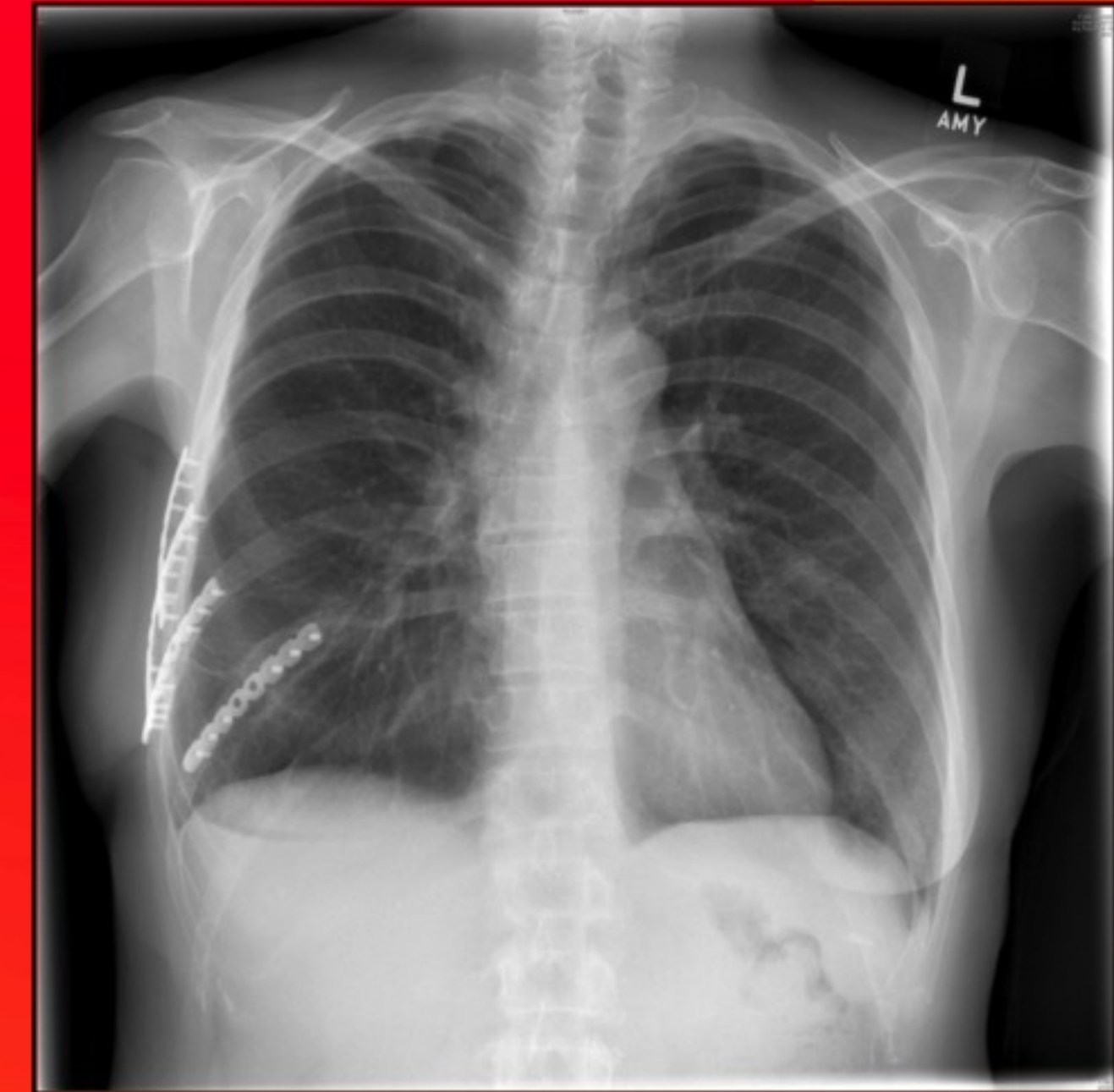


IS RIB FIXATION WORTHWHILE AND WHAT ABOUT THE STERNUM?



Miss Kate Martin.
General and Trauma Surgeon.
Alfred Hospital.
Injury 2016. 4th August.



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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



Flail Chest Injury

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.

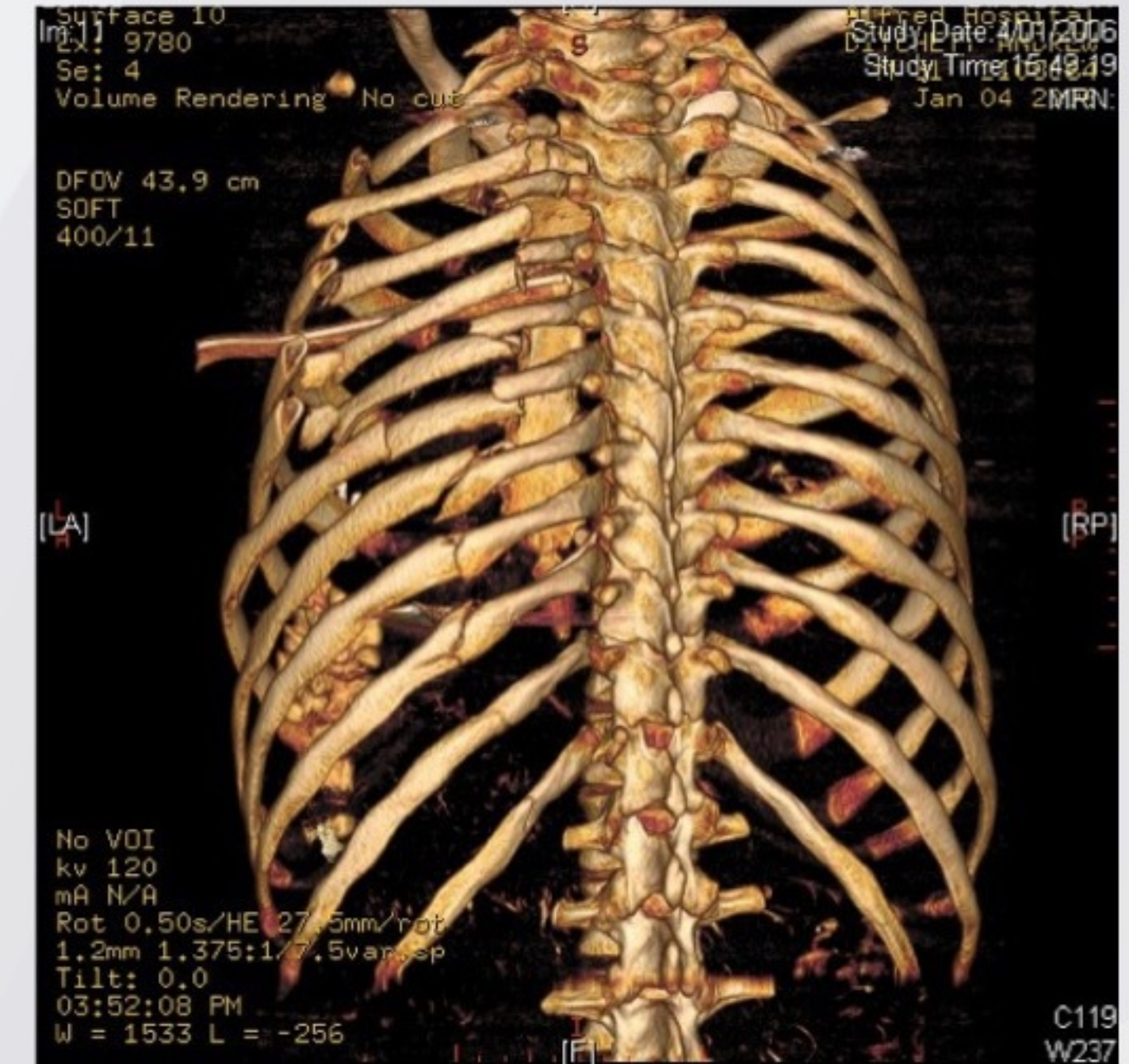
Flail Chest Injury

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.

Flail Chest Injury

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*.

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Flail Chest Injury

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

Invited Commentary
*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 management 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 bony 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? A Prospective Randomized Study of Management of Severe Flail

Hideha
Hideak

doi: 10.1510

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

Silvana F Marasco, MSurg, FRACS, Andrew R Davies, FRACP, FCICM, Jamie Cooper, FRACP, FCICM, MD, Dinesh Varma, FRANZCR, Victoria Bennett, BNSc, CCRN, Rachael Nevill, BNurs, 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,*}

^aDepartment of Thoracic Surgery, Klinikum Evangelisches Krankenhaus Duisburg-Nord, Fahrner Str. 133, Duisburg 47169, Germany

^bDepartment of Cardiothoracic Surgery, Faculty of Medicine, Zagazig University, Cairo, Egypt

^cDepartment of Chest Medicine, Faculty of Medicine, Cairo University, Cairo, Egypt

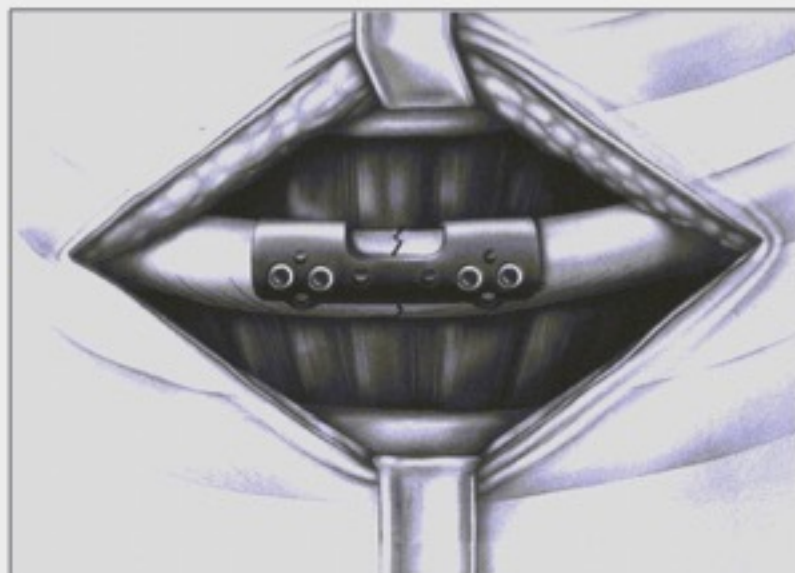
Received 21 April 2005; received in revised form 28 July 2005; accepted 2 September 2005



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:	<i>Compare two methods of chest wall stabilisation via conservative and</i>
	<i>packing and strapping</i>
	<i>surgical fixation</i>
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





Marasco et al, 2013. Australia.

- Aim:** *To investigate the effect of ORIF of rib fracture 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



Subsequent Publications



**Cochrane
Library**

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 treatment 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



Current Practice

- 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

Dehghan N, et al. J Trauma Acute Care Surg. 2014;76(2);462-68.

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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

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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‘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....’

1

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)

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

Yeh DD et al. J Surg Research 2014. 186;39-43.



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.

Odell DD, et al. J Trauma Acute Care Surg. 2013. 75;448-52.



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

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