Objectives

- Recognize findings of instability
- Become familiar with injury patterns
- Understand biomechanics of fixation
- Become familiar with fixation/reduction techniques

Introduction: Pelvic Ring Stability

- Stability defined as ability to support **physiologic load**
  - Sitting
  - Side lying
  - Standing
Introduction:
Pelvic Ring Stability

Posterior ring integrity is important in transferring load from torso to lower extremities

Defining Instability

- Loss of posterior ring integrity often leads to instability
- Loss of anterior ring integrity may contribute to instability, and may be a marker to posterior ring injury

Is it stable?

- Is there deformity?
  - Deformity on presentation predicts instability
  - Accurately assess posterior ring
Is it stable?

- Is there deformity?
  - Assess with CT

Is it stable?

- Is there deformity?
  - Stress radiographs
  - C-arm image in OR

Is it stable?

- Is there deformity?
  - Are there clues to soft tissue injury?
  - LS transverse process fx
  - Ischial spine avulsion
  - Lateral sacral avulsion
Describing Instability

- Tile Classification
  - A stable
  - B partially stable
  - C unstable

In order to assess posterior ring instability, the whole pelvis must be considered and evaluated

Initial evaluation

- ATLS
- Binder
  - open book/APC
- NV examination
- Open injuries
  - GU/GR
- Imaging
  - XR
  - CT

Non-Operative Management

- Lateral impaction with min (< 1.5 cm) displ.
- Pubic rami fxs w/o posterior displacement
- Minimal gapping of pubic symphysis
  - W/O SI injury
  - 2.5 cm or less, assuming no motion
  - This number is not absolute
    - R/O other evidence of instability (like SI injury)
Non-Operative Treatment

- Tile A (stable) injuries
  - WBAT +/- assistive devices
- Serial radiographs followed during healing
- Displacement requires reassessment of stability and consideration given to operative treatment

Non-Operative Treatment

- Tile B (partially stable) injuries
  - Nonop if deformity is minimal
  - TTWB on ipsilateral side
  - Serial radiographs
- Displacement requires reassessment of stability and consideration given to operative treatment

Non-Operative Treatment

- Failure of non-operative treatment may be due to displacement after mobilization
- Excessive pain which precludes early mobilization may also be failure of non-operative treatment

MUST BE WILLING TO CHANGE ON THE FLY
Principles of Operative Treatment

- Posterior ring structure is important
- Goal is restoration of anatomy and sufficient stability to maintain reduction during healing
- Most injuries involve multiple sites of injury
  - In general, more points of fixation lead to greater stability
  - This does NOT mean that all sites of injury need fixation

Principles of Operative Treatment

- Anterior ring fixation may provide structural protection of posterior fixation
- If combined open and percutaneous techniques are used, open portion often performed first to aid reduction for percutaneous portion

Preoperative Planning

- Clearance, imaging, surgical planning steps – discussed at another time

- Will focus on operative stabilization techniques for posterior ring/SI
Preoperative Planning

- Reduction tools
  - Traction
  - Pelvic manipulator (e.g. femoral distractor)
  - Specialized clamps

- Implants needed
  - Extra-long screws
  - Cannulated screws, often extra-long
  - Specialized plates for contourability (recon plates)
  - External fixation

Preoperative Planning

- Surgical approaches planned
  - Soft tissues examined
  - Patient positioning planned
    - Is it safe to prone patient?
    - Equipment/padding for safe prone positioning

Surgical Approaches: Posterior Pelvic Ring

- Anterior approach
  - Iliac window of the ilioinguinal
  - Exposure of SI joint

Surgical Approaches: Posterior Pelvic Ring

- Posterior approach
  - Exposure of sacrum and posterior ilium
  - Sacral fractures
  - Iliac fracture dislocations of the SI joint (crescent fracture)

Surgical Approaches: Posterior Pelvic Ring

- Posterior approach
  - Paramedian incision

Reduction and Fixation: SI Joint Dislocation

- Anterior exposure facilitates reduction of dislocation
- Iliac window of ilioinguinal approach
Reduction and Fixation: Anterior ring

- Anterior ring stabilization/reduction
  - May be required to reduce posterior ring
  - ORIF
  - In-Fix
  - Ex-Fix
  - Nothing

Reduction and Fixation: SI Joint Dislocation

- Clamp applied from lateral, posterior ilium to anterior sacral ala

Reduction and Fixation: SI Joint Dislocation

- Plating
  - Need more than one plate to avoid linkage displacement
  - Can be used in tandem or with SI screw
Reduction and Fixation:
SI Joint Dislocation

- SI screw
  - Cannulated for ease of placement
  - Partially threaded for reduction
  - Fully threaded for improved fixation
  - Knowledge of anatomy and imaging is essential
  - Be aware of sacral dysmorphism

Iliosacral screw

- Angle enables compression across SIJ
- S1 – L5 nerve root
- Lat/Inlet/Outlet and tactile feel

Trans-sacral screw

- Anchors into good cortical bone
- Perpendicular to fracture site
  - Compression safe?
- Lat/Inlet/Outlet and tactile feel
- S1 – L5 nerve root
- Resist vert. shear
KNOW YOUR ANATOMY!

Dysmorphism can be problematic...

**Anatomic determinants of sacral dysmorphism and implications for safe iliosacral screw placement**

**Background**
- Qualitative Characteristics:
  1. Sacrum NOT recessed in the pelvis
  2. Presence of mamillary processes
  3. An acute alar slope
  4. A residual disc between S1/S2
  5. Non-circular sacral foramina

**Sacral dysmorphism: screw insertion implications**
- S1 corridor is more up-sloped
- S2 corridor is wider
Sacral dysmorphism: screw insertion implications

- S1 corridor is more upsloped
- S2 corridor is wider
- S1 – IS screw only
- S2 – IS or TS screws

Reduction and Fixation:
SI Joint Fracture/Dislocation
“Crescent Fracture”

- SI screw
  - If caudal segment is in the path of fixation screw
  - Opportunity for percutaneous treatment
Reduction and Fixation:
SI Joint Fracture/Dislocation
“Crescent Fracture”

• SI screw and plate
  – Anterior ORIF if large fragment
  – Supplement as needed with SI screw

Reduction and Fixation:
SI Joint Fracture/Dislocation
“Crescent Fracture”

• ORIF with plate
  – Posterior approach

Reduction and Fixation:
SI Joint Fracture/Dislocation
“Crescent Fracture”

• ORIF with plate
  – Posterior approach
Reduction: Sacral Fracture

- Indirect reduction
  - Anterior ring reduction

Reduction: Sacral Fracture

- Indirect reduction
  - Anterior ring reduction
  - Open reduction pubic root

Reduction: Sacral Fracture

- Indirect reduction
  - Anterior ring reduction
Reduction: Sacral Fracture

• Indirect reduction
  – Distractor
  – Traction

• Direct reduction
  – Posterior exposure
  – Clamp application
    • Pointed Weber clamps
  – Can decompress as well if needed
Reduction:
Sacral Fracture

Fixation:
Sacral Fractures

- Lumbopelvic fixation
  - Vertical control
  - Can be useful in unstable H or Y type sacral fracture
- Transiliac plating

Biomechanics of Pelvic Fixation:

- No clinical comparison studies exist
- Experimental biomechanical data exist
- In general, it seems that more points/planes of fixation provide better stability
- How much stability is enough is injury dependent
Biomechanics of Pelvic Fixation: Posterior Fixation

- Lumbopelvic fixation
  - Lumbopelvic dissociation (unstable Y, H, or U type sacral fractures)
  - Sacral fractures with significant instability
  - Can provide axial (vertical) stability that is not as dependent on fracture reduction/stability

Summary

- Complex constellation of injuries

- Treatment based on
  - Comprehensive understanding of potential pelvic ring instability
  - Displacement
  - Associated injuries
  - Comfort/skill level