Osteosynthesis in severe chest trauma: rationale and results

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Treatment options for severe chest wall injury

**STABILISATION !!!!**

- Pneumatic
- External traction
- Osteosynthesis

*Epidural analgesia*
Why to operate rib fractures: rationale

Evidence based surgery!!

Pierre-Emmanuel Falcoz
Nicola Santelmo & Gilbert Massard
Which is the mortality and morbidity associated with rib fractures?
Fatality risk and the presence of rib fractures.

Kent R, Woods W, Bostrom O.

University of Virginia Center for Applied Biomechanics, Dept. of Mechanical and Aerospace Engineering, Charlottesville, VA, USA.

Relation  AGE – number of rib fractures – MORTALITY

National Trauma Databank USA
Car accident
2 age groups: 18 – 45 vs > 45 years
AIS > 3
181,331 patients

• Death caused by rib fractures:
  O.R.  $\Rightarrow$  1.4 (18-45 years) vs 2.5 (>45 years)

• 55% of patients > 60 years dying after chest trauma have no more than rib fractures…. 
Morbidity from Rib Fractures Increases after Age 45

John B Holcomb, MD, FACS, Neil R McMullin, BS, Rosemary A Kozar, MD, PhD, FACS, Marjorie H Lygas, MS, FNP, Frederick A Moore, MD, FACS

Relation AGE – number of fractures– MORBI-MORTALITY
Retrospective study– 15 years
171 patients

Table 2. Pulmonary Complications and Outcomes

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group 1 n (%)</th>
<th>Group 2 n (%)</th>
<th>Group 3 n (%)</th>
<th>Group 4 n (%)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>78 (46)</td>
<td>26 (15)</td>
<td>44 (26)</td>
<td>23 (13)</td>
<td>–</td>
</tr>
<tr>
<td>Pulmonary complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARDS</td>
<td>9 (11)</td>
<td>2 (8)</td>
<td>3 (7)</td>
<td>6 (26)</td>
<td>–</td>
</tr>
<tr>
<td>Empyema</td>
<td>0</td>
<td>0</td>
<td>2 (4)</td>
<td>0</td>
<td>–</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>5 (6)</td>
<td>1 (4)</td>
<td>3 (7)</td>
<td>2 (8)</td>
<td>–</td>
</tr>
<tr>
<td>Total</td>
<td>14 (18)</td>
<td>3 (12)</td>
<td>8 (18)</td>
<td>8 (35)</td>
<td>NS</td>
</tr>
<tr>
<td>Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilator days</td>
<td>2 ± 0.5</td>
<td>1 ± 1</td>
<td>2 ± 1</td>
<td>6 ± 2*</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>ICU days</td>
<td>2 ± 0.5</td>
<td>3 ± 1</td>
<td>2 ± 1</td>
<td>8 ± 2*</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>Hospital days</td>
<td>8 ± 1</td>
<td>8 ± 1</td>
<td>7 ± 1</td>
<td>14 ± 2*</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>Deaths</td>
<td>1 (1)</td>
<td>1 (2)</td>
<td>0</td>
<td>1 (4)</td>
<td>–</td>
</tr>
</tbody>
</table>

There were no differences between groups 1, 2, and 3. Group 4 patients demonstrated prolonged ventilator, ICU, and hospital days.
CONCLUSIONS:

Patients over the age of 45 with more than four rib fractures are more severely injured and at increased risk of adverse outcomes. Efforts to decrease rib fracture morbidity should focus not only on elderly patients but those as young as 45 years. Based on these data we have initiated a multidisciplinary clinical pathway focusing on patients 45 years and older who have more than four rib fractures. (J Am Coll Surg 2003;196:549–555. © 2003 by the American College of Surgeons)
A multidisciplinary clinical pathway decreases rib fracture–associated infectious morbidity and mortality in high-risk trauma patients

S. Rob Todd, M.D. a,*, Michael M. McNally, M.D. b, John B. Holcomb, M.D. c, Rosemary A. Kozar, M.D., Ph.D. d, Lillian S. Kao, M.D. b, Ernest A. Gonzalez, M.D. e, Christine S. Cocanour, M.D. f, Gary A. Verbrugge, M.D. g, Marjorie H. Lygas, M.S. d, Bobbie K. Brasseaux, R.R.T. h, Frederick A. Moore, M.D. a


Prospective cohort study
Patient > 45 years AND > 4 rib fractures
2 groups of 150 patients
BEFORE and AFTER
Multidisciplinary clinical pathway

Multidisciplinary clinical pathway
Adjustment on age / ISS / Nb of rib fractures:

• 2,4 days in ICU (p=0.01)
• 3,7 hospital stay (p=0.02)
• Nb pneumonias (OR=0.12; p=0.001)
• Mortality (OR=0.37; p=0.06)
Flail chest: osteosynthesis or pneumatic internal fixation?
Surgical Stabilization of Internal Pneumatic Stabilization? A Prospective Randomized Study of Management of Severe Flail Chest Patients

Hideharu Tanaka, MD, Tetsuo Yukioka, MD, Yoshihiro Yamaguti, MD, Syoichiro Shimizu, MD, Hideaki Goto, MD, Hiroharu Matsuda, MD, and Syuji Shimazaki, MD

Flail chest
37 patients on ventilator

Surgical stabilization
N=18

Internal pneumatic stabilisation
N=19

Randomisation at D5

J Trauma. 2002;52:727–732
### Table 2 Incidence of Pneumonia on Days 7 and 21, Length of Mechanical Ventilation, Total Length of TICU Stay, and Incidence of Tracheostomy on Days 7 and 21 in Internal Pneumatic Stabilization and Surgical Stabilization Groups

<table>
<thead>
<tr>
<th>Postoperative Day</th>
<th>Incidence of Pneumonia</th>
<th>Total Length (Days after Surgery)</th>
<th>Tracheostomy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D7 (%)</td>
<td>D21 (%)</td>
<td>Length of Mechanical Ventilation</td>
</tr>
<tr>
<td>Surgical</td>
<td>8.2 ± 4.1</td>
<td>1/18</td>
<td>4/18</td>
</tr>
<tr>
<td>(n = 18)</td>
<td></td>
<td>(5)</td>
<td>(22)</td>
</tr>
<tr>
<td>Internal</td>
<td>NA</td>
<td>3/19</td>
<td>17/19</td>
</tr>
<tr>
<td>(n = 19)</td>
<td></td>
<td>(16)</td>
<td>(28)</td>
</tr>
<tr>
<td>p Value</td>
<td>NS</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

D7, 7 days after injury; D21, 21 days after injury; NA, not available; NS, not significant. Mean ± SD.
Surgical Stabilization of Internal Pneumatic Stabilization? A Prospective Randomized Study of Management of Severe Flail Chest Patients

Hideharu Tanaka, MD, Tetsuo Yukioka, MD, Yoshihiro Yamagui, MD, Syeichiro Shimizu, MD, Hideaki Goto, MD, Hiroharu Maisuda, MD, and Syuji Shimazaki, MD

J Trauma. 2002;52:727–732

Level 1

Questionnaire at 12 months after injury:

- Chest Tightness: 84% (S group 11/18, I group 6/18)
- Thoracic Cage pain: 89% (S group 17/19, I group 7/18)
- Dyspnea on effort: 63% (S group 12/19, I group 5/18)

Resumed work:

- S group (N=18): 11/18 high activity
- I group (N=19): 1/19 low activity

Statistical significance:

- * P<0.01
- * P<0.05
MANAGEMENT OF FLAIL CHEST INJURY: INTERNAL FIXATION VERSUS ENDOTRACHEAL INTUBATION AND VENTILATION

Zahoor Ahmed, and Zahoor Mohyuddin,
Abu Dhabi, United Arab Emirates

Prospective study– 10 years
427 chest trauma
64 flail chests
26 surgical stabilisations
38 pneumatic stabilizations

Level 2
Summary of EBM statements

• Mortality and morbidity associated with rib fractures increase with age (> 45 years) and number (> 4 fractures) (level 2)

• Multidisciplinary management of chest trauma may decrease mortality and morbidity (level 2)

• Surgical stabilisation of flail chest decreases mortality and morbidity, decreases duration of mechanical ventilation, ICU and hospital stay, improves functional and cosmetic outcome, and is cost efficient (level 1)
Immediate advantages of surgical stabilisation

• Exploration of the chest
  – adequate drainage of hemothorax
  – identification of associated injuries

• Restoration of chest wall rigidity
  – relieve of pain
  – chest wall motion
  – effective cough

• Immediate mobilization of the patient
  – No prolonged intubation
  – No prolonged bed rest & consequences
Long term advantages of surgical stabilisation

• Decrease of long term complications
  – Chest wall deformity & fibrothorax
  – Pseudarthrosis
  – Chronic pain
  – Restrictive respiratory failure

• Social consequences
  – Decreased ICU & Hospital stay
  – Earlier autonomy & return to work
Targets for rib osteosynthesis

- Severe trauma
  - Stabilisation of the chest wall („flail chest“)
  - Repair of chest wall impactation
  - Osteosynthesis of staged rib fractures
- Benign trauma: Osteosynthesis of single rib fractures
  - COPD
  - Poor pain control
When to operate?

- Routine emergency repair
- Elective repair
  - poor pain control
  - risk for respiratory failure
  - major deformity
- While closing thoracotomy
STRATOS-STRACOS meets all needs in trauma surgery!

- STRACOS -3D clips: pink
  - simple fractures
- STRATOS clips with connecting bar: gold
  - 3rd fragment / loss of bone
Less satisfactory alternatives

• Simple sutures and wires
  – no guarantee for stability!

• Intracostal pins and struts
  – technically difficult
  – risk of migration of material

• Plates & screws (Synthes)
  – very expensive
  – lengthy operation
  – problems with osteoporosis, comminutive fractures
Experience in Strasbourg

- Multidisciplinary consultation since July 2010
## Results

**July 2010 – August 2011**

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>Number (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>34</td>
</tr>
<tr>
<td>Male</td>
<td>23</td>
</tr>
<tr>
<td>Female</td>
<td>11</td>
</tr>
<tr>
<td>Median age (years)</td>
<td>65 (18-84)</td>
</tr>
<tr>
<td>Comorbidities (patients)</td>
<td>21</td>
</tr>
<tr>
<td>- Cardiovascular</td>
<td>18</td>
</tr>
<tr>
<td>- COPD</td>
<td>9</td>
</tr>
<tr>
<td>- Metabolic disease</td>
<td>13</td>
</tr>
<tr>
<td>Flail chest (patients)</td>
<td>11</td>
</tr>
<tr>
<td>Bilateral rib fractures (patients)</td>
<td>23</td>
</tr>
<tr>
<td>Average number of rib fractures</td>
<td>10.4 (3-29)</td>
</tr>
<tr>
<td>Associated lesions (patients)</td>
<td>20</td>
</tr>
</tbody>
</table>
# Results

**July 2010 – August 2011**

<table>
<thead>
<tr>
<th>Mortality</th>
<th>0</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>morbidity</td>
<td>8</td>
<td>23 %</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>2.5 days (0-26)</td>
<td>Med. 0</td>
</tr>
<tr>
<td>ICU stay</td>
<td>5 days (0-35)</td>
<td>Med. 0</td>
</tr>
<tr>
<td>Hospital stay</td>
<td>15.2 days (3-48)</td>
<td>Med. 12</td>
</tr>
</tbody>
</table>
## Risk factor analysis

<table>
<thead>
<tr>
<th>Comorbidity</th>
<th>ventilation</th>
<th>ICU</th>
<th>Hosp stay</th>
<th>N patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;1</td>
<td>5.3 d</td>
<td>8.8 d</td>
<td>20 d</td>
<td>13</td>
</tr>
<tr>
<td>1</td>
<td>0.5 d</td>
<td>2.6 d</td>
<td>11.8</td>
<td>21</td>
</tr>
<tr>
<td>p</td>
<td>0.02</td>
<td>0.03</td>
<td>0.045</td>
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</table>

<table>
<thead>
<tr>
<th>COPD</th>
<th>Ventilation</th>
<th>ICU</th>
<th>Hosp stay</th>
<th>N patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPD</td>
<td>7.25 d</td>
<td>11.1 d</td>
<td>24 d</td>
<td>9</td>
</tr>
<tr>
<td>No COPD</td>
<td>0.6 d</td>
<td>2.7 d</td>
<td>11.6 d</td>
<td>25</td>
</tr>
<tr>
<td>p</td>
<td>0.02</td>
<td>0.007</td>
<td>0.005</td>
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</table>
## Risk factor analysis

<table>
<thead>
<tr>
<th>Combined trauma</th>
<th>N patients</th>
<th>Ventilation</th>
<th>ICU</th>
<th>Hosp stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>18</td>
<td>4.3 d</td>
<td>8.8 d</td>
<td>21 d</td>
</tr>
<tr>
<td>none</td>
<td>16</td>
<td>0.1 d</td>
<td>0.1 d</td>
<td>7.2 d</td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>0.04</td>
<td>0.002</td>
<td>0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metabolic disorders</th>
<th>N patients</th>
<th>Ventilation</th>
<th>ICU</th>
<th>Hosp stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>12</td>
<td>5.2 d</td>
<td>7.8 d</td>
<td>17.4 d</td>
</tr>
<tr>
<td>none</td>
<td>22</td>
<td>0.8 d</td>
<td>3.5 d</td>
<td>14 d</td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>0.04</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>
149а

РАСНЫЙ ПУТЬ
Conclusions

• Acceptable mortality & morbidity
• Acceptable hospital stay
• Risk factors:
  – Comorbidities
  – COPD
  – Combined injuries
• Social benefit to be evaluated
Merci
NHC, 3 décembre 2009

Merci