International Perspectives – from the United Kingdom

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pre-existent myocardial damage. Suspected or proved cases of cardiac trauma should be treated as if there had been an attack of coronary thrombosis.

Cardiac injuries are discussed further in Chapter 13.

Fig. 23-1.—Severe multiple injuries, abdominal, fracture of left humerus and cerebral laceration.

A severe crush injury of the left chest had produced paradoxical movements of that side and there was also a tension pneumothorax. Tracheotomy, traction on the floating chest segment by means of wire encircling the ribs and two intercostal tubes have relieved grave thoracic complications. The tracheotomy tube can be used for intermittent bronchial suction and the administration of oxygen, or assisted respiration.

**COMPRESSION AND CRUSH INJURIES WITH FRACTURE OF THE RIBS AND STERNUM**

Apart from the wounds of warfare these are usually associated with an intact overlying skin and produced mainly by an external force. The fractures may be transverse or oblique and extend downwards to produce laceration of the lungs; haemoptysis or pneumo
Operative fixation of the floating ribs by open operation rapidly prevents the paradoxical movement, reduces the period spent in hospital and leads to rapid return of function. The fixation may be by silk or wire sutures passed through holes drilled on each side of the fractures or by the use of intramedullary nails. Alternatively by direct traction methods, sutures or metal clips are passed round the floating ribs and held out by weights applied over pulleys. Strong steel wire, covered by polythene tubing, can be passed round several ribs under local anaesthesia; to these are attached weights of 2–5 lb. suspended over pulleys. In injuries severe enough to require such measures a temporary tracheotomy will almost invariably be required (Fig. 23·1).

“Operative fixation of the floating ribs by open operation rapidly prevents the paradoxical movement, reduces the period spent in hospital and leads to rapid return of function”

Alphonsus D’Abreu, Birmingham, 1953
732 patients with flail chest
66 patients underwent surgery
Background:

Flail chest has a high morbidity and mortality:
- Prolonged ICU and hospital stay
- Chest wall deformity
- Reduced long-term pulmonary function

Treatment of Flail Chest:

Epithelial analysis
CPAP (Chest Pneumatic Fixation)
Surgical stabilisation of flail chest

Earlier techniques
- Sternal wires
- Sternal resection
- Sternal reconstruction techniques

Previous Studies:
- Sternal vs. conservative treatment at 24 hours, n=10
  - Reduced chest infection, ventilation and deformity
- Shorter ICU and hospital stay
- Better lung function tests at 3/12

Incidental injuries vs. internal pneumothorax: stabilisation at 3/7, n=37
- Reduced pneumonia, ventilation and ICU stay
- Earlier return to work

Fixation with reconstruction plates (case series)
- 46 operated from 752 patients with isolated or flail chest
- Mortality: 1%
- Reduced post-operative ventilation, ICU stay and complications

There are few data regarding POSTEROLATERAL flail chest

Methods:

CT with 3D reconstructions for planning
- Posterior lateral thoracotomy, muscle-sparing, where possible
- Reduction and fixation with reconstruction plates and ribbion
- Titanium meshwork preferred with cancellous screws
- Usually fixation of alternate ribs
- Combined procedure with orthopaedic surgeons

Results:

Seven patients
- 3 male, 4 female
- Age: 48 (38-76) years

Indications for Surgery:
- Chest deformity: 4/7
- Impending respiratory failure: 3/7
- Previous painful flail: 1/7
- Ruptured diaphragm: 1/7

Time to surgery: 5 (1-12) days
- Operating time: 1 (1.9-5.25) hours
- Postoperative ventilation: 3 (0-230) hours
- Intensive care stay: 2 (0-10) days
- Hospital stay: 18 (7-50) days

Data expressed as median (range)

Critical Care Utilisation:

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<tr>
<th>Day</th>
<th>AC</th>
<th>PH</th>
<th>BM</th>
<th>RM</th>
<th>JH</th>
<th>SH</th>
<th>EG</th>
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Morbidity and Hospital Stay:

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Associated Injuries:

- AC: 37M - none
- PH: 36M - # incision
- BM: 75F - # incision
- RM: 74F - ruptured diaphragm, perforated colon
- JH: 35M - # clavicle
- SH: 74F - # clavicle
- EG: 76F - # iliac/rib (Fx x1), # humerus

Late Postoperative Results:

At 3 months post injury, all three patients in preoperative employment have returned to work

Pulmonary function tests
- Median FVC: 98% (61-105)
- Median FEV1: 99% (67-125)

Conclusions:

Surgical stabilisation of posterolateral flail chest has satisfactory outcome and restores pre-injury status and lung function

Patients with posterolateral flail chest should be assessed and considered for this procedure

References:

1. Ahmadi, Z et al. J Thorac Cardiов Surg 189:1-10(137-140)
2. Tamura, J Evacu. 1982;510:517-520
Insertion of metal rib reinforcements to stabilise a flail chest wall

The National Institute for Health and Clinical Excellence (NICE) has issued full guidance to the NHS in England, Wales, Scotland and Northern Ireland on Insertion of metal rib reinforcements to stabilise a flail chest wall.

Description

The condition in which multiple rib fractures allow a segment of the rib cage to move independently from the main chest wall is called a flail chest. This effect compromises breathing and may be life-threatening. In this procedure, metal (usually titanium) is used to stabilise the flail segment of chest wall. This procedure aims to improve lung function and reduce the length of critical care and hospital stay.

CPCS4.5 Code(s)

The following CPCS4 codes are available:

W19.8 Other specified primary open reduction of fracture of bone and intramedullary fixation
W19.9 Unspecified primary open reduction of fracture of bone and intramedullary fixation
W20.1 Primary open reduction of fracture of long bone and extramedullary fixation using plate NEC
W20.6 Wiring of sternum
W20.8 Other specified primary open reduction of fracture of bone and extramedullary fixation
W20.9 Unspecified primary open reduction of fracture of bone and extramedullary fixation

The following site codes can be added to identify which ribs are involved:

Z74.3 First rib
Z74.4 Second to tenth rib
Z74.5 Eleventh or twelfth rib
Z74.6 Rib NEC

Other information

- IPG361 Insertion of metal rib reinforcements to stabilise a flail chest wall: guidance (web format)
- Insertion of metal rib reinforcements to stabilise a flail chest wall: consultation comments (text)
- Insertion of metal rib reinforcements to stabilise a flail chest wall: Equality Impact Assessment
- IPG361 Insertion of metal rib reinforcements to stabilise a flail chest wall: Consultative Document
- Insertion of metal rib reinforcements to stabilise a flail chest wall: Consultative Document

This page was last updated 15 June 2012
Insertion of metal rib reinforcements to stabilise a flail chest wall

1 Guidance
1.1 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 in the context of patients who have had severe trauma with impaired pulmonary function. Therefore the procedure may be used provided that normal arrangements are in place for clinical governance, consent and audit.

1.2 Patient selection should be carried out by critical care specialists, chest physicians and thoracic surgeons with appropriate training and experience.

2 The procedure
2.1 Indications and current treatments
2.1.1 Chest wall injury is common as a result of major blunt trauma (for example, motor vehicle accidents). It varies in severity from minor bruising or an isolated rib fracture, to severe crush injuries leading to respiratory compromise.

2.1.2 A flail chest occurs when a segment of the thoracic cage moves independently from the rest of the chest wall. A flail chest causes paradoxical movement of this segment of the chest wall—drawing in on inspiration and moving outwards on expiration—and this segment of chest wall fails to contribute to lung expansion. Flail chest has been defined in a variety of ways, but at least 2 fractures per rib in at least 2 ribs are needed to produce a flail segment. Large flail segments may extend bilaterally or involve the sternum, and may compromise respiration sufficiently to require mechanical ventilation.

2.1.3 Management of chest wall injury is directed towards protecting the underlying lung, achieving adequate ventilation and oxygenation, and preventing infection. Analgesia sufficient to allow normal respiration and coughing may be adequate for mild cases. More severe cases require ventilatory support, and suction to remove mucus or secretions from the airways to prevent atelectasis.

2.2 Outline of the procedure
2.2.1 Surgical stabilisation with metal rib reinforcements aim to allow earlier weaning from ventilatory support, reduce acute complications, and avoid chronic pain sometimes associated with permanent deformity of the chest wall.

2.2.2 With the patient under general anaesthesia, an incision is made over the rib fractures to be treated, and the fractured ribs are reduced. The affected ribs are stabilised using struts or metal plates, fixed with screws or intramedullary wires. These metal plates and screws are usually left in place in the long term.

2.2.3 There are many variations in the materials and techniques used to stabilise flail chest with metal rib reinforcements. It should be noted that Kirschner wires, used alone, are not covered by this guidance.

Sections 2.3 and 2.4 describe efficacy and safety outcomes from the published literature that the Committee considered as part of the evidence about this procedure. For more detailed information on the evidence, see the overview available at www.nice.org.uk/ipb25overview

Interventional procedure guidance 361
This guidance makes recommendations on the safety and efficacy of the procedure. It does not cover whether or not the NHS should fund a procedure. Funding decisions are taken by local NHS bodies after considering the clinical effectiveness of the procedure and whether it represents value for money for the NHS.

This guidance is for healthcare professionals and people using the NHS in England, Wales, Scotland and Northern Ireland, and is endorsed by NHS QIS for implementation by NHSScotland.
MTC-22 National Peer Review Meeting
Birmingham 2 July 2014

- Recognition of neglect of chest wall trauma
- Working party established

- TARN
  - Data coding review
  - Addition of data points to track
  - Set metrics for each unit and national review

- MTC Peer Review
  - Agreement to assess multiple rib fracture management pathways

- Education

- Service Implementation
  - Costs and coding structures
MTC-22 Ortho-Thoracic Meetings

• 26\textsuperscript{th} Jan 2015

• 4\textsuperscript{th} Nov 2015

• Next meeting: 11\textsuperscript{th} Jan 2017
MTC-22 Ortho-Thoracic Meeting
Birmingham 4th Nov 2015

Discussed:
• TARN Data Points to improve data collection for rib fractures
• TARN Working Group
• Survey of Current Practice
• Funding and Coding
• National Audit Standards for Chest Wall Trauma
• National Audit Standards for Resuscitative Thoracotomy

Future Plans:
• Operation Note template
• CT scan reporting template
• TARN data analysis to inform development of national RCT
Welcome

Every year across England and Wales, 12,500 people die after injury. It is the leading cause of death among children and young adults of 44 years and under. In addition, there are many thousands who are left severely disabled for life.

Our foundation in research and our highly skilled team ensures that we provide accurate and relevant information to help Doctors, Nurses and Managers improve their services.

Equivalent to National Trauma Research Databank
## TARN Rib Fractures data for England and Wales, 2010-2015

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<tr>
<th></th>
<th>2010</th>
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<td>17.4</td>
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<td>19.4</td>
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<tr>
<td>% of all thoracic cases</td>
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<td>74.5</td>
<td>76.6</td>
<td>77.9</td>
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<tr>
<td>Median age (IQR)</td>
<td>55.5 (39.1 - 73.2)</td>
<td>56.6 (41.7 - 74.9)</td>
<td>59 (43.6 - 76.8)</td>
<td>61.5 (44.9 - 78.6)</td>
<td>62.1 (45.8 - 79.1)</td>
<td>62.3 (46.9 - 78.9)</td>
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<tr>
<td>Median ISS (IQR)</td>
<td>16 (9 - 26)</td>
<td>16 (9 - 25)</td>
<td>14 (9 - 24)</td>
<td>14 (9 - 24)</td>
<td>16 (9 - 24)</td>
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<td>% over 64 years</td>
<td>35.7%</td>
<td>39.1%</td>
<td>42.5%</td>
<td>46.3%</td>
<td>47.1%</td>
<td>47.5%</td>
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<td>% male</td>
<td>70.2% (68.7 - 71.7)</td>
<td>69.1% (67.8 - 70.5)</td>
<td>67.5% (66.4 - 68.7)</td>
<td>65.9% (64.8 - 66.9)</td>
<td>65.8% (64.8 - 66.7)</td>
<td>66.6% (65.5 - 67.6)</td>
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<tr>
<td>% injured by RTC</td>
<td>42.5% (40.9 - 44.1)</td>
<td>42.3% (40.9 - 43.5)</td>
<td>37.9% (36.7 - 39)</td>
<td>36% (35 - 37.1)</td>
<td>35.9% (34.9 - 36.9)</td>
<td>36.7% (32.4 - 37.1)</td>
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<td>% injured by fall</td>
<td>49.6%</td>
<td>50.1%</td>
<td>54.1%</td>
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<td>57.5%</td>
<td>57.3%</td>
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<td>(95% CI)</td>
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<td>48.8 - 51.5</td>
<td>52.9 - 55.3</td>
<td>56 - 58.2</td>
<td>56.5 - 58.5</td>
<td>56.2 - 58.4</td>
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<td>% penetrating</td>
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<td>1.7%</td>
<td>1.4%</td>
<td>1.3%</td>
<td>1.1%</td>
<td>1.3%</td>
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<tr>
<td>% with any associated lung injury</td>
<td>28.5%</td>
<td>27.3%</td>
<td>24.5%</td>
<td>23.4%</td>
<td>24.3%</td>
<td>25%</td>
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<td>% with polytrauma</td>
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<td>31.5%</td>
<td>29.5%</td>
<td>29.3%</td>
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<td>28.4%</td>
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<tr>
<td>% with other torso bony injury**</td>
<td>37.2%</td>
<td>37.4%</td>
<td>36.7%</td>
<td>35.7%</td>
<td>37.3%</td>
<td>37.2%</td>
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<td>% intubated at any time</td>
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<td>14.5%</td>
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<td>11.4%</td>
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<tr>
<td>% received epidural***</td>
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<td>% received chest drain at any time</td>
<td>27.6%</td>
<td>25.3%</td>
<td>21.9%</td>
<td>21.6%</td>
<td>18.7%</td>
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<tr>
<td>% receiving thoracic surgery at any time</td>
<td>5.2%</td>
<td>5%</td>
<td>4.3%</td>
<td>4%</td>
<td>3.7%</td>
<td>4.4%</td>
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<td>% where first hospital is current MTC</td>
<td>43.9%</td>
<td>43.5%</td>
<td>46.6%</td>
<td>49.9%</td>
<td>53.2%</td>
<td>57.2%</td>
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<td>% transferred into MTC</td>
<td>4.9%</td>
<td>5.3%</td>
<td>5.6%</td>
<td>6.3%</td>
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<tr>
<td>% (n)known outcome</td>
<td>94.5% (3513)</td>
<td>94.9% (4978)</td>
<td>93.4% (6148)</td>
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<td>95.2% (8900)</td>
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<td>Crude mortality</td>
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<td>8.5%</td>
<td>8.8%</td>
<td>8.1%</td>
<td>7.2%</td>
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TARN Rib Fractures data for England and Wales, 2010-2015

• Over these 6 years:
  – Rib fractures from 15% to 19% of all TARN cases
  – Median age increased from 55 to 62 years
  – Age over 64 years: 36% to 48%
  – “Fall” as mode of injury increased from 49 to 57%
Survey of Cardiothoracic and Orthopaedic & Trauma Surgeons

- November 2015
- Responses from every MTC in England
- Activity
- Research
MTC-22 Survey Nov 2015

- Date service started
- How many cases in total?
  - Each year?
- Service delivery model?
- Guidelines?
- Definitions of injury?
- Positions of equipoise?
- Trial recruitment ability/willing?
Co-location of Cardiothoracic Surgery and ED/O&T

- **Same site**: 11
- **Split site**: 11
MTC-22 Survey November 2015

- (Cardio)Thoracic alone 11
- (Cardio)Thoracic and O&T 7
- Orthopaedic and Trauma alone 4
- O&T and General/Vascular Surgery 2

Other units displayed:
- London – Guys (for Brighton)
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<td>London – St Marys</td>
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<tr>
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<tr>
<td>Southampton</td>
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Fixation Cases per annum in England
Fixation Cases in 2015
## MTCs in England: TARN Activity

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<th>Cases</th>
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<td>525</td>
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<td>84</td>
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<td><strong>TOTAL</strong></td>
<td><strong>25237</strong></td>
<td><strong>11693</strong></td>
<td><strong>3666</strong></td>
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Modeling of future activity

- Is 20% of patients with 3+ rib fractures an appropriate target?
- Then approx 730 patients would be fixed per annum in England
- Increase by 135% over current activity
Is it *ethical* to conduct a trial of acute rib fractures:

<table>
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<tr>
<td></td>
<td>With deformity</td>
<td>No deformity</td>
<td>With deformity</td>
<td>No deformity</td>
</tr>
<tr>
<td>Randomised Trial indicated</td>
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<td>21</td>
<td>15</td>
<td>20</td>
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<tr>
<td>Already proven benefit</td>
<td>23</td>
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</tr>
<tr>
<td>No indication for surgery</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>
SMuRFS

Sheffield MUltiple Rib Fractures Study:

Multiple Rib Fractures: Evolution of Classification, Management and Outcomes

NCT02608541
• Proposal of a novel Rib Fracture Classification system
  – Created in a derivation dataset of 94 patients (1032 fractures)
  – Pilot Agreement Study underway

• Analysis of a comprehensive retrospective dataset of 792 cases with multiple rib fractures, cross-referenced to HES and TARN data

• Establishment of a prospective study of Patient Reported Outcome Measures for patients with multiple rib fractures admitted to STH

• External validation of existing rib fracture classifications
International Perspectives from the United Kingdom

• The MTC-22 Ortho-Thoracic Group has worked to increase best practice, audit, activity and research

• Activity is increasing rapidly, with different models of service delivery

• In Sheffield, we are developing and testing classification systems, using institutional and TARN data

• UK-based randomised trials are under development