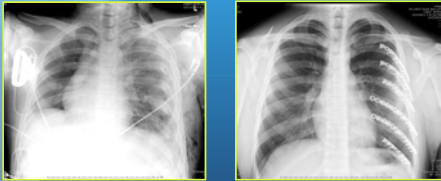


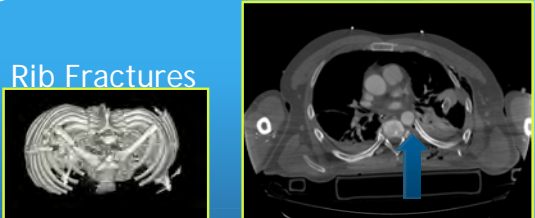
Rib Fracture Fixation: An Orthopaedist's Perspective



Bruce French, MD
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DJ -6585


Rib Fractures



- 350,000 people per year in the U.S
 - 1/3 will be admitted to hospital
 - 1/3 will have significant complications
- Trauma patients
 - 25% of deaths due to chest trauma
 - Rib fractures present in 39% of chest trauma patients
 - Mortality rates up to 12% with multiple fractures and 33% with flail chest

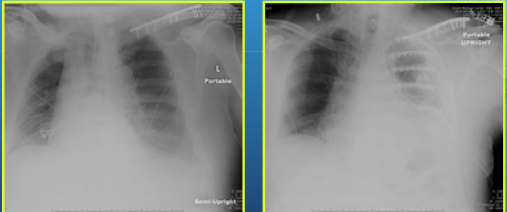
Why AM I Here?

- My view of the patient
- Clavicle fractures
 - "Scar for a Lump"
 - "All do well"
- "Nonoperative Treatment Compared With Plate Fixation of Displaced Midshaft Clavicular Fractures : A Multicenter, Randomized Clinical Trial"
JBJS 2007



•Clavicle Fracture Fixation

- Improved Validated Patient Outcome Scores
- Improved Patient Satisfaction
- Faster Time to Union
- Improved Shoulder Function




RIBS ARE BONES, TOO

Surveyed Opinion of American Trauma, Orthopedic, and Thoracic Surgeons on Rib and Sternal Fracture Repair

405 surgeons

- Mostly academic
- Mostly Level 1 trauma centers
- Web-based survey



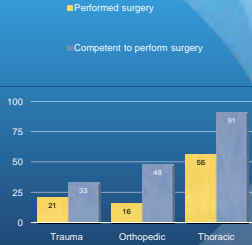
238 trauma surgeons
97 orthopaedic surgeons
70 thoracic surgeons

Mayberry et. al, J Trauma, 2009

Surveyed Opinion of American Trauma, Orthopedic, and Thoracic Surgeons on Rib and Sternal Fracture Repair

Who is fixing ribs?

Who feels comfortable fixing ribs?



Specialty	Performed surgery	Competent to perform surgery
Trauma	21	33
Orthopedic	16	45
Thoracic	56	91

Mayberry et. al, J Trauma, 2009

Surveyed Opinion of American Trauma, Orthopaedic, and Thoracic Surgeons on Rib and Sternal Fracture Repair

- Chest wall defect/pulmonary hernia
- Flail chest, failure to wean 7 days
- Flail chest, failure to wean 14 days
- Fracture displacement > 1 rib width
- Fibrous non-union (2 months)
- Chronic pain
- Thoracotomy for other reasons
- Persistent pain at 7-10 days
- Flail chest not needing ventilation

Specialty	Surgery indicated	Opposed to surgery
Trauma	82	17
Orthopaedic	66	32
Thoracic	71	23

Mayberry et al, J Trauma, 2009

Surveyed Opinion of American Trauma, Orthopaedic, and Thoracic Surgeons on Rib and Sternal Fracture Repair

Specialty	Surgery indicated	Knowledge of the literature
Trauma	82	16
Orthopaedic	66	3
Thoracic	71	8

Mayberry et al, J Trauma, 2009

What does this tell us?

- There is a disconnect
- Majority of surgeons responded that rib fracture repair indicated in certain situations
- Although most thought they were capable of performing the surgery.....
- Most have never done it
- Most were not familiar with the literature

Flail Chest

- 3 or more ribs with segmental fractures
- Paradoxical chest wall motion

Flail Chest Clinical Studies

A total of 650 surgical repairs are reported 1975-2008

Study Type	Percentage
Prospective randomized	12%
Matched case series	26%
Prospective, non-randomized	10%
Retrospective case series	52%

Nirula et al. World J Surgery, 2009

Surgical Stabilization or Internal Pneumatic Stabilization? A Prospective Randomized Study of Management of Severe Flail Chest Patients

37 Patients (111 patients excluded)

18 surgical (Judet struts)
19 non-surgical (PPV)

Required mechanical ventilation 6 or more fractures

	surgical	nonsurgical
Vent days	10.8	18.3
ICU days	16.5	26.8
pneumonia	22%	90%
employment	11/18	1/19
expense	13,455	23,423

Identical extubation criteria

Tanaka, J Trauma, 2002

Surgical Stabilization or Internal Pneumatic Stabilization? A Prospective Randomized Study of Management of Severe Flail Chest Patients

Questionnaire at 12 months after injury

Outcome	I group	S group
Chest Tightness	84%	33%*
Thoracic Cage pain	89%	39%*
Dyspnea on effort	63%	28%*

*P<.05

Tanaka, J Trauma, 2002

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

40 Patients
3 or more fractures with paradoxical motion

	surgical	nonsurgical
ventilation	45%	35%
Vent days	2	12
ICU days	9.6	14.6
deformity	1	9
pneumonia	10%	50%
Wound problems	20%	0
mortality	10%	15%

Surgical: k-wires and stainless steel wire
Non-surgical: Strapping

Fixation patients demonstrated significantly increased FVC and TLC

Granetzny et al: Interactive Cardiovascular and Thoracic surgery, 2005

Potential Clinical Benefits of Operative Fixation Flail Chest

	surgical	nonsurgical
Vent days	3.7-10.8	15-30.7
ICU days	6.8-16.5	21-28.3
pneumonia	7.6-24%	50-77%
Return to work	95-100%	48%
Chest wall pain	11%	49%

Lardinols et al. Eur J Cardiothorac Surg, 2001
Meier et al. Schweiz Med Wochr, 1978
Ahmed et al. J Thorac Cardiovasc Surg, 1995
Tanaka et al. J Trauma, 2002
Voggenreiter et al. Unfallchirurg, 1996
Voggenreiter et al. J Am Coll Surg, 1998
Mouton, Thorac Cardiovasc Surgeon, 1997
Latzke, Langenbecks Arch Chir, 1981

The Elderly Patient

- Linear relationship between age, number of rib fractures and complications
- For each additional rib fracture in patient older than 65, mortality increased by 19% and risk of pneumonia increased by 27%
- Significant increase in vent days, ICU days, hospital days and mortality patients older than 65 with at least 4 rib fractures
- Elderly crash victims with rib fractures and AIS >3 have odds ratio for death 2.5
- 55% of patients > age 60 who died of chest injury had no injury worse than rib fractures

Bulger et al. J Trauma, 2000
Holcomb et al. J Amer Coll Surg, 2003
Kent et al. Ann Adv Automot Med, 2008

Rib Fractures and the Elderly Patient

- Vulnerable population
- Adequate pain control is critical to the outcomes, particularly in this population
 - Epidural
 - Narcotics
- Multi-disciplinary approach decreases complications

Room for Improvement

- The acute period
 - Pain associated with rib fractures is legendary
 - Decreased clearance pulmonary secretions
 - Pulmonary atelectasis
 - Pneumonia/empyema
 - Need for mechanical ventilation
- The Long Run
 - Chest wall difficulties
 - Deformity
 - Pain
 - nonunion
 - Pulmonary issues

Rib fracture pain and disability

- Pain level 3.5/10 at 30 days
- Significantly more disabled than chronic illness
- Average patient missed 70 days from work/school
 - 7.7 years lost productivity for 40 patients
- Current management does not facilitate pain relief or a speedy return to activity
- Any improvement in pain control and disability would have a positive effect on health and economic status...



Kerr-Valentic, J of Trauma, 2003

Rib fractures without Flail Chest

- Limited case series
- Dramatic pain relief
- Decreased ventilator days
- Very high patient satisfaction
- "Under-utilized procedure"



Richardson et al. The American Surgeon, 2007
Khandelwal et al. Int J Surg, 2011

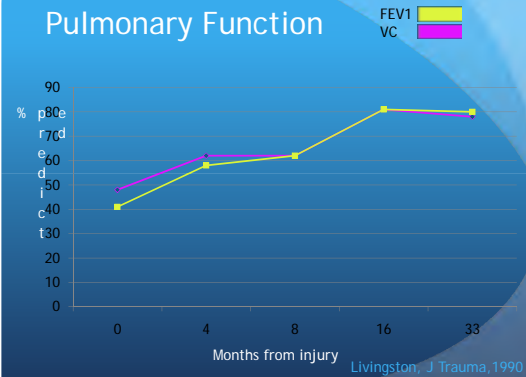
Functional Outcomes



- 39% unable to return to work
- 49% frequent chest wall pain exacerbated by exertion
- 63% dyspnea complaints
- 46% had significant decrease chest wall expansion
- 57% abnormal spirometry
- 70% mild/moderate decrease in calculated dyspnea index

Landercasper et al. J Trauma, 1984
Beal et al, Amer J surgery, 1985

Pulmonary Function



Pulmonary Function testing after operative stabilization of the chest wall for flail chest

- 66 patients ORIF flail chest
- 11% chest wall pain
- 100% back to work at mean 8 weeks
- Pulmonary function test at 6 months
 - 52% normal
 - 22% obstructive
 - 16% mixed obstructive/restrictive
 - 10% had TLC < 85% of predicted values



Lardinois et al. Europ J Cardio-thoracic Surg, 2001

Summary

- The best indication for early operative chest wall stabilization is the presence of anterolateral flail chest and respiratory failure without severe pulmonary contusion, especially in the elderly
- Stabilization is recommended in patients with pulmonary contusion showing persistent instability of the chest wall which prevents weaning from the ventilator
- 3 or more displaced rib fractures (4-10) with impending or acute respiratory failure, especially in the elderly
- ? 3 or more displaced rib fractures (4-10) with recalcitrant pain????



What are the barriers to Internal Fixation?

- Trauma / Thoracic Surgeons
- Intrathoracic Injuries
- Pulmonary injury/contusion
- Tradition
 - Pain control
 - Limit fluids
 - Respiratory support
- Orthopaedic Surgeons
 - Fracture reduction
 - Fracture fixation



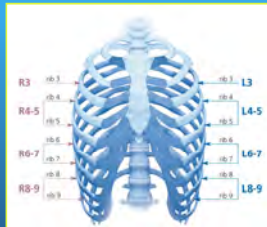
Implants?



Precontoured Titanium Locking Plates

Precontoured plates

- 4 plates each side
- Right = Rose-red
- Left = Light blue
- Profile 1.5mm
- 15, 16, 17 and 18 holes



Universal plate

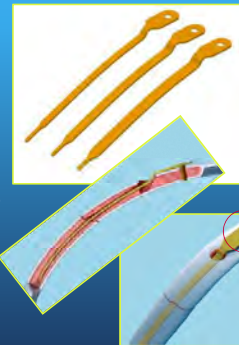
- 8 holes
- Gold



MatrixRIB System Overview - DJ1667

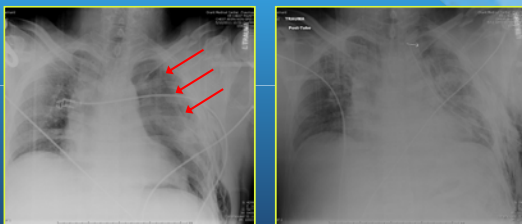
Intramedullary Splints

- 3 Widths
 - Small - 3 mm
 - Medium - 4 mm
 - Large - 5 mm
- Length 92.5 mm (75 mm in IM canal)
- Ideal for Posterior Fractures
- Minimally invasive
- One screw to secure splint



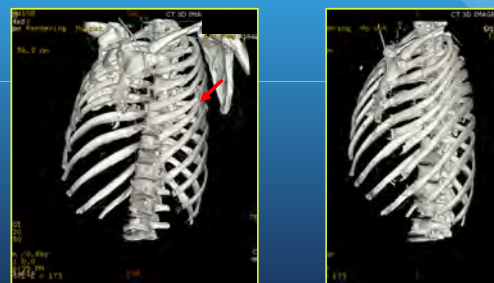
MatrixRIB System Overview - DJ1667

Case example



3-D CT scan with and without scapula

- Implosion injury featuring multiple contiguous anterolateral rib fractures and clavicle fracture

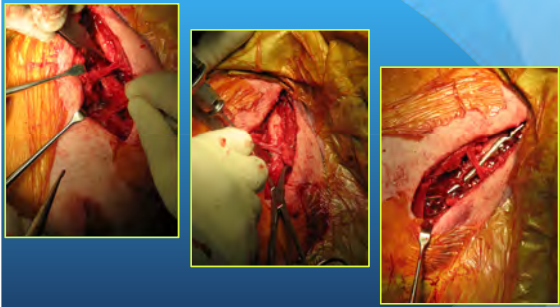


Preparation



This slide illustrates the preparation phase of the surgery. It includes a photograph of the surgical team in full scrubs and masks, a tray of surgical instruments, a stack of yellow bean bags, and a monitor displaying chest X-rays.


Clavicle Fixation First



This slide shows the initial surgical steps. It features three photographs: the first shows the clavicle being exposed and prepared; the second shows the clavicle being secured with a locking plate and screws; the third shows the final fixation of the clavicle.

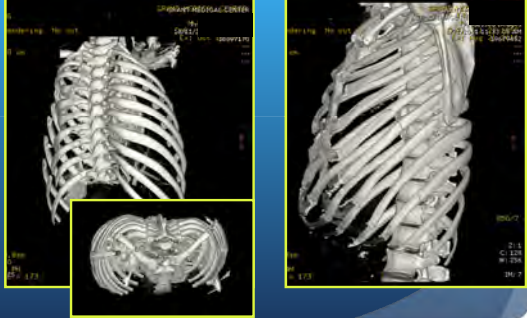
Positioning

- Lateral-flail
- 45°-anterolateral
- Bean bag
- Break the table
- Remove the chest tube
- ? Single lung ventilation?



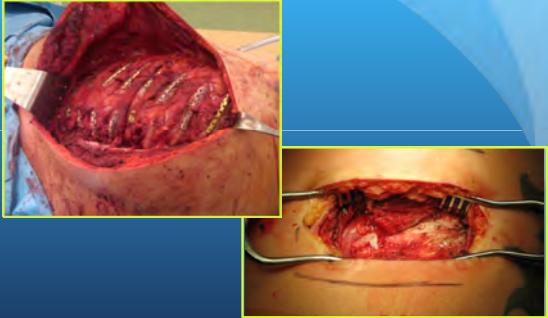
This slide details the patient's positioning. It includes two photographs: one showing the patient in a lateral position on the operating table, and another showing a bean bag used to support the patient's arm.

Approach: Thoracotomy or Anterolateral



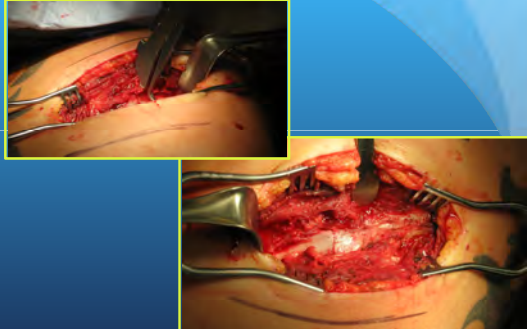
This slide displays CT scans of the chest to determine the surgical approach. It shows three views: a posterior view, a lateral view, and an anterior view of the rib cage.

Exposure

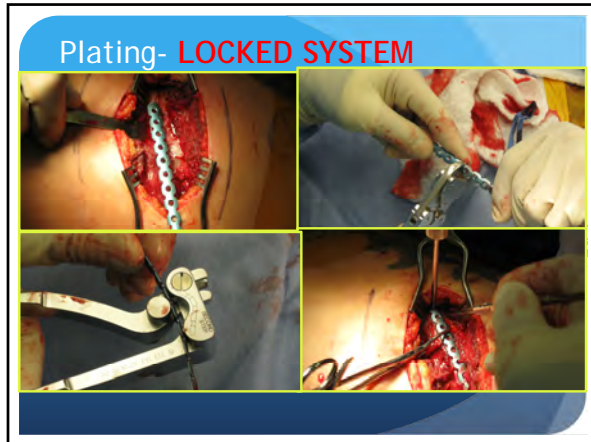


This slide shows the surgical exposure of the chest. It includes two photographs: one showing the rib cage being retracted to provide access to the thoracic cavity, and another showing the chest wall being opened.

Reduction



This slide illustrates the reduction phase of the surgery. It features two photographs showing the surgical team using retractors and other instruments to reduce the chest wall and prepare for the final closure.



Factors to consider

- Chest tube
- One or two lung anesthesia
- Intra pleural exploration
- Pain control

Summary

- There are patients who benefit from ORIF Ribs
- Multidisciplinary approach
- More level one data
 - Better delineation indications
 - Pulmonary contusion
- Functional outcomes
 - Shoulder function
 - Pulmonary function
 - Patient satisfaction

Jacoby Ellsbury

Can we do better?

YEAR	GAMES	AB	R	H	HR	RBI	SB	BA
2009	153	624	94	188	8	60	70	0.301
2010	18	78	10	15	0	5	7	0.192