IS RIB FIXATION WORTHWHILE AND WHAT ABOUT THE STERNUM?



Miss Kate Martin.

General and Trauma Surgeon.

Alfred Hospital.

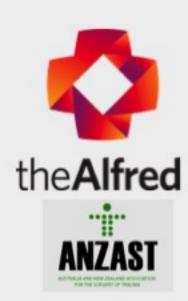
Injury 2016. 4th August.



Overview

- Flail Chest Injury overview
- Non-operative management of severe chest injury
- Evolution of rib fixation
- Modern methods
- Evidence
- And what about the sternum?
- Summary





Rib fractures:

10 to 39% of patients with blunt chest trauma

Flail Injury:

- 2.5-5.8% patients with rib fractures
- Defined as 3 or more consecutive ribs fractured in two or more places each
- May be clinically evident by paradoxical chest wall movement with spontaneous ventilation
- ·Is a marker of severe chest injury

Liman et al 2003. Eur J Card Thor Surg. Sirmali et al 2003. Eur J Card Thor Surg. Civil 1999. Aust NZ J Surg.

Cameron et al 1996. Aust NZ J Surg. Ziegler and Agarwal 1994. J Trauma.



Etiology:

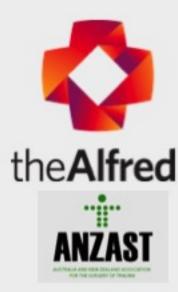
- •MVA (79%)
- Domestic falls (16%)
- Other blunt mechanisms (5%)

Associated injuries:

- •Pulmonary contusion: 40-60%
- •HTHx and/or PTHx: 70%
- Head injury: 15-66%
- Skeletal injury: 64%
- Abdominal injury: 34%



Cataneo et al. Cochrane Database of Systematic Reviews 2015. (7). Dehghan N, et al. J Trauma Acute Care Surg. 2014:76(2);462-68.

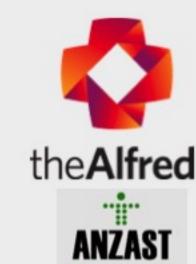


Pathophysiology:

- Failure of mechanical ventilation
- Increased work of breathing
- Impaired gas exchange in presence of pulmonary contusions

Complications:

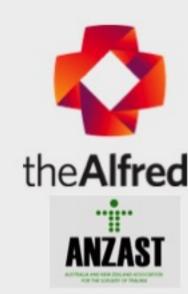
- Increased incidence of respiratory failure requiring mechanical ventilation
- Prolonged duration of mechanical ventilation and thus ICU stay
- Pneumonia
- Need for tracheostomy
- Chronic chest wall deformity and loss of respiratory volume
- Chronic chest wall pain



Am Surg 2010. Nirula & Mayberry. Am Surgeon 2014. Vana *et al.*

Morbidity and mortality are multifactorial:

- Injury Severity Score (ISS)
- Age
- Number of rib fractures
- Presence of associated chest injuries
- pulmonary contusion
- Presence of other injuries outside the chest
- Severe head injury
- Co-morbidities



Flail Chest Injury Mortality

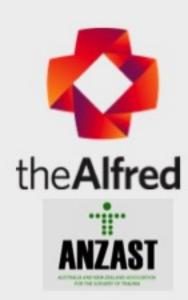
Rib Fracture Fixation: Controversies and Technical Challenges

RAMINDER NIRULA, M.D.,* JOHN C. MAYBERRY, M.D.+

From the *Department of Surgery, Burns/Trauma/Critical Care Section, University of Utah, Salt Lake City, Utah and the †Department of Surgery, Trauma/Critical Care/Acute Care Surgery, Oregon Health and Science University, Portland, Oregon

Age 18-44: 9.6%

Age >84yo: 22.5%







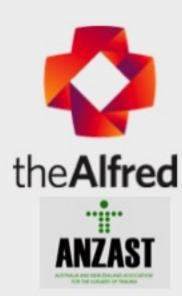
Management of Flail Chest: a Historical Perspective

Early 20th century:

- Towel-clip devices, traction
- Tapes, sandbags and other splints

Mechanical Ventilation:

- Revolutionised the mangement of ventilation failure
- •Focus on chest wall fracture management shifted to treatment of the underlying pulmonary contusion
- Advances in mechanical ventilation and anaesthesia have contributed to improved survival



Internal Fixation of Rib Fractures

First described over 50 years ago:

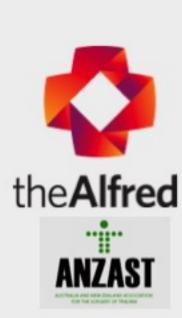
• 1950's: wire suture fixation and intramedullary wire fixation

Potential use recognised in the setting of:

- Prolonged mechanical ventilation
- Severe chest wall defects and deformity
- Cases where thoracotomy was indicated for other reasons

Increased use over the last 10-15 years associated with:

- Recognition of significant short and longer term complications of flail chest injury
- Initially due to advances in the development of devices used primarily for the internal fixation of boney fractures elsewhere in the
- Rib-specific devices have now been developed



Randomised Trials

The Journal of TRAUMA® Injury, Infection, and Critical Care

Surgical Stabilization of Internal Pneumatic Stabilization?

Flai

Hideha Prospective Randomized Controlled Trial of Operative Rib Fixation in Traumatic Flail Chest

dot: 10, 1510.

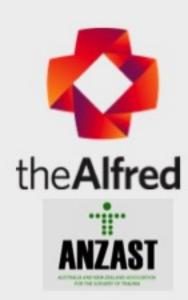
Silvana F Marasco, MSurg, FRACS, Andrew R Davies, FRACP, FCICM, Jamie Cooper, FRACP, FCICM, MD, Dinesh Varma, FRANZCR, Victoria Bennett, BNSc, CCRN, Rachael Nevill, BNuss, Geraldine Lee, MPhil, Michael Bailey, PhD, MSc (statistics), Mark Fitzgerald, FACEM

Surgical versus conservative treatment of flail chest. Evaluation of the pulmonary status

Andreas Granetzny^a, Mohamad Abd El-Aal^b, ElRady Emam^b, Alaa Shalaby^c, Ahmad Boseila^{a,*}

*Department of Thoracic Surgary, Klinikum Evangelisches Krankenhaus Duisburg-Nord, Fahrner Str. 133, Duisburg 47169, Germany *Department of Cardiotheracic Surgary, Faculty of Medicine, Zagazig University, Catro, Egypt *Department of Chest Medicine, Faculty of Medicine, Cairo University, Cairo, Egypt

Received 21 April 2005; received in revised form 28 July 2005; accepted 2 September 2005



Tanaka et al, 2002. Japan.



Aim: Evaluate clinical efficacy of surgical

stabilisation compared to internal pneumatic

stabilisation

Method: Judet struts

Patients: 18 operative, 19 non-operative

Outcomes: Clinical benefits

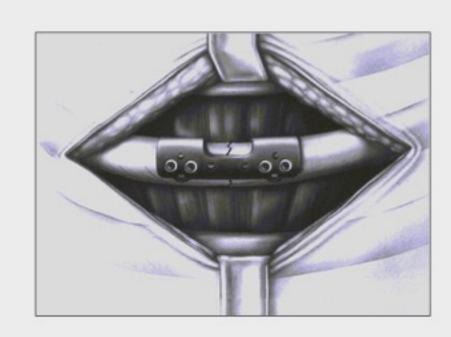
Financial savings

Improved return to work and activity

Conclusion: Judet strut stabilisation may be preferentially

applied for severe flail chest patients in whom

prolonged ventilation is expected





Granetzny et al, 2005. Egypt.



Aim: Compare two methods of chest

wall stabilisation via

conservative packing and strapping

and surgical fixation

Method: Kirschner and stainless steel

wires

Patients: 20 operative, 20 non-operative

Outcomes: Clinical benefits

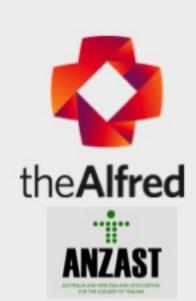
Decreased LOS

Conclusions: Surgical fixation allows for

stability without

deformity









Aim: To investigate the effect of ORIF of rib f

racture on mechanical ventilation time and

ICU stay.

Method: Inion resorbable (Inion OTPS) plates and

bicortical screws

Patients: 23 operative, 23 non-operative

Outcomes: Clinical benefits

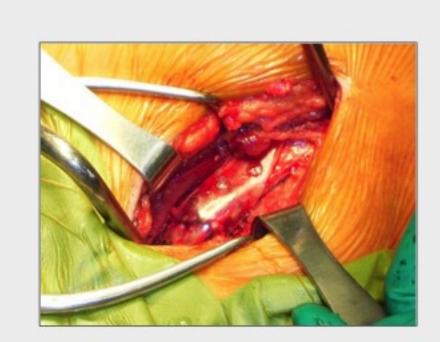
Financial benefits

Conclusions: Clinical benefits and cost savings for

operative fixation of flail rib fractures

Further trials required into non-ventilator

dependent patients





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Subsequent Publications



Cochrane Database of Systematic Reviews

Surgical versus nonsurgical interventions for flail chest (Review)

Cataneo AJM, Cataneo DC, de Oliveira FHS, Arruda KA, El Dib R, de Oliveira Carvalho PE

- Cochrane review 2015
 - Meta-analysis of the only 3 randomised trials
 - 123 patients in total
 - Surgical v's non-surgical treatment of flail chest
 - No evidence that surgery improves mortality
 - '...there is some evidence that surgical intervention is superior to non-surgical intervention in the tratment of flail chest.'

Cataneo et al. Cochrane Database of Systematic Reviews 2015. (7).

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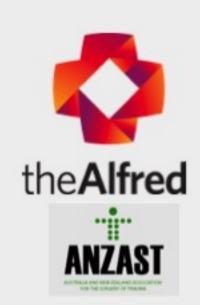
Subsequent Publications

ORIGINAL ARTICLE

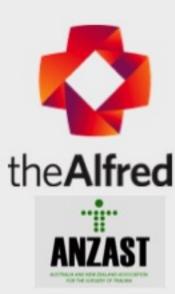
Flail chest injuries: A review of outcomes and treatment practices from the National Trauma Data Bank

Niloofar Dehghan, MD, Charles de Mestral, MD, PhD, Michael D. McKee, MD, Emil H. Schemitsch, MD, and Avery Nathens, MD, MS, PhD, MPH, Toronto, Ontario, Canada

- National Trauma Data Bank 2014
 - Retrospective analysis 2007-2009
 - Review of practice and outcomes in 3,467 patients
 - 59% required intubation (15% of all patients had a severe HI)
 - Mortality: 16%
 - Rib fixation in only 0.7% (24 patients)
 - Patients with severe TBI- significantly higher rates of complications and poor outcomes



- Based primarily on non-operative management
- Treatment directed toward maintenance of good ventilation
- Endotracheal intubation and controlled ventilation (IPPV): Pneumatic Internal Stabilisation (PIS)
- Analgesia
- Pulmonary toilet
- Physiotherapy
- Nutrition
- Mobilisation
- Most patients do not require surgical intervention



National Guidelines Recommend Rib Fixation in Selected Patients



Insertion of metal rib reinforcements to stabilise a flail chest wall

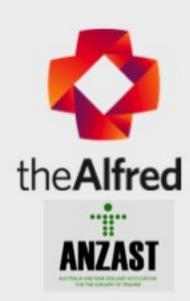
Issued: October 2010

NICE interventional procedure guidance 361 www.nice.org.uk/ipg361 'Current evidence on insertion of metal rib reinforcements to stabilise a flail chest wall is limited in quantity but consistently shows efficacy. In addition there are no major safety concerns....'

NHS Evidence has accredited the process used by the NICE Interventional Procedures Programme to produce interventional procedures guidance. Accreditation is valid for three years from January 2010 and applies to guidance produced since January 2009 using the processes described in the 'Interventional Procedures Programme: Process guide, January 2009' and the 'Interventional Procedures Programme: Methods guide, June 2007'



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National Guidelines Recommend Rib Fixation in Selected Patients

Management of pulmonary contusion and flail chest: An Eastern Association for the Surgery of Trauma practice management guideline Bruce Simon, MD, James Ebert, MD, Faran Bokhari, MD, Jeannette Capella, MD, Timothy Embor, MD, Thomas Hayward, III, MD, Aurelio Rodriguez, MD, and Lou Smith, MD		
BACKGROUND	The purpose of this updated EAST practice management	rulmonary contusion and flail chest (PC-PC) as a combined, complex injury and morbidity of this entity have not improved during the last three decades, out guideline was to present evidence-based recommendations for the treat-
METHODS	ment of PC-PC. A query was conducted of MEDLINE, Embase, PubMed and Cachrane databases for the period from January 1986 through June 30, 2011. All evidence was reviewed and graded by two members of the guideline committee. Guideline formulation was performed by committee consensus. Of the 218 articles identified in the search, 129 were deemed appropriate for review, grading, and inclusion in the guideline. This	
PRINCES EXECUTES A		
CONCLUSION:	fusion. Obligatory mechanical ventilation in the abse- and aggressive chest physiotherapy should be applied preferred mode of analgesia delivery in severe flail ch- and may be appropriate in certain situations when epic A trial of mask continuous positive airway pressure shi requiring mechanical ventilation should be supported	stricted but should be resuscitated to maintain signs of adequate tissue per- nce of respiratory failure should be avoided. The use of optimal analgesia to minimize the likelihood of respiratory failure. Epidural catheter is the lest injury. Paravertebral analgesia may be equivalent to epidural analgesia lural is contraindicated. build be considered in alert patients with marginal respiratory status. Patients in a manner based on institutional and physician preference and separated
KEY WORDS:	be provided. High-frequency oscillatory ventilation should him a ventilation may also be considered in severe unit. Surgical fixation of flail chest may be considered in a considered in a constantly is required for other reasons. Self-activating matternes and should be considered where feasible. Steroids should not be used in the therapy of pulmonary	the considered for patients failing continuous positive airway pressure should be considered for patients failing conventional ventilatory modes. Independent ideral pulmanary contusion when shunt cannot be atherwise corrected, asses of severe flail chest failing to wean from the ventilator or when there-ided in the sentiator or when there-ided in the sentiator of which in the sentiator of the s
Thoracic injury and the ensuing complications are responsible for as much as 25% of blunt trauma mortality. Pulmonary contusion (PC) in turn is the most common injury identified		in the setting of blunt thoracic trauma, occurring in 30% to 75% of all cases. I isolated PC may occur consequent to explosion injury, but most patients with multiple injuries have concurrent injury to the chest wall. Conversely, flail ches (PC), the most severe form of blunt chest wall injury with mortality rates of 10% to 20%, is typically accompanied by significant PC. While injuries to the chest wall itself may
Address for reprints: B.	Revised: August 1, 2012. Accepted: August 1, 2013. Frauma and Critical Care (B.S., T.E.). University of teal Conter. Worsessler, Massachusetts. Department of the Conter. Worsessler, Massachusetts. Department of the Conter. Worsessler, Massachusetts. Department of the Conter. Care (F.B.), John H. Strogen Jr. Hospital organ. and Critical Care (F.B.), John H. Strogen Jr. Hospital Center (J.C.), in Indiana University/Withhard Memorial Hospital (TH), Sinai Hospital of Baltimore (A.R.). Baltimore, Maryland: by (L.S.), University of Texas.	rarely be the primary cause of death in patients with multiple injuries, they greatly impact management and the eventua survival of these individuals." In some series, most of the severe lung contusions that require ventilatory support (85%) are associated with severe bony chest wall injury. Despite the prevalence and recognized association of PC and flail chest (PC-FC) as a complined, complex injury patient with interrelated pathophysiology, the mortality and short term morbidity of this entity have not improved during the las
DOI: 10.1097/TA.06013:	2182701964	three decades. Advances in diagnostic imaging and critical

'....this modality may be considered in cases of severe FC (flail chest) failing to wean from the ventilator or when thoracotomy is required for other reasons' 'The patient subgroup that would benefit from early "prophylactic" fracture fixation has not been identified'



Current Operative Management

- Continues to be performed by a small, though increasing number of surgeons in Australia and New Zealand
- Aim to fix ribs early to limit ventilation time
- Patients referred early for consideration for operative intervention for rib fractures include:
- All patients with flail chest injury, particularly those with a clinically evident flail
- Patients with severely displaced rib fractures
- Patients with CT-evidence of lung entrapment between ends of fractured ribs
- Development of rib-specific fixation devices has facilitated the management of more posterior fractures





And What About The Sternum?

- Surgical stabilisation of flail chest injuries includes stabilisation of fractured structures-
 - Ribs
 - Costal cartilage
 - Sternum
- Isolated sternal fracture is generally not associated with significant morbidity or mortality
- Etiology is the same as for flail chest injury- predominantly MVA, followed by falls from standing
- Increasing thoracic fracture burden is associated with worse outcomes
- Aims of surgical fixation are the same for flail rib fractures
 - Stabilisation of the chest wall to allow for effective mechanical ventilation
 - Severely displaced fractures (especially if poor response to analgesia)

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And What About the Sternum?

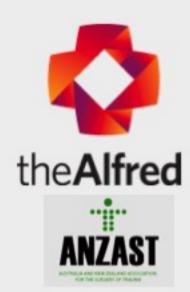
Association for Academic Surgery

Sternal fracture—an analysis of the National Trauma Data Bank

D. Dante Yeh, MD,* John O. Hwabejire, MD, MPH, Marc A. DeMoya, MD, Hasan B. Alam, MD, David R. King, MD, and George C. Velmahos, MD, PhD

Division of Trauma, Emergency Surgery, and Surgical Critical Care, Department of Surgery, Massachusetts General Hospital, Harvard Medical School

- Analysis of National Trauma Data Bank 2013
 - 2007-2010
 - Sternal fracture present in 3.7% of patients after MVA
 - Isolated in 13.2%
 - Associated rib # in 69.9%
 - Associated pulmonary contusions in 29.5%
 - Outcomes (including Blunt Cardiac Injury) determined by associated injuries



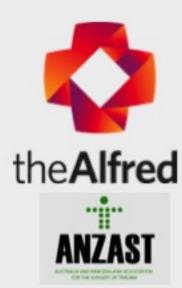
And What About the Sternum?

ORIGINAL ARTICLE

Sternal fracture: Isolated lesion versus polytrauma from associated extrasternal injuries—Analysis of 1,867 cases

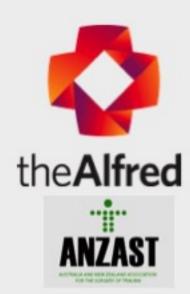
David D. Odell, MD, MMSc, Kobi Peleg, PhD, MPH, Adi Givon, BS, Irina Radomislensky, BS, Ian Makey, MD, Malcolm M. DeCamp, MD, Richard Whyte, MD, MBA, Sidhu P. Gangadharan, MD, Robert L. Berger, MD, and the Israeli Trauma Group*, Boston, Massachusetts

- Retrospective analysis of Israeli National Trauma Registry 1997-2008
 - 1,867 patients
 - Incidence of BCI 1.8%
 - Isolated sternal fracture in 26.4%- identified as mild injury.



Summary

- Severe chest wall injury can result in significant morbidity and mortality
- Most patients with severe chest wall injury can be managed non-operatively
- Evidence suggests that rib fixation is probably beneficial in selected patient groups
- Aim of fixation is to allow for effective mechanical ventilation, and to minimise complications of pain and prolonged ventilation
- Sternal fractures are treated as part of the chest wall injury





Thank-you! ka.martin@alfred.org.au

