Goals

• Define pelvic ring instability
• Decision process: operate or not?
• Non-operative treatment
• Principles of operative treatment
• Preoperative planning
• Surgical approaches
• Techniques of pelvic reduction and fixation
• Biomechanics of fixation techniques
• Outcomes of pelvic ring injury
Introduction:
Pelvic Ring Stability

• Stability defined as ability to support physiologic load
• Physiologic load may be sitting, side lying, or standing, as dictated by patient needs
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
- Tile classification scheme based on instability patterns
Is it stable?

• Is there deformity?
  – Deformity on presentation predicts instability
Is it stable?

- Is there deformity?
- Is the posterior pelvic ring intact?
  - CT scan
Is it stable?

- Is there deformity?
- Is the posterior pelvic ring intact
- Stress radiographs
Is it stable?

- Is there deformity?
- Is the posterior pelvic ring intact
- Stress radiographs
- Are there clues to soft tissue injury?
  - LS transverse process fx
  - Ischial spine avulsion
  - Lateral sacral avulsion
Describing Instability

• Refer to previous lecture on Classification
• Tile Classification
  – A stable
  – B partially stable
  – C unstable
Operative Indications

• Resuscitation
  – See previous lecture on Acute Management
• 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
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
  – Without associated SI injury
  – 2.5 cm or less, assuming no motion with stress or mobilization
  – This number is not absolute, so other evidence of instability (like SI injury) must be ruled out
Non-Operative Management

• X-rays are static picture of dynamic situation
  – It may be that the deformity is worse than seen on X-rays taken
  – Stress radiographs may be helpful
  – Post-mobilization radiographs should be taken in all cases of non-operative treatment
  – Other evidence of instability should be sought
    • Lumbar transverse process fractures
    • Avulsions of sacrotuberosus/sacrospinous ligaments
Non-Operative Treatment

• Tile A (stable) injuries can generally bear weight as tolerated
• Walker/crutches/cane often helpful in early mobilization
• Serial radiographs followed during healing
• Displacement requires reassessment of stability and consideration given to operative treatment
Non-Operative Treatment

- Tile B (partially stable) injuries can be treated non-operatively if deformity is minimal
- Weight bearing should be restricted (toe-touch only) on side of posterior ring injury
- Serial radiographs followed during healing
- 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
Principles of Operative Treatment

- Posterior ring structure is important
- Goal is restoration of anatomy and enough 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, the open portion is often done first to aid in reduction of the percutaneously treated injury
Surgical Treatment: Preoperative Planning

• Consider patient related factors
  – Surgical clearance, resuscitation
  – Coordination of care
    • Trauma surgeon, intensivist, neurosurgeon
Surgical Treatment: Preoperative Planning

• Consider patient related factors
  – Associated injuries
    • May need general surgeon, genitourinary surgeon, gynecologist, plastic surgeon
Preoperative Planning

• Timing of surgery
  – Reduction may be easiest in first 24-48 hours
    • May aid in percutaneous reduction
  – Patients often not adequately resuscitated in first 24 hours
  – Potential for surgical “secondary hit” on post-injury days 2-5
    • May be a significant issue in open procedures
Preoperative Planning

• Intraoperative imaging
  – Radiolucent table
  – Fluoroscopy
  – Radiologic Technician and Surgeon understand C-arm views necessary
Preoperative Planning

• Reduction tools
  – Traction
  – Pelvic manipulator (e.g. femoral distractor)
  – Specialized clamps
Preoperative Planning

• Implants needed
  – Extra-long screws
  – Cannulated screws, often extra-long with appropriate instruments
  – Specialized plates for contourability (reconstruction 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: Anterior Pelvic Ring

• Pfannenstiel
  – Exposure of symphysis pubis and pubic bones
  – Avoid transection of rectus tendons
  – Elevate rectus subperiosteally
Surgical Approaches: Anterior Pelvic Ring

- Stoppa extension
  - Exposes symphysis to SI joint along pelvic brim
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
Reduction and Fixation: Symphysis

• Reduction with clamp
  – Weber clamp on pectineal eminences

Matta and Tornetta, CORR 329, pp129-140, 1996
Reduction and Fixation: Symphysis

- Reduction with clamp
  - Jungbluth clamp with screws

Matta and Tornetta, CORR 329, pp129-140, 1996
Reduction and Fixation: Symphysis

- Pelvic reconstruction plate
  - Commonly 6 hole plate
  - Variable directions of screws
Reduction and Fixation: Ramus Fractures

• Pelvic reconstruction plate

• Medullary screw fixation
  – Retrograde
  – Antegrade
Reduction and Fixation: Ramus Fractures

- Pelvic reconstruction plate
- Medullary screw fixation
  - Retrograde
  - Antegrade
Reduction and Fixation: Ramus Fractures

- Pelvic reconstruction plate
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Reduction and Fixation: Ramus Fractures

- Anterior External Fixation
  - Controls rotation only
  - Pins in gluteus medius pillar of ilium
  - Alternative placement in Anterior Inferior Iliac Spine
Reduction and Fixation: SI Joint Dislocation

- Anterior exposure facilitates reduction of dislocation
- Iliac window of ilioinguinal approach
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
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
Reduction: Sacral Fracture

- Indirect reduction
  - Distractor
  - Traction
Reduction:
Sacral Fracture

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

Matta and Tornetta, CORR 329, pp129-140, 1996
Fixation: Sacral Fracture

- Iliosacral screws
  - Upper 2 sacral segments
  - Fully threaded screws
  - Know morphology, anatomy
Fixation: Sacral Fracture

- **Iliosacral screws**
  - Upper 2 sacral segments
  - Fully threaded screws
  - Know morphology, anatomy
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 dependant
Biomechanics of Pelvic Fixation: Anterior Fixation

- Anterior plating superior to external fixation in internal/external rotation
- Neither technique very effective at control of vertical displacement
- Anterior fixation can “protect” posterior fixation from failure
Biomechanics of Pelvic Fixation: Anterior Fixation

- Two hole symphyseal plate inadequate
- Retrograde pubic screw higher failure rate than antegrade
Biomechanics of Pelvic Fixation: Posterior Fixation

- Options include single SI screw, multiple SI screws, double plating of SI joint, transiliac plate of sacral fracture, or plate plus SI screw for sacral fracture or SI dislocation
- Any of the above are more stable than single SI screw in unstable injuries
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 dependant on fracture reduction/stability
Outcomes

• Pain common
• Improvement occurs for at least a year in most patients
• Neurologic injury most common predictor of poor outcome
Outcomes

- SI dislocations have poor tolerance for residual displacement
- Sacral fractures have more tolerance for displacement, but parameters poorly understood
- Injury Severity Score and fracture type do not correlate with functional outcome
Conclusions: Pelvic Ring Injury

- Complex constellation of injuries
- Treatment based on comprehensive understanding of potential pelvic ring instability, displacement, and associated injuries
- Surgical techniques for reduction and stabilization continue to evolve
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