The Acute Management of Pelvic Ring Injuries

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Original Author: Kyle F. Dickson, MD; Created March 2004
Sean E. Nork, MD; Revised December 2010
New Author: October 2017
Conflicts of Interest

- I have no conflicts of interest to report.
Pelvic Ring Injuries

High energy

Morbidity/Mortality

Hemorrhage
Pelvic Ring Injuries

An unstable pelvic injury may allow hemorrhage to collect in the true pelvis as there is no longer a constraint which allows tamponade.

The volume was traditionally assumed to be a cylinder with a volume of $\frac{4}{3}\pi r^3$. However…

Best estimated by a hemi-elliptical sphere

(Stover et al, J Trauma, 2006)
Primary survey: ABC’s

Airway maintenance with cervical spine protection
Breathing and ventilation
Circulation with hemorrhage control
Disability: Neurologic status
Exposure/environment control: undress patient but prevent hypothermia
Considerations for Transfer or Care at a Specialized Center: Pelvic Fractures

- Significant posterior pelvis instability/displacement on the initial AP X-ray (indicates potential need for ORIF)
- Bladder/urethra injury
- Open pelvic fractures
- Lateral directed force with fractures through iliac wing, sacral ala or foramina
- Open book with anterior displacement > 2.5 cm (value of 2.5 centimeters somewhat arbitrary and controversial with regards to reliability)
Physical Exam

- Degloving injuries
- Limb shortening
- Limb rotation
- Open wounds
- Swelling & hematoma
Defining Pelvic Stability???

- Radiographic
- Hemodynamic
- Biomechanical (Tile & Hearn)
- Mechanical

“Able to withstand normal physiological forces without abnormal deformation”
Stable or Unstable?

- Single examiner
- Use fluoro if available
- Best in experienced hands
Radiographic Signs of Instability

• Sacroiliac displacement of 5 mm in any plane

• Posterior fracture gap (rather than impaction)

• Avulsion of fifth lumbar transverse process, lateral border of sacrum (sacro-tuberous ligament), or ischial spine (sacro-spinous ligament)
Open Pelvic Injuries

- Open wounds extending to the colon, rectum, or perineum: strongly consider early diverting colostomy

- Soft-tissue wounds should be aggressively debrided

- Early repair of vaginal lacerations to minimize subsequent pelvic abscess
Urologic Injuries

- 15% incidence

- Blood at meatus or high riding prostate

- Eventual swelling of scrotum and labia (occasional arterial bleeder requiring surgery)

- Retrograde urethrogram indicated in pelvic injured patients
Urologic Injuries

- Intraperitoneal & extraperitoneal bladder ruptures are usually repaired

- A foley catheter is preferred

- If a supra-pubic catheter is used, it should be tunneled to prevent anterior wound contamination

- Urethral injuries are usually repaired on a delayed basis
Sources of Hemorrhage

- External (open wounds)
- Internal:
  - Chest
  - Long bones
  - Abdominal
  - Retroperitoneal
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<table>
<thead>
<tr>
<th>Chest x-ray</th>
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<tbody>
<tr>
<td>Physical exam, swelling</td>
</tr>
<tr>
<td>DPL, ultrasound, FAST</td>
</tr>
<tr>
<td>CT scan, direct look</td>
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</tbody>
</table>
Shock vs Hemodynamic Instability

- Definitions Confusing
- Potentially based on multiple factors & measures
  - Lactate
  - Base Deficit
  - SBP < 90 mmHg
  - Ongoing drop in Hematocrit
  - Response to fluid challenge
Pelvic Fractures & Hemorrhage

- Fracture pattern associated with risk of vascular injury (Young & Burgess)
- External rotation and vertical shear injury patterns at higher risk for a vascular injury that internal rotation patterns
- APC & VS (antero-posterior compression and vertical shear) at increased risk of hemorrhage
- Injury patterns that are tensile to N-V structures at increased risk
  (eg iliac wing fractures with GSN extension)

Dalal et al, JT, 1989
Burgess et al, JT, 1990
Whitbeck et al, JOT, 1997
Switzer et al, JOT, 2000
Eastridge et al, JT, 2002
Pelvic Fractures & Hemorrhage: Young and Burgess Classification

Lateral Compression (LC)

Anteroposterior Compression (APC)

Vertical Shear (VS)
Hemorrhage Control: Methods

• Pelvic Containment
  • Sheet
  • Pelvic Binder
  • External Fixation
• Angiography
• Laparotomy
• Pelvic Packing
Circumferential Sheeting

- Supine
- 2 “Wrappers”
- Placement
- Apply
- “Clamper”
- 30 Seconds
Sheet Application
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Friday, November 3, 2017

Sheet Application

Before
North Oaks Trauma Symposium
Friday, November 3, 2017

After
Pelvic Binders

Commercially available. Placed over the TROCHANTERS and not over the abdomen.
# External Fixation

<table>
<thead>
<tr>
<th>Location</th>
<th>Clinical Application</th>
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<tbody>
<tr>
<td>AIIS</td>
<td>Resuscitative</td>
</tr>
<tr>
<td>ASIS</td>
<td>Augmentative</td>
</tr>
<tr>
<td>C-clamp</td>
<td>Definitive</td>
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</tbody>
</table>
Biomechanics of External Fixation: Anterior External Fixation

- Open book injuries with posterior ligaments (hinge) intact: 
  
  *All designs work*

- C-type injury patterns
  
  *No designs work well (but AIIS frames help more than ASIS frames)*
Biomechanics of External Fixation: Considerations

- Pin size
- Number of pins
- Frame design
- Frame location
ASIS Frames

- Placed at the iliac crests bilaterally
- Not a good vector for controlling the pelvis
AIIS Frames

- Placed at the AIIS bilaterally
- At least biomechanically equivalent, thought to be superior to ASIS frames
- Patients can sit

Kim et al, CORR, 1999
AIIS Frames

Placed at the AIIS bilaterally
At least biomechanically equivalent, thought to be superior to ASIS frames

Patients can sit

Kim et al, CORR, 1999
Indications for External Fixation

- Resuscitative (hemorrhage control, stability)
- To decrease pain in polytraumatized patients?
- As an adjunct to ORIF
- Definitive treatment (Rare!)
  - Distraction frame
  - Can’t ORIF the pelvis
Indications for External Fixation

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Theoretical and a marginal indication, but there is literature support

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Indications for External Fixation

• Resuscitative (hemorrhage control, stability)

• To decrease pain in polytraumatized patients?

• As an adjunct to ORIF

• Definitive treatment (Rare!)
  • Distraction frame
  • If can’t ORIF the pelvis
Anti-shock Clamp (C-clamp)

Better posterior pelvis stabilization

Allows abdominal access

Consider application with fluoro or in the OR to prevent poor pin placement

Can be combined with pelvic packing

Ertel, W et al, JOT, 2001
Anti-shock Clamp (C-clamp)

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Emergent Application
Pelvic Packing

- Ertel, W et al, JOT, 2001
- Pohlemann et al, Giannoudis et al,
Role of Angiography???

- Valuable for arterial only
- Estimated at 5-15%
- Timing (early vs late?)
- Institution dependent
Role of Angiography???

- Fracture pattern may predict effectiveness
- Contrast CT suggests
- Effective in retrospective studies!!!
Vascular Injuries

- Arterial vs Venous vs Cancellous
- Unstable posterior ring association
- Associated fracture extension into notch
- Role of angiography

Cryer et al, JT, 1988
O’Neill et al, CORR, 1996
Goldstein et al, JT, 1994
Acute Hemipelvectomy....
Acute Hemipelvectomy….

Rarely required (thankfully)
Life saving indications only
Retrospective evidence suggests…

- Hypotensive with stable pelvic pattern…
  - Proceed to Laparotomy (85% with abdominal hemorrhage)
- Hypotensive with unstable pelvic pattern…
  - Proceed to Angio (59% with positive angio)

Eastridge et al, JT, 2002

Contrast enhanced CT very suggestive of arterial source
(40 fold likelihood ratio)
(PPV and NPV of 80%, 98%)

Stephen et al, JT, 1999
Example of a protocol for management
Example of a protocol for management

• Hypovolemic shock and no response to fluids…
  • (+) DPL: 1. Laparotomy (+/- packing with ex fix)
  • 2. Angio
  • (-) DPL: 1. Sheet/binder/ex-fix (some still crash lap)
  • 2. Angio

Hypovolemic shock with response to fluids…

(+++) DPL: 1. Laparotomy (+/- packing with ex fix)
  2. Ex Fix
  3. Angio

(+) DPL: 1. Ex Fix
  2. Laparotomy
  3. Angio

(-) DPL: 1. Sheet/binder
  2. Angio
  3. Ex Fix
Example of a protocol for management

Pelvic Fracture Protocol

- Pelvic fracture
  - SBP 100 mm Hg
    - Y: Binder
    - N: Age > 55
  - Age > 55
    - Y: Binder
    - N: Complex fracture (APC 2, APC 3, LAC 3, VS)
    - Y: Binder
    - N: SDF
      - Y: Abdominal injury?
        - Y: Pelvic angiogram
        - N: Routine workup
      - N: Routine workup
  - SDF
    - Y: Do you bleed?
      - Y: Expiratory angiogram
        - Y: Consider pelvic angiogram
        - N: Other sources of bleeding?
          - Y: Pelvic angiogram
          - N: Other sources of bleeding?
            - Y: Pelvic angiogram
            - N: Routine workup
  - Routine workup

* Fluid resuscitation is assumed
* Order angiogram as “Level 1”
Protocol for Management

- **Biffl et al.** Evolution of a multidisciplinary clinical pathway for the management of unstable patients with pelvic fractures. *JOT*, 2001

<table>
<thead>
<tr>
<th>5 elements:</th>
<th>Immediate trauma surgeon availability (+ Ortho!)</th>
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<tbody>
<tr>
<td></td>
<td>Early simultaneous blood and coagulation products</td>
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<tr>
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<td>Prompt diagnosis &amp; treatment of life threatening injuries</td>
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<tr>
<td></td>
<td>Stabilization of the pelvic girdle</td>
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<tr>
<td></td>
<td>Timely pelvic angiography and embolization</td>
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</tbody>
</table>

| Changes: | Patients more severely injured (52% vs 35% SBP < 90) |
|          | DPL phased out for U/S |
|          | Pelvic binders and C-clamps replaced traditional ex fix |
Protocol for Management

- Biffl et al, Evolution of a multidisciplinary clinical pathway for the management of unstable patients with pelvic fractures. JOT, 2001

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<thead>
<tr>
<th></th>
<th>Mortality decreased</th>
<th>Exsanguination death</th>
<th>MOF</th>
<th>Death (&lt;24 hours)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>from 31% to 15%</td>
<td>from 9% to 1%</td>
<td>from 12% to 1%</td>
<td>from 16% to 5%</td>
</tr>
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The evolution of a multidisciplinary clinical pathway, coordinating the resources of a level 1 trauma center and directed by joint decision making between trauma surgeons and orthopedic traumatologists, has resulted in improved patient survival. The primary benefits appear to be in reducing early deaths from exsanguination and late deaths from multiple organ failure.
Immediate Percutaneous Fixation

From Chip Routt, MD

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Summary: Acute Management

• Play well with others (general surgery, urology, interventional radiology, neurosurgery)

• Understand the fracture pattern

• Do something (sheet, binder, ex fix, c-clamp)

• Combine knowledge of the fracture, the patients condition, and the physical exam to decide on the next step
Thank You!

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