Controversies in Orthopaedic Trauma Surgery

Eric G. Meinberg, MD
Associate Clinical Professor
UCSF/SFGH Orthopaedic Trauma Institute

- Hemodynamically unstable pelvic fractures
- Damage Control
- Orthopaedics
- Geriatric trauma

Low-energy Fractures

- Fall from standing height
  - Simple fracture patterns
  - Stable
  - Conservative treatment

Management of Hemodynamically Unstable Pelvic Fractures
High-energy Fractures

• Associated with significant problems
  – 75% abdominal or pelvic hemorrhage
  – 12% urogenital injury
  – 8% lumbosacral fracture
  – 60 – 80% associated fractures
  – 12-25% mortality

Lateral Compression

LC-3
• ‘Windswept pelvis’
• External rotation and disruption of contralateral hemipelvis
• Rollover or crush
  • Unstable

AP Compression

APC-1
• <2.5 cm symphysis disruption
• Ramus fractures
• No posterior injury
  • Stable

AP Compression

APC-2
• >2.5 cm diastasis
• Opening of SI joint
• Floor ligaments torn
  • Rotationally unstable
  • Vertically stable
**AP Compression**

- APC-3
  - >2.5 cm symphysis disruption
  - Complete rupture of posterior ligaments
  - Rotationally and vertically unstable

**Vertical Shear**

- Fall from height
- Significant vertical forces
- Anterior and posterior vertical displacement
- Unstable

**Combined Mechanism**

- Combination of multiple mechanisms
- Significant associated injuries
- Majority are LC-2 and VS
- Unstable

**Associated Injuries**

**AP compression**

- Pelvic floor disruption
- Intra-pelvic and retroperitoneal vascular injuries
- Shock, sepsis, ARDS, death
- 20% mortality

**Lateral compression**

- Pelvic floor is intact
- Decreased intra-pelvic bleeding
- Brain and visceral injuries
- 7% mortality
Immediate Management

- In the field or trauma bay
- Pelvic binder or bedsheets
- Apply around greater trochanters
- Maintains continuous reduction until fixator applied (up to 72h safe)
- May be left on in OR for other procedures
Proper Placement?
- Works like a sheet
- Easy to place by emergency staff
- Less likely to be over-tightened
- Low risk of skin necrosis
- Looks ‘official’

Pelvic Binder

External Fixation
- Fast and effective way of pelvic stabilization
- Re-establishes pelvic ring and decreases intrapelvic volume
- Decreases hemorrhage by tamponade, reapproximating fracture edges, decreasing motion

C-Clamp
- Temporary fixation of posterior instability and widening
- Act as temporary SI screws
- Applied bedside or OR
- Allows access to abdomen and patient
- Only emergent method to adequately stabilize posterior displacement
C-Clamp Considerations

- Not readily available
- Requires c-arm guidance for placement
- Contraindicated in ilium fractures
- May over-compress sacrum fractures
- Sciatic nerve, gluteal artery injury reported

Extraperitoneal Pelvic Packing

- Rationale:
  - Only treatment to control bleeding from venous plexus
  - Controls arterial bleeding
  - Enables control of large vessel bleeding
  - Simultaneous treatment of associated abdominal trauma
- Performed after reduction of pelvic volume with fixator
The Case for Pelvic Packing

Ertal et al. JOT, 2001

• 20 patients with pelvic disruption
• Mean ISS 41.2
• C-clamp applied in the ER
• Lactate q30 min.
• Pelvic packing for persistent bleeding (non decreasing lactate)

The Case for Pelvic Packing

Ertal et al. JOT, 2001

• Pelvic packing in 14
• 4 patients died (20%)
• Lactate levels predicted mortality

Preperitonal Pelvic Packing for Hemodynamically Unstable Pelvic Fractures: A Paradigm Shift

Cothren, Osborn, Moore, Morgan, Johnson, Smith, MD

The Journal of TRAUMA 2007

Transfusion requirements Pre – packing compared with subsequent 24 hrs were significantly less (12 versus 6; p 0.006)
Preperitoneal Pelvic Packing for Hemodynamically Unstable Pelvic Fractures: A Paradigm Shift

Cothren, Osborn, Moore, Morgan, Johnson, Smith, MD

25% Mortality

Institutional Protocols

- Biffl et al: J Orthop Trauma 2001
- Evolution of a multidisciplinary clinical pathway for the management of unstable patients with pelvic fractures

<table>
<thead>
<tr>
<th>Problem</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>31% -&gt; 15%</td>
</tr>
<tr>
<td>Death by exsanguination</td>
<td>9% -&gt; 1%</td>
</tr>
<tr>
<td>Multi-organ failure</td>
<td>12% -&gt; 1%</td>
</tr>
<tr>
<td>Death within 24h</td>
<td>16% -&gt; 5%</td>
</tr>
</tbody>
</table>
Institutional Protocols

- ATLS - identify pelvis as source
- Temporary pelvic volume reduction
- Acute external fixation +/- traction
- Laparotomy +/- pelvic packing
- Pelvic angiography & embolization

Who should get angiography?

- Concerns:
  - Venous and fracture (cancellous bone) bleeding account for >90%
  - Arterial bleeding accounts for <10%

2 Patients....

Case 1

- 30 year old male
- 1 hour after motorcycle accident
- initial vital signs:
  - blood pressure 100/60
  - heart rate 100
  - respiratory rate 40
- Acute abdomen, and....
Emergent laparotomy, ex fix, packing

Classic Indication

- Persistent shock despite treatment

Ongoing ‘Shock’

angiography

external fixator

packing

embolization
Case 2

- 70 year old female
- Struck by car
- Initial responder but ongoing low blood pressure
- Only injury..........

Initial treatment

- No need for binder
- Skeletal traction leg
- Transfusion 4 units packed cells and 6L crystalloid first 4hrs

Classic Indications

- Persistent shock despite treatment
- Shock with normal pelvic volume
Ongoing hypotension

9 hours post injury:
• Successful angiographic embolization of obturator artery

‘Clues’ re: need for angio
• transfusion requirements
• contrast extravasation (CE)
• age ≥ 60
• bladder displacement
  — ‘pelvic hemorrhage volume’

Extravasation

• Identification of ‘extravasation’ on contrast CT that correlated with angiographic findings

‘Clues’ re: need for angio
• transfusion requirements
• contrast extravasation (CE)
• age ≥ 60
• bladder displacement
  — ‘pelvic hemorrhage volume’
Age

Kimbrell et al: Arch Surg 2004
- angio 92 patients -> 55 (60%) embolization
- age > 60: 94% embolization (vs 50%)
- 2/3 patients > 60 yo = normal BP @ admission
- embolization -> 100% efficacy

Velmahos J Trauma 2002

‘Clues’ re: need for angio

- transfusion requirements
- contrast extravasation (CE)
- age > 60
- bladder displacement
  - ‘pelvic hemorrhage volume’

Case - acetabular fracture

Successful embolization of SGA
Angiography/ embolization

- Should be used in a protocol
  - Frequency ≈10%
- Indications
- ‘clues’
- Avoid bilateral internal iliac a. embolization
- Associated risks:
  - acute renal failure
  - gluteal muscle necrosis
  - deep infection

Damage Control Orthopaedics (DCO)

60’s to 80’s
“The patient is too sick to have surgery”

80’s to the 90’s
“Patient is too sick NOT to have surgery”

• Riska 1976
• Goris 1982
• Meek 1986
• Bone 1989
Origins of “damage control”

Temporary stabilization of fractures soon after injury, minimizing the operative time, and preventing heat and blood loss.

In severely injured patients, initial orthopaedic surgery should not be definitive treatment.

Definitive treatment delayed until after patients overall physiology improves


Orthopedic Damage Control

Damage Control

- Decompression of body cavities
- Bleeding control
- Repair of hollow viscus injuries
- Stabilization of central fractures
  - Pelvis
  - Femur

Decision Making Must Focus on the Patient as a “Whole”
Orthopaedic Damage Control

- Avoid worsening the patients condition by a major orthopaedic procedure (“2nd Hit”)

ARDS and Multiple Organ Failure

- Cascade of inflammatory reactions
- Exaggerated systemic inflammatory response syndrome (SIRS)
- ARDS and Multiple Organ Failure (MOF)

20 years of data at the Hannover Trauma Center suggest that patients who underwent a major (> 3 hour) operation on PTD 3 – 5 had increased mortality

Secondary surgical procedure acted as a “second hit”, exacerbating the primed systemic inflammatory response

No Severe Pulmonary Injury

- In patients without severe chest trauma
  - Early IM nailing reduced the length of ICU stay (7.3 days vs. 18.0 days)
  - Reduced the length of intubation (5.5 days vs. 11.0 days)
- In the absence of severe chest trauma primary IM femoral nailing is beneficial

Severe Pulmonary Injury

- In patients with severe chest trauma when IM nailing was performed in the first 24 hours
  - Higher incidence of posttraumatic ARDS (33% vs. 7.7%)
  - Higher mortality (21% vs. 4%)


Treatment Protocol

Temporary External Fixation

- Mean OR time
- Mean blood loss
- External fixation 35 min. 90 cc
- Reamed femoral nail 135 min. 400 cc


Temporary External Fixation

- 1.7 % infection rate
- One stage conversion considered safe
  - Ex fix on for short time (< 2 weeks)
  - No signs of pin site or systemic infection
  - No loosening of pins

Conclusion: Timing of 2\textsuperscript{nd} Definitive Surgery

- Avoid days 2 – 4 after injury
- Inflammatory system primed for an exaggerated response
- Wait until day 7 or later

DCO Stable vs unstable patient?

- Polytrauma patient
- Temporary ex fix
- IM nail at 7–14 days

Management of the Geriatric Trauma Patient

Geriatric Trauma

- Fatal injuries occur at a rate 3x higher than their representative numbers
- 28\% of all traumatic deaths occur in the geriatric age group despite having only 13\% of the population
- WHY??
The Elderly Are Different

• When controlled for severity, the elderly were six times as likely to die as their younger counterparts
• Osler, 1988

Hospital Triage

• Trauma outcomes in the very elderly (>80 years)
• Meldon et al (J Trauma 2002) – Retrospective cohort study
• Trauma centers had significantly better outcomes than acute care hospitals
• In severely injured patients (ISS 21-45) SURVIVAL was 56% in trauma centers vs. 8% in acute care hospitals

Appropriate Patient Triage

• Florida hospital system
• Consensus definition of major and minor trauma
• Geriatric trauma 24.2% of total patients but 37.8% of deaths
• Overall over triage rate of 7.4%
• Overall under triage rate of 71%

Motor Vehicle Accidents

• Pedestrian vs. Auto
• Car crashes
  – Restrained?
  – Airbags?
• Cause of crash?
  – Normal causes
  – Intoxication
  – TIA / CVA
  – Cardiac event
  – Hypoglycemia
  – Dementia
Impact of Pre-existing Disease

• Mortality was 9.2% with pre-existing disease compared to 3.2% without
• Mortality was 18% with 2 or more PED’s
• Renal disease, malignancy, and cardiac disease all had higher mortality

Milzman et al, 1992

Impact of Pre-existing Disease

<table>
<thead>
<tr>
<th># Co-morbidities</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.2%</td>
</tr>
<tr>
<td>1</td>
<td>6.1%</td>
</tr>
<tr>
<td>2</td>
<td>15.5%</td>
</tr>
<tr>
<td>&gt; 3</td>
<td>24.9%</td>
</tr>
</tbody>
</table>

Milzman et al, 1992

Impact of Pre-existing Disease

<table>
<thead>
<tr>
<th></th>
<th>Incidence (%)</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTN</td>
<td>7.7</td>
<td>10.2</td>
</tr>
<tr>
<td>COPD</td>
<td>3.7</td>
<td>8.4</td>
</tr>
<tr>
<td>CAD</td>
<td>2.9</td>
<td>18.4</td>
</tr>
<tr>
<td>IDDM</td>
<td>2.5</td>
<td>12.1</td>
</tr>
<tr>
<td>Obesity</td>
<td>2.1</td>
<td>4.8</td>
</tr>
<tr>
<td>Malignancy</td>
<td>1.0</td>
<td>20</td>
</tr>
<tr>
<td>Renal</td>
<td>0.5</td>
<td>37.5</td>
</tr>
<tr>
<td>Hepatic</td>
<td>0.5</td>
<td>12.2</td>
</tr>
</tbody>
</table>

NTDB Pelvic Fractures

• 45,081 patients identified by ICD-9 codes
• MVC most common in Adults (58%)
• Low-velocity falls most common in E/G (40%)
• Overall survival 89.9%
• Overall major complication 16.9%

<table>
<thead>
<tr>
<th>Group</th>
<th>Survival</th>
<th>&gt;/1 Major Comp</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>89.9%</td>
<td>16.9%</td>
</tr>
<tr>
<td>Adult</td>
<td>91.5%</td>
<td>15.8%</td>
</tr>
<tr>
<td>Elderly</td>
<td>87.1%</td>
<td>19.6%</td>
</tr>
<tr>
<td>Geriatric</td>
<td>90.5%</td>
<td>14.2%</td>
</tr>
</tbody>
</table>
Odds Ratios

<table>
<thead>
<tr>
<th>Group</th>
<th>Death</th>
<th>Severe Comp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elderly</td>
<td>2.74, 95% CI: 2.48-3.02</td>
<td>1.60, 95% CI: 1.45-1.76</td>
</tr>
<tr>
<td>Geriatric</td>
<td>5.19, 95% CI: 4.31-6.27</td>
<td>1.21, 95% CI: 0.94-1.54 (NS)</td>
</tr>
<tr>
<td>Male sex</td>
<td>1.36, 95% CI: 1.23-1.49</td>
<td>1.72, 95% CI: 1.56-1.89</td>
</tr>
<tr>
<td>Hypovolemic shock</td>
<td>3.67, 95% CI: 3.34-4.03</td>
<td>0.87, 95% CI: 0.78-0.98</td>
</tr>
<tr>
<td>Head injury</td>
<td>1.53, 95% CI: 1.33-1.75</td>
<td>1.40, 95% CI: 1.22-1.61</td>
</tr>
<tr>
<td>ISS &gt; 25</td>
<td>7.81, 95% CI: 7.06-8.64</td>
<td>4.12, 95% CI: 3.75-4.53</td>
</tr>
</tbody>
</table>

* Adults and elderly survive with a major complication (2,891, 94%) significantly more commonly than geriatric patients (210, 7%)*

Acetabulum Fractures

- U.S. National Trauma Database - 2002-6
- 17% of all acetabular fractures are in patients > 65 years old

<table>
<thead>
<tr>
<th>Acetabular Fractures</th>
<th>Age &lt; 65</th>
<th>Age ≥ 65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N = 9560</td>
<td>7938</td>
<td>1622</td>
</tr>
</tbody>
</table>

Who are these patients?

<table>
<thead>
<tr>
<th></th>
<th>&lt;65</th>
<th>≥65</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>7938</td>
<td>1622</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>71%</td>
<td>58%</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
| Mechanism
| Fall   | 18% | 61% |         |
| MVA     | 55% | 25% | <0.0001 |
| GCS <13 | 18% | 22% | <0.001  |
| Open fracture | 1.81% | 0.49% | 0.0001 |
| Systolic BP <90  | 14% | 17% | 0.0067  |

Lower Energy, Higher Complications

Acute In-Hospital Complications?

<table>
<thead>
<tr>
<th></th>
<th>&lt;65</th>
<th>≥65</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>7938</td>
<td>1622</td>
<td></td>
</tr>
<tr>
<td>Aspiration Pneumonia</td>
<td>4%</td>
<td>6%</td>
<td>1.5x</td>
</tr>
<tr>
<td>Cardiac Arrest</td>
<td>3%</td>
<td>5%</td>
<td>1.75x</td>
</tr>
<tr>
<td>Renal Failure</td>
<td>2%</td>
<td>6%</td>
<td>3x</td>
</tr>
<tr>
<td>UTI</td>
<td>22%</td>
<td>30%</td>
<td>1.5x</td>
</tr>
<tr>
<td>Death in house</td>
<td>1.5%</td>
<td>5%</td>
<td>3.3x 0.0001</td>
</tr>
</tbody>
</table>

Lower Energy, 3.3 x Rate of Mortality

**Discharge Location**

<table>
<thead>
<tr>
<th></th>
<th>&lt;65</th>
<th>≥65</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>7938</td>
<td>1622</td>
</tr>
<tr>
<td>SNF</td>
<td>5%</td>
<td>27%</td>
</tr>
<tr>
<td>Home</td>
<td>58%</td>
<td>19%</td>
</tr>
<tr>
<td>Nursing Home</td>
<td>2%</td>
<td>12%</td>
</tr>
<tr>
<td>Rehab</td>
<td>17%</td>
<td>25%</td>
</tr>
</tbody>
</table>

**Risk of Mortality in Acute Period**

- 3.8 x risk of mortality
- 3.7 times increased odds of complications
- Need More Post Discharge Services

**Summary**

- We will see an increase in seriously injured geriatric patients
- Must assess and address the patients acute and chronic health issues
- Geriatric patients are not like other trauma patients
- Early, aggressive care is mandatory to maximize survival
- Multidisciplinary management is very important

*Good results can be obtained with careful management!*

eric.meinberg@ucsf.edu