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Does surgical fixation improve pain and quality of life in patients with non-flail rib fractures? A best evidence topic review

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Abstract

A best evidence topic in thoracic surgery was written according to a structured protocol. The question addressed was 'does surgical stabilization of rib fractures improve pain and quality of life in patients with non-flail rib fractures?'. Altogether >300 papers were found using the reported search, of which 6 represented the best evidence to answer the clinical question. The authors, journal, date and country of publication, patient group studied, study type, relevant outcomes and results of these papers were tabulated. Whilst several non-randomized cohort studies demonstrate superior pain and quality of life outcomes with surgical fixation as compared to conservative management, this is not replicated by the findings of a recent randomized trial which found worse pain, but early return to work in those treated with surgical stabilization of rib fractures. Given this, clinicians will need to carefully consider the indications for treating painful non-flail rib fractures as surgical fixation represents a reasonable treatment option in only appropriately selected candidates.

Keywords: Review • Rib fracture • Non-flail • Fixation • Surgical stabilization of rib fractures • Quality of life • Pain

INTRODUCTION

A best evidence topic was constructed according to a structured protocol. This is fully described in the *ICVTS* [1].

THREE-PART QUESTION

Does [surgical fixation] improve [pain and quality of life] in patients with [non-flail rib fractures]?

CLINICAL SCENARIO

A 38-year-old male patient is involved in a high-speed motor vehicle accident and is admitted to the trauma ward. His CT chest demonstrated fractures of ribs 3, 4 and 6 on the right side, with significant displacement. There is no haemothorax or pneumothorax and he had no other injuries. On the morning ward round, he reports severe thoracic pain on breathing, coughing and movement despite receiving multimodal oral analgesia and intravenous morphine patient-controlled analgesia. His oxygen saturations are 99% on room air. Your registrar suggests that the thoracic team consider surgical fixation of his rib fractures to treat his pain and optimize his recovery. You proceed to check the literature for evidence.

SEARCH STRATEGY

Medline was searched using the PubMed database, with the following search terms: [(rib fractures) AND (surgical fixation OR surgery OR operative management OR Open reduction internal fixation OR ORIF) AND (analgesia OR nonoperative management OR conservative management) AND (outcomes OR pain scores OR quality of life OR complications OR length of stay)].

SEARCH OUTCOME

At the time of writing, 310 papers were found using the reported search. From these, 6 papers were identified that provided the best evidence to answer the question. These are presented in Table 1.

RESULTS

Girsowicz *et al.* [2] published a best evidence topic review in 2012 that synthesized the results of 9 studies addressing whether surgical stabilization of non-flail rib fractures improves outcomes as compared to conservative management. Collectively the studies suggested that surgical fixation is safe and effective at treating pain and disability, however the studies were limited to cohort

Table 1: Summary of studies

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Girsowicz *et al.* (2012), Interact CardioVasc Thorac Surg [2] [R] Best Evidence Topic	Critical synthesis of 9 studies (comprising level 3 and level 4 evidence)	Surgical fixation is safe and effective at treating pain and disability	Studies demonstrated: 1. Reduced pain (McGill pain questionnaire) 2. Improved quality of life (RAND 36-Item Health Survey) 3. Reduced socio-professional disability	Selected studies represent low levels of evidence, including cohort studies with no comparison group and case reports Authors acknowledge the absence of prospective trials at time of writing
Marasco *et al.* (2022), J Trauma Acute Care Surg [3] Prospective randomized trial (level 2)	124 patients 61 randomized to operative management 61 randomized to nonoperative management	McGill Pain Rating Index, median (IQR)	3 months: Operative: 7.7 (1.7–19.8) Nonoperative: 3.6 (0.7–15.3) *P* = 0.17 6 months: Operative: 2.6 (0–17.1) Nonoperative: 0 (0–5.7) *P* = 0.04	Inclusion criteria are non-ventilated patients with at least 3 consecutive rib fractures High number of cross overs
		Short Form 12 physical component score, mean (SD)	3 months: Operative: 42.9 (10) Nonoperative: 44.4 (9.6) *P* = 0.43 6 months: Operative: 44.4 (11.5) Nonoperative: 47.6 (9.5) *P* = 0.16	
		Short Form 12 mental component score, mean (SD)	3 months: Operative: 51.8 (9.5) Nonoperative: 50.9 (10.0) *P* = 0.66 6 months: Operative: 51.6 (10.1) Nonoperative: 50.5 (11.9) *P* = 0.65	
		Return to work, %	3 months: Operative: 48.7% Nonoperative: 40% *P* = 0.42 6 months: Operative: 65.7% Nonoperative: 36.8% *P* = 0.01	
Pieracci *et al.* (2020), J Trauma Acute Care Surg [4] Prospective controlled trial (level 2)	110 patients. 23 selected randomization, 87 selected observation 51 patients in total underwent SSRF within 72 h of admission. 59 nonoperative	Numeric pain scores	2 weeks: SSRF: 2.9 Nonoperative: 4.5 *P* < 0.01 4 weeks: SSRF: 2.4 Nonoperative: 3.3 *P* = 0.03 8 weeks: SSRF: 1.5 Nonoperative: 3.3 *P* = 0.02	Only a small subset of the total patients were randomized. Potential allocation bias Loss to follow-up limiting the power of the analysis at longer durations of follow-up Potential institutional bias due to variability in analgesic regimens
		Narcotic consumption (narcotic equivalents)	2 weeks: SSRF: 0.5 Nonoperative: 1.2 *P* = 0.05 4 weeks: SSRF: 0.3	

Continued

Table 1: Continued

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
			Nonoperative: 1.5 *P* = 0.13	
			8 weeks: SSRF: 0.2 Nonoperative: 0.5 *P* = 0.08	
		Respiratory disability-related quality of life at 2 weeks	2 weeks: SSRF: 21 Nonoperative: 25 *P* = 0.03	
			4 weeks: SSRF: 17 Nonoperative: 22 *P* = 0.07	
			8 weeks: SSRF: 16 Nonoperative: 10 *P* = 0.27	
		Spirometry values	2 weeks: SSRF: 87.0% Nonoperative: 90.0% *P* = 0.41	
			4 weeks: SSRF: 100.0% Nonoperative: 100.0% *P* = 0.72	
			8 weeks: SSRF: 100.0% Nonoperative: 97.5% *P* = 0.17	
		Pleural space complications (tube thoracostomy or surgery for retained haemothorax or empyema >24 h from admission)	SSRF: 0% Nonoperative: 10.2% *P* = 0.02	
Li *et al.* (2020), *J Thoracic Dis* [5] Prospective cohort study (level 3)	98 patients with non-flail rib fractures 66 underwent MIS fixation 32 matched controls received nonoperative treatment	Pain index as measured by VAS at time of discharge	MIS: 3 Nonoperative: 6 *P* < 0.001	Only 75.8% of surgically treated patients and 75% of nonoperative patients completed follow-up, reducing the power of the analysis
		Lung function at time of discharge	Vital capacity: MIS: 42.1% Nonoperative: 35.3% *P* = 0.027	
			FEV1: MIS: 44.2% Nonoperative: 35.9% *P* = 0.027	
			PEF: MIS: 21.2% Nonoperative: 19.6% *P* = 0.127	
		Duration of pain [time required for complete disappearance of chest	MIS: 1.0 months Nonoperative: 1.9 months *P* < 0.001	

Continued

Table 1: Continued

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
		pain or for only occasional pain (VAS < 2) to remain]		
		Duration of chest discomfort	MIS: 1.1 months Nonoperative: 2.9 months *P* < 0.001	
		Time to return to daily self-care	MIS: 0.9 months Nonoperative: 1.2 months *P* < 0.001	
		Time to return to mental labour	MIS: 1.9 months Nonoperative: 2.8 months *P* < 0.001	
		Time to return to moderate–severe physical labour	MIS: 5.4 months Nonoperative: 5.8 months *P* = 0.001	
Zhang *et al.* (2019), World J Clin Cases [6] Prospective cohort study (level 3)	78 patients enrolled (with 3 or more severely displaced fractures, excluding flail pattern) 39 surgical fixation 39 nonoperative management	Digital pain score (from 0 to 10) at 72 h, 1 week, 2 weeks, 4 weeks, 6 weeks, 3 months and 6 months	Mean pain scores for surgical group were significantly lower than nonoperative group at every timepoint ($F = 84.830$, $P < 0.001$).	A variety of analgesic regimens were used in the conservative group. May introduce inter-subject variability
		Quality of life (SF-36 score)	3 months: Surgical: 393.57 ± 68.51 Nonoperative: 335.12 ± 83.11 *P* = 0.001	
			6 months: Surgical: 493.07 ± 69.97 Nonoperative: 363.64 ± 72.02 *P* < 0.001	
		Return to pre-injury level of work at 6 months	Surgical: 94.87 Nonoperative: 64.10% *P* < 0.05	
Qiu *et al.* (2016), Indian J Surg [7] Retrospective cohort study (level 3)	162 patients in total In non-flail subgroup of 124 patients: 65 surgical management 59 nonoperative management	Mean hospital stay (days)	Surgical: 11.09 ± 1.88 Nonoperative: 15.93 ± 2.75 *P* = 0.013	Potential selection bias due to non-randomized retrospective design
		VAS pain score at 2 months	Surgical: 1.45 ± 0.65 Nonoperative: 4.50 ± 1.05 *P* = 0.003	
		Return to normal activity (days)	Surgical: 28.18 ± 9.21 Nonoperative: 42.42 ± 10.12 *P* = 0.028	
		Fracture healing	Surgical: 98.46% Nonoperative: 93.22% *P* = 0.154	
		Atelectasis	Surgical: 6.15% Nonoperative: 22.03% *P* = 0.010	
		Pulmonary infection	Surgical: 4.62% Nonoperative: 16.95% *P* = 0.025	

CT: computed tomography; FEV1: forced expiratory volume in 1 second; IQR: interquartile range; MIS: minimally invasive surgery; PEF: peak expiratory flow; SD: standard deviation; SSRF: surgical stabilization of rib fractures; VAS: visual analogue scale.

studies and case reports, with no prospective trials published at the time of writing.

Marasco *et al.* [3] performed a prospective multicentre randomized trial of 124 patients who were not ventilator dependent and had at least 3 consecutive rib fractures, randomized to either surgical stabilization of rib fractures (SSRF) or conservative management with oral and parenteral analgesia. Patients were included if they had either ongoing pain or fractures that were displaced by at least 1 rib width. The intention-to-treat analysis showed no significant differences in McGill Pain Rating Index at 3-month follow-up, and the operative group had higher pain scores at 6 months. Whilst there were no significant differences in physical and mental disability at 3 and 6 months, a significantly greater proportion of operative patients returned to work at 6 months. Postoperative complications included pneumonia in 1 patient, haemothorax in 1 patient, reintubation in 1 patient and ongoing pain requiring plate removal in 1 patient at 6 months. These cannot be disregarded as additional factors that may have impacted patients' quality of life postoperatively. Eighteen of the 63 patients (29%) assigned to conservative management crossed over to surgical fixation predominately due to worsening pain. Ten of 61 (16%) patients assigned to SSRF did not receive surgery owing to an improvement in their clinical condition. Patients who crossed over from the nonoperative to the operative arm had significantly higher pain indices at 3 months and lower mental component scores at 6 months, conversely those who crossed over from operative to nonoperative management had significantly lower pain scores at 3 months. The high number of crossovers limits the real-world generalizability of this study. There were also a range of fixation techniques and analgesia regimens utilized as per clinician preference, which is a potential source of variability in the results of this study, as the fixation technique may influence postoperative pain scores. Ultimately, based on the data, the authors could not recommend surgical fixation of simple rib fractures over conservative management.

In another prospective multicentre controlled trial, Pieracci *et al.* [4] compared pain outcomes and quality of life between surgical and conservative management. Patients were included only if they had at least 3 ipsilateral, bicortical, severely displaced fractures of ribs 3–10. A total of 110 patients were enrolled; however, randomization was subject to patient preference. Twenty-three patients selected randomization whilst 87 selected observation, which enabled them to decide on surgical or nonoperative management after an informed discussion with the treating team. Randomized patients were allocated to either operation or conservative management by a block-randomization schema. Surgically managed patients had significantly lower numeric pain scores at 2, 4 and 8 weeks of follow-up. There was a trend towards lower narcotic consumption in the surgical group at 2 weeks ($P = 0.05$). Respiratory Disability-Related Quality of Life was significantly superior in the surgical group at 2 weeks, but equivocal at 4 and 8 weeks. Pleural space complications were significantly lower in the operative group. In this study, loss to follow-up is likely to have impacted the power of the analysis at later stages of follow-up. Whilst there were no significant differences in baseline pain scores between randomized and observational groups, the allocation bias introduced by patient preference may have influenced self-reported pain scores at follow-up. In addition, whilst some elements of the surgical fixation technique were standardized across centres, the differences in implant system and surgical operators at different centres could have influenced pain outcomes. Notwithstanding these limitations, this study supports surgical management over conservative management.

Li *et al.* [5] conducted a prospective cohort study involving 98 patients with non-flail fractures of at least 3 consecutive ribs, with 66 undergoing surgical fixation and 32 matched controls receiving conservative treatment. Surgically treated patients had significantly lower Visual Analogue Scale pain indices at discharge, and significantly shorter duration of pain. Patients in the operative group also returned to self-care, mental labour and physical labour significantly faster than the control group; however, these data were acquired via telephone interview rather than a validated questionnaire. At discharge, vital capacity and FEV1 was significantly superior in the surgical group. Approximately 25% of patients were lost to follow-up in both groups, which may have influenced the findings of this study. Overall, Li *et al.* demonstrated superior pain and quality of life outcomes with surgical fixation of non-flail rib fractures versus conservative therapy alone; however, this was a non-randomized single-centre study with small patient numbers, limiting its generalizability.

Zhang *et al.* [6] performed a prospective cohort study of 78 patients with at least 3 non-flail rib fractures with severe displacement, comparing operative and nonoperative modalities. The method of allocation to treatment groups was not described by the authors; however, there were no significant differences in baseline characteristics or preoperative pain scores between them. Surgically treated patients had significantly lower digital pain scores at every follow-up interval from 3 days to 6 months. They also had significantly higher quality of life scores at 3 and 6 months, and higher rates of return to work at 6 months. There was no standard analgesic regimen in the nonoperative group, and patients received a combination of NSAIDs, opioids and loco-regional anaesthesia. This inter-subject variability could have affected the reported pain scores in the nonoperative group. Although this study demonstrated superior pain control and quality of life outcomes after surgical fixation versus conservative management, this was again a non-randomized single-centre study with a small sample size.

Qiu *et al.* [7] retrospectively compared multiple outcomes between surgical and non-surgical management in a cohort of 162 patients, of which 142 had non-flail fractures. There were no significant differences in baseline characteristics between groups. Surgically treated patients had significantly shorter durations of hospital stay, lower VAS scores at 2-month follow-up, shorter time to return to normal activity and lower rates of atelectasis and pulmonary infection. This retrospective study did not utilize any validated questionnaires to assess the quality of life outcomes in each subgroup and did not specifically look at analgesia requirements. Overall, the study demonstrated considerable advantages of surgical fixation over conservative management.

CLINICAL BOTTOM LINE

Whilst several small non-randomized cohort studies support the use of surgical fixation for improving pain and quality of life outcomes in patients with non-flail rib fractures, the findings of the most recent randomized trial by Marasco *et al.* suggest that SSRF is likely to improve ability to return to work in only selected patients, as the study seemed to suggest that there was no benefit for SSRF for both those individuals with the highest and those with the lowest pain scores. In several of the cited cohort studies,

the use of one-dimensional pain indices such as the digital pain scale and visual analogue scale, rather than comprehensive pain assessment tools, further limits their generalizability to real-world patients. The results of the ongoing FixCon trial (Early fixation versus conservative therapy of multiple, simple rib fractures) [8], in which thoracic pain during different activities is a secondary outcome, will shed further light on this controversial subject. This study will also analyse thoracic injury-related and surgery-related complications in detail, which are important factors for patient quality of life that have not been thoroughly addressed by the existing trials. Whilst awaiting the results of this trial, we recommend clinicians exercise best judgement and informed decision-making when treating painful non-flail rib fractures, with surgical fixation representing a reasonable treatment option only in highly selected candidates and offering poor relief of long-term pain and disability for those with the worst pain.

Conflict of interest: none declared.

Reviewer information

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