The Acute Management of Pelvic Ring Injuries

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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 assume 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 &
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 (sacrotuberous ligament), or ischial spine (sacrospinous 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
Sources of Hemorrhage

- External (open wounds)
- Internal: Chest
  - Long bones
  - Abdominal
  - Retroperitoneal

- Chest x-ray
- Physical exam, swelling
- DPL, ultrasound, FAST
- CT scan, direct look
Shock vs Hemodynamic Instability

- Definitions Confusing
- Potentially based on multiple factors & measures
  - Lactate
  - Base Deficit
  - SBP < 90 mmHg
- Ongoing drop in Hematocrit
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
Circumferential
• Supine
• 2 “Wrappers”
• Placement
• Apply
• “Clamper”
• 30 Seconds

Routt et al, JOT, 2002
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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</thead>
<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
AS

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

- Placed at the AIIS bilaterally
- At least biomechanically equivalent, thought to be superior to ASIS frames
- Patients can sit
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
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Theoretical and a marginal indication, but there is literature support

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  - If can’t ORIF the pelvis
Technical Details: ASIS & AIIS Frames
Pin Orientation: ASIS
Pin Orientation: AIIS
Pin Orientations
Technical Details: ASIS frames...

- Fluoro dependent
- 3 to 5 cm posterior to the ASIS
- Along the gluteus medius pillar
- Incisions directed toward the anticipated final pin location
- Pin entry at the junction of the lateral 2/3 and medial 1/3 of the iliac crest (lateral overhang of the crest)

  Aim: 30 to 45 degrees (from lateral to medial)

  Toward the hip joint

Consider partial closed reduction first!
Outlet Oblique Image

- Inner Table
- Outer Table
- ASIS
Outlet Oblique Image

- Inner Table
- Outer Table
- ASIS
Confirm Pin Placement
Technical Details: AIIS frames...

- Fluoro dependent:
  1. 30/30 outlet/obturator oblique incision (confirm entry location and direction)
  2. Iliac oblique (confirm direction above sciatic notch)
  3. Inlet/obturator oblique (confirm location and depth)

- Incisions directed toward the anticipated final location

- Blunt dissection

- Aim: According to fluoro
  
  Consider partial closed reduction first!
Outlet Obturator Oblique Image
5 degrees too much obturator

5 degrees too little obturator

5 degrees too much outlet

5 degrees too little outlet
5 degrees too much obturator

5 degrees too little obturator

5 degrees too much outlet

5 degrees too little outlet
Outlet Obturator Oblique Image
Pin Orientation

Inlet (with obturator oblique)
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
C-clamp: Anatomical Landmarks

- Same (similar location) as the starting point for an iliosacral screw
- “Groove” located on the lateral ilium as the wing becomes the posterior pelvis
- Allows for maximum compression
- Can be identified without fluoro in experienced hands

Pohlemann et al, JOT, 2004
Caution...

Avoid Over-compression in Sacral Fractures!
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 unstable pelvic pattern...
- Proceed to Laparotomy (85% with abdominal hemorrhage)
- Hypotensive with unstable pelvic pattern...
- Proceed to Angio (59% with post angiography)

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

Hemodynamically Unstable Patient w/Pelvic Fracture

- Identify treat life-threatening hemorrhage
- Apply Non-Invasive Pelvic Stabilization (if indicated)

- Transfer:
  - Definitive treatment promptly available? yes
  - No

- Intra-Abdominal Hemorrhage:
  - Life Threatening
  - LVQ absent present

- Initial Skeletal Stabilization/Angiography
- Initial Skeletal Stabilization/Laparotomy

- Large expanding BPx?:
  - yes Angiography
  - no ICU Admission
    - Further work-up & stabilization

- Angiography
  - yes Repeat Angiography
  - no Remains Unstable?
    - Excessive Transfusion Requirement?
      - yes Is Pelvic Frx OPEN?
      - no No Colostomy Required

- Buttock-Perineal Wound?
  - yes Definitive Pelvic fracture fixation
  - no Serial i&d of wound
    - Perform diverting colostomy within 48 hours of injury

Definitive Pelvic fracture fixation
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 < 100mm Hg
    - Y: Binder
    - N: Fast +
  - Age > 55
    - Y: Binder
    - N: Complex fracture (APC 2, APC 3, LC 3, V5)
      - Y: Binder
      - N: Routine work-up
  - Fast +
    - Y: Binder
    - N: Abdominal/pelvic CT scan
      - Y: Intra-abdominal injury?
        - Y: Exploratory laparotomy vs. observe
        - N: Pelvic hematoma?
          - Y: Pelvic angiogram
          - N: Routine work-up
      - N: Routine work-up
  - NC-1 fracture?
    - Y: Exploratory laparotomy
    - N: Consider pelvic angiogram
  - Other source of bleeding?
    - Y: Treat other sources of bleeding
    - N: Routine work-up

* 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

5 elements:
- Immediate trauma surgeon availability (+ Ortho!)
- Early simultaneous blood and coagulation products
- Prompt diagnosis & treatment of life threatening injuries
- Stabilization of the pelvic girdle
- Timely pelvic angiography and embolization

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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<th>Indicator</th>
<th>Improvement</th>
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<tr>
<td>Mortality decreased</td>
<td>from 31% to 15%</td>
</tr>
<tr>
<td>Exsanguination death</td>
<td>from 9% to 1%</td>
</tr>
<tr>
<td>MOF</td>
<td>from 12% to 1%</td>
</tr>
<tr>
<td>Death (&lt;24 hours)</td>
<td>from 16% to 5%</td>
</tr>
</tbody>
</table>

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
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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HMC Faculty
Barei, Beingessner, Bellabarba, Benirschke, Chapman, Dunbar, Hanel, Hanson, Henley, Krieg, Routt, Sangeorzan, Smith, Taitsman
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