to the results until data collection was completed. While it was necessary for the surgeon to be aware of the study’s interventions in order to perform the procedure, there may have been bias when investigators made decisions such as deciding whether to wean a patient off a ventilator or whether to discharge a patient from the ICU.

Patients in the operative group underwent surgery within 48 hours of enrollment. Only fractures of ribs 3 through 10 were fixed. Only 1 fracture per rib was fixed and ribs with single fractures were left untouched unless there was a gross deformity prompting intervention. All fractures were treated with fracture reduction followed by Inion resorbable plate and screw fixation to the external cortical surface of the rib. The level of training or experience of the performing surgeon was not described. This may be a

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confounding factor given the technical difficulty of the surgery and therefore increasing dependence on the skill of the performing surgeon (i.e. a senior trauma surgeon would likely have more experience in the surgery than a junior attending and would therefore be more proficient in the procedure, potentially producing better post-operative outcomes). Patients in the non-operative group were treated with mechanical ventilator management while the non-displaced rib fractures were allowed to heal of their own accord. Regardless of assigned group, weaning from mechanical ventilation was attempted via the same protocol. If needed, tracheostomy was also performed via the same protocol between the two groups. There is no mention as to what analgesia methods were utilized in either treatment group as the authors appropriately thought assessment of analgesic requirement would be confounded by the other injuries requiring pain control. All patients were seen in clinic for a 3-month follow-up, and subsequently sent a Health Status Questionnaire at 6 months to assess physical, emotional, and social functionality and limitations.

The primary outcomes of the study were duration of ICU stay and mechanical ventilation. Number of respiratory complications, rate of failed extubation, rate of tracheostomy, readmission to ICU, duration of hospital stay, and cost assessment were secondarily analyzed. Mean age was similar between the two groups, age 57.8 and 59.3 years in the operative and non-operative group respectively. This is similar to our patient as his age falls within the standard deviation of the study population. Gender was also distributed equally with 20 males and 3 females in each group.

Although there was no difference between the two groups in terms of duration of invasive ventilation, patients in the non-operative group were more likely to receive non-invasive ventilation and for a longer duration than those in the operative group. Patients in the non-operative group also experienced longer ICU stay (average 359 hours for the conservative group versus 285 hours for the surgical group) and higher rates of tracheostomy. Interestingly, despite the shorter ICU stay, there was no statistically significant difference in length of total hospital stay between the 2 groups. The authors debated whether this could be due to delay in transfer to rehabilitation hospitals, although they admit this would have affected both groups equally and therefore an unlikely explanation. However, the reduction in ICU stay in the operative group had significant cost savings, although this may be unique to each hospital billing system. No difference was demonstrated between the 2 groups for the subsequent 3 and 6-month follow-up assessments. One patient in the non-operative group died before discharge, and four patients in each treatment group were lost to follow-up (no details provided behind reason). This study has level 1 evidence per the Strength of Recommendation Taxonomy (SORT) criteria.

Clinical Application

This study concludes that patients with traumatic flail chest may benefit from surgical rib fixation by shorter duration of ICU stay, decreased need and shorter duration of non-invasive ventilation, and reduced rate of tracheostomy compared to non-operative management. Mr. Smythe met the inclusion criteria for this study and ultimately underwent successful surgical rib fixation. He was then transferred to a Canadian hospital once sufficiently stable for transfer and lost to follow-up. The Marasco et al. study is overall well-designed and answers our clinical question well, however, its applicability to broader patient populations is unclear as it was limited to only one institution. A larger multi-institutional study should be performed to provide further supporting evidence. The surgical technique is also technically challenging and the training of current and future surgeons should be emphasized.

An important consideration, especially for Mr. Smythe, was the cost of treatment. The significant reduction in overall cost due to decreased ICU stay seen in the patients treated with surgery could be relieve financial burden to not only patients, particularly those with poor or absent health insurance, but to the health system as well.

Learning points:

1. Surgical treatment of traumatic rib fixation reduces the duration of ICU stay and non-invasive mechanical ventilation compared to non-surgical management.

2. There is potential for considerable cost savings to the health system by treating flail chest patients with surgery.

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3. Although supported by previous studies, a larger multi-institutional study should be performed to further solidify the results and strength of recommendation.

References

1. Gerakopoulos E, Walker L, Melling D, Scott S, Scott S. Surgical Management of Multiple Rib Fractures Reduces the Hospital Length of Stay and the Mortality Rate in Major Trauma Patients: A Comparative Study in a UK Major Trauma Center. *Journal of Orthopaedic Trauma*. 2019;33(1):9-14.
2. Granetzny A, Abd El-Aal M, Emam E, Shalaby A, Boseila A. Surgical versus conservative treatment of flail chest. Evaluation of the pulmonary status. *Interactive CardioVascular and Thoracic Surgery*. 2005;4(6):583-587. doi: 10.1510/icvts.2005.111807
3. Granhed HP, Pazooki D. A feasibility study of 60 consecutive patients operated for unstable thoracic cage. *Journal of Trauma Management & Outcomes.* 2014;8(1). doi: 10.1186/s13032-014-0020-z
4. Kasotakis G, Hasenboehler EA, Streib EW, Patel N, Patel MB, Alarcon L, et al. Operative fixation of rib fractures after blunt trauma. *Journal of Trauma and Acute Care Surgery*. 2017;82(3):618-626. doi: 10.1097/ta.0000000000001350
5. Marasco SF, Davies AR, Cooper J, et al. Prospective Randomized Controlled Trial of Operative Rib Fixation in Traumatic Flail Chest. *Journal of the American College of Surgeons*. 2013;216(5):924-932. doi: 10.1016/j.jamcollsurg.2012.12.024.
6. Naidoo K, Hanbali L, Bates P. The natural history of flail chest injuries. *Chinese Journal of Traumatology*. 2017;20(5):293-296. doi: 10.1016/j.cjtee.2017.02.005
7. Tanaka H, Yukioka T, Yamaguti Y, Shimizu S, Goto H, Matsuda H, Shimazaki S. Surgical Stabilization of Internal Pneumatic Stabilization? A Prospective Randomized Study of Management of Severe Flail Chest Patients. *The Journal of Trauma: Injury, Infection, and Critical Care*. 2002;52(4):727-732. doi: 10.1097/00005373-200204000-00020
8. Xu J, Qiu P, Yu R, Gong S, Ye Y, Shang X. Better short-term efficacy of treating severe flail chest with internal fixation surgery compared with conservative treatments. *European Journal of Medical Research*. 2015;20(1). doi: 10.1186/s40001-015-0146-0
9. Zhang X, Guo Z, Zhao C, Xu C, Wang Z. Management of patients with flail chest by surgical fixation using claw-type titanium plate. *Journal of Cardiothoracic Surgery*. 2015;10(1). doi: 10.1186/s13019-015-0363-1

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