Management of Pelvic Injuries
Orthopedic Perspective
Pelvic Fractures

HIGH ENERGY IMPACT

• Falls
• High speed VA
• Crush injury
  Marker for severe injury
• Overall mortality 6-10%
• Life threatening
• ACL injury 500-1000N
• pelvic fracture 6000-9000N
<table>
<thead>
<tr>
<th>Injury</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed-head injury</td>
<td>51</td>
</tr>
<tr>
<td>Long-bone fracture</td>
<td>48</td>
</tr>
<tr>
<td>Peripheral nerve injury</td>
<td>26</td>
</tr>
<tr>
<td>Thoracic injury</td>
<td>20</td>
</tr>
<tr>
<td>Bladder</td>
<td>10</td>
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<tr>
<td>Spleen</td>
<td>10</td>
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<tr>
<td>Liver</td>
<td>7</td>
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<tr>
<td>Gastrointestinal tract</td>
<td>7</td>
</tr>
<tr>
<td>Kidney</td>
<td>7</td>
</tr>
<tr>
<td>Urethra</td>
<td>6</td>
</tr>
<tr>
<td>Mesentery</td>
<td>4</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>2</td>
</tr>
</tbody>
</table>
Bone Anatomy

- Two innominate bones with sacrum.
- Ilium, ishium and pubis
- Gap in symphysis < 5 mm
- SI joint gap 2-4 mm
Ligamentous Anatomy

- Ligaments:
  - Posterior SI
  - Anterior SI
  - Interosseous ligaments
  - Pubic symphysis
  - Sacrotuberous
  - Sacrospinous

- Posterior ligaments are stronger than anterior
Ligaments

- **Ant. SI**: Resist external rotation (rotational stability)
- **Post. SI and Interosseous** – long posterior provide vertical stability, strongest in body.
- **Iliolumbar ligaments**: provide rotational stability
- **Lumbosacral ligaments**: provide vertical stability
- **Sacrotuberous**: Resists shear and flexion of SI joint
- **Sacrospinous**: provide rotational stability
Vascular Anatomy

- Internal iliac artery courses medial to the vein, splits into anterior and posterior branches.
- Posterior branch is more likely injured (Sup. Gluteal A. is largest branch).
Possible Bleeders

- Sacral venous plexus*
- Iliolumbar a.
- Internal iliac a.
- Superior gluteal a.*
- Lateral sacral a.
- Pudendal a.
- Cancelluos bone
- Retroperitoneal veins
Potentially Damaged Visceral Anatomy

- Blunt vs. impaled by bony spike
  - Bladder/urethra
  - Rectum
  - Vagina
Pelvic Stability

- Stability – ability of pelvic ring to withstand physiologic forces without abnormal deformation

- Strength of ring: 40% anterior and 60% posterior
Important Stabilizing Ligaments

- Anterior Sacroiliac ligament
- Posterior Sacroiliac ligament
- Sacrotuberous ligament
- Sacrospinous ligament
- Illiolumbar ligament
- Interosseous ligament
- Symphysis
Forces acting on pelvis
Radiographs

- Anteroposterior (AP)
- Inlet (40°)
- Outlet (40°)
- CT scan
- Judet (acetabular fractures)
If evidence of pelvic ring fracture...
Inlet View

- Horizontal Plane Rotation
- Posterior Displacement
OUTLET VIEW
Outlet View

- Sacrum
- Cephalad Displacement
- Sacral Foramina
CT Scan

- Better defines posterior injury
- Amount of displacement versus impaction
- Rotation of fragments
- Amount of comminution
- Assess neural foramina
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),
  - ischial spine (sacrospinous ligament)
Classification

- USEFUL IN UNDERSTANDING

- Hemodynamic instability
- Visceral and genitourinary injuries
- Pelvic instability
- Mechanism of injury, force vector of injury.

• Planning surgical technique for Reduction & fixation
Classification Systems

• Anatomical (Letournel)
• Stability & Deformity (Pennal, Bucholz, Tile)
• Vector force and associated injuries (Young & Burgess)
• OTA-research
Tile classification

- Type A: pelvic ring stable
- Type B: rotationally unstable, vertical stable
- Type C: rotationally and vertically unstable

Advantages: Tile classification aids in the determination of prognosis
Young-Burgess

- Based on mechanism of injury
- Predictive of associated local & distant injury
- Useful for planning acute treatment
Young and Burgess classification

- Lateral compression (LC)
- Antero posterior compression (APC)
- Vertical shear (VS)
- Combined mechanism (CM)

Advantages: this classification alerts the surgeon to potential resuscitation requirements and associated injury patterns
MECHANISM OF INJURY

- **Lateral compression** (implosion)
- **AP compression** (external rotation)
- **Vertical shear**
- **Combined injury**
APCompression

- Urologic injury
- Hemorrhage
- Pelvic vascular injury,
Vertical Shear

- Always unstable
- Ant. symphsis or vertical rami fractures-post. Injury variable
- Vertical displacement
COMBINED MECHANICAL INJURY

Combined vectors occasionally 2 separate injuries (ejection/landing).
ASSOCIATED INJURIES

Lateral Compression:
- Abdominal visceral injury
- Head injury
- Few pelvic vascular injuries

AP Compression:
- Urologic injury
- Hemorrhage/pelvic vascular injury:
  APCII-10%, APCIII-22%
RESUSCITATION REQUIREMENTS

- LC-I: 2.3 units
- LC-II: 3.1 units
- LC-III: 7.4 units
- VS: 9.4 units
- AP-II: 7.6 units
- AP-III: 35.4 units

Blood resuscitation requirements for different units and time periods.
Mortality

Deaths:

- LC: 6.60%
- VS: 0%
- APC: 20%
Treatment Planning (Young-Burgess)

- LC-I, AP-I
  - Conservative Treatment

- AP-II
  - Anterior Stabilization
  - Anterior and Posterior Stabilization

- AP-III, VS
Management of Pelvic Injuries
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
Physical Examination

- Neurologic deficit involving lumbosacral plexus
- Pelvic/flank/perineal contusions, ecchymoses, abrasions
- Blood at urethral meatus
- Blood in or around rectum
- Open wound of groin, buttock, or preineum
- Leg length inequality or external rotation of one extremity
- Abnormal pelvic motion on AP or lateral compression of anterior iliac spines and iliac crests
Neurological exam

- Rectal exam for tone
- Bulbocavernosus reflex

- Myotomes of lower extremity
  - L1-2: hip flexor
  - L3-4: Quadriceps/knee extension
  - L4-5: Ankle and toe dorsiflexion
  - S1: ankle plantarflexion
  - S2-3: toe plantarflexion
RED FLAGS IN 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
Physical Exam

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

- Radiographic
- Hemodynamic
- Biomechanical
ASSESSMENT

- INJURY SEVERITY SCORE
- REVISED TRAUMA SCORE
- TRANSFUSION NEED CORRELATE DIRECTLY WITH INCREASED MORTALITY

- External: open wounds

- Internal
  - Long bones
  - Abdominal
  - Retroperitoneal
  - Chest

Hemodynamic instability
Sources of Hemorrhage

- Cancellous bone at fracture
- Retroperitoneal vessels
- Internal iliac artery
- Hypogastric arterial bleed
- External (open wounds)

- Internal: Chest
- Long bones
- Abdominal
Hemorrhage Control: Methods

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

- Supine
- 2 “Wrappers”
- Placement
- Apply
- “Clamper”
- 30 Seconds
Pelvic Binders

Commercially available. Placed over the TROCHANTERS and not over the abdomen not more than 24 hours.
Pelvic binder

Before

After
## External Fixation

<table>
<thead>
<tr>
<th>Location</th>
<th>Clinical Application</th>
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<tbody>
<tr>
<td>AIIS</td>
<td>Resuscitative</td>
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<tr>
<td>ASIS</td>
<td>Pain management</td>
</tr>
<tr>
<td>(Posterior) C-clamp</td>
<td>Adjunct to ORIF</td>
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<tr>
<td></td>
<td>Definitive</td>
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Indications for External Fixation

- Resuscitative (hemorrhage control, stability)
- To decrease pain in polytrauma patients.
- As an adjunct to ORIF
- Definitive treatment.
EXTERNAL FIXATOR
Anti-shock Clamp (C-clamp)

- Better posterior stabilization
- Allows abdominal access
- Apply under fluoro or in the OR to prevent poor pin placement
- Can be combined with pelvic packing
Emergent Application C-clamp under fluoro
Avoid Over-compression in Sacral Fractures!
Pelvic Packing
Role of Angiography???

Arterial only

5-15%
Acute Hemipelvectomy....
Pelvic Fracture
Definitive Management
Non-Operative Management

• Lateral impaction type injuries with minimal (< 1.5 cm) displacement
• Pubic rami fractures with no posterior displacement
• Minimal gapping of pubic symphysis
  – If NO associated SI joint injury
Non-Operative Management

• X-rays are static picture of dynamic situation
  – Stress radiographs may help
  – Post-mobilization radiographs are essential
• Regular follow-up during conservative management.
  – In case of displacement reassess stability.
Operative Indications

• Resuscitation
• Assist in mobilization
  – Just as stabilizing long bones helps in mobilization of polytrauma patients
• Prevent long term functional impairment
  – Deformity of pelvic ring can impact function
Surgical Treatment: Preoperative Planning

Coordination of care

- Trauma surgeon, intensivist, neurosurgeon, G. surgeon, plastic surgeon, Gynecologist

Associated injuries
Preoperative Planning

• **Timing of surgery**
  
  Reduction may be easiest in first 24-48 hours.

  Resuscitation should be the priority

  Team Approach
Conclusions

- Multidisciplinary approach (general surgery, urology, interventional radiology, neurosurgery)
- Understand the fracture pattern
- Do something (sheet, binder, ex fix, c-clamp)
- Combine knowledge of the fracture, the patient's condition, and the physical exam to decide on the next step
- Treatment is based on:
  - Pelvic instability,
  - Displacement,
  - Associated injuries
- Surgical techniques for reduction and stabilization continue to evolve
Thank you