FEMORAL NECK FRACTURES

- Femoral neck fractures in young patients
  - Rare injuries
  - Well-documented complications
  - 20% to 30% nonunion, osteonecrosis, malunion, and implant failure being the most common
  - Predicting poor outcomes difficult
  - Treatments vary and are evolving

Demographics: 2 distinct groups
- Young, high energy mechanism
- Older, low energy

Young (active)
- High energy injuries
  - Often multi-trauma
  - Often High Pauwels Angle (shear)

PAUWELS CLASSIFICATION

- Poor interobserver reliability
- Modified to:
  - Non-displaced
    - Garden I (valgus impacted)
    - Garden II (non-displaced)
  - Displaced
    - Garden III and IV

GARDEN CLASSIFICATION

Anatomy
- Circulation
  - Medial circumflex femoral artery
  - Lateral epiphyseal artery
- Capsule
  - Blood supply limited to intra-ossous flow
  - Cantilever architecture, eccentric loading
  - High physiologic forces

FACTORS CONTRIBUTING TO HIGH COMPLICATION RATES
- Intracapsular location
- Fracture bathed in synovial fluid
- Displaced fractures
- Disrupt circulation to femoral head
- Tamponade effect of blood in intact capsule
- Theoretical risk of AVN with increased pressure
- Comminution
  - Exposed to high shear with weight bearing

Management
- Goal of management is to restore function and limit complications

TREATMENT
- Historically treated as a surgical emergency
- Rationale: decreased time to surgery would decrease risk of complications
- Closed Reduction
  + /- capsulotomy
  + Screw fixation

CURRENT TREATMENT
- Recent push in North America towards open reduction, anatomic reduction and fixation
- Screws vs DHS
- Rationale: ensure anatomic reduction

Globally
- Closed reduction
- Cancellous screw fixation
Regardless of treatment
- Well documented high rate of complications

Nonunion
- Clinical presentation
  - Groin / buttck pain
  - Activity / weight bearing related
  - Symptoms
    - More severe / occur earlier than AVN

Comlications
- Nonunion
  - 0-5% in Non-displaced fractures
  - 9-35% in Displaced fractures
  - Increased incidence with
    - Posterior comminution
    - Initial displacement
    - Imperfect reduction
    - Non-compressive fixation

Nonunion: Treatment
- Valgus intertrochanteric osteotomy (Pauwels)

Osteonecrosis
- 5-8% Non-displaced fractures
- 20-45% Displaced fractures
- Clinical presentation
  - Groin / buttck / proximal thigh pain
  - May not limit function
  - Onset usually later than nonunion

Malunion
- Healed FNF with shortening associated with poorer functional outcomes

Zwipp et al, Femoral Neck Shortening after Fracture Fixation with Multiple Cannulated Screws, J. Trauma 2008
OSTEONECROSIS (AVN)

- Treatment
  - Young Patients
  - Proximal Femoral Osteotomy
  - Arthroplasty
  - Arthrodesis
  - Significant functional deficits
  - Prevention is the Key

- Failure of Fixation
  - Adequate / unstable reduction
  - Poor bone quality
  - Poor choice of implant

- Starting point below the lesser trochanter

- Which Factors Predict Complications
  - Initial displacement
  - Time to surgery
  - Open vs closed reduction
  - Quality of reduction
  - Implant choice

- Increased displacement + Higher nonunion/malunion

- Poorer reduction + Higher nonunion/malunion
Posterior comminution + increased difficulty with stable fixation

Timing of surgery = no difference/not clear

Evidence based update: Open versus closed reduction

Prospective RCT comparing open versus closed reduction with cannulated screws

- Jain et al. JBJS Am 2002
  - < 60 year old, 12 hr cutoff
  - 20% AVN in < 8 hr & > 36 hr groups
- Duckworth et al. JBJS Br 2011
  - > 24 hr to surgery associated with failure
- Swiontkowski et al. JBJS Am 1984, 12 hr cutoff
  - 20% AVN in < 8 & > 36 hr groups
- Haidukewych, JBJS Am 2004
  - < 50 years old, 24 hr cutoff
  - 20% AVN in both groups
  - Displacement and reduction most important

- Upadhyay et al. JBJS Br 2004
  - Prospective RCT comparing open versus closed reduction with cannulated screws
  - 102 patients < 50 years old
  - No difference in AVN or nonunion
  - Posterior comminution, poor reduction, and poor screw placement associated with nonunion
  - > 48 hours to surgery in both groups
  - Varying constructs

Higher rate of deep infection in open reduction group:
- 0.5% versus 4%

No difference in AVN

No difference in nonunion
- 12% in closed group versus 13% in open group (p = 0.29)

Closed versus open reduction

Reduced intracapsular pressure from fracture hematoma
- Bonnaire et al. CORR 1987
- Harper et al. JBJS 1991
- Holmberg et al. CORR 1987

Increased capsular pressure not clinically associated with AVN
- Maruenda et al. CORR 1997

85% of patients with AVN had low intracapsular pressure

Vascular damage at time of injury may be more important
**FIXATION CONSTRUCTS**

- 3 Screws
  - Holmes, 1993
  - Swiontkowski, 1986
  - Swiontkowski, 1987
  - Springer, 1991

- 4 Screws
  - Kauflman, 1999
  - Dynamic hip screw
  - Holmes, 1993
  - Blade plate
  - Broos, 1998

**CANNULATED SCREWS VERSUS SLIDING HIP SCREW**

- Groth et al., J Orthopaedics 2015
- Retrospective review of 3 level 1 trauma centers
- 40 sliding hip screw, 29 cannulated screws
- Poor reduction highly significant for failure
- Cannulated Screws had higher short term failure

**CANNULATED SCREWS VERSUS FIXED ANGLE DEVICE**

- Most RCT included elderly patients
- Retrospective cohort studies
  - Liporace et al., JALS Am 2008
    - Fixed angle (mix of devices) versus cannulated screws (multiple configurations)
    - 10% infection in screws vs 1% infection in fixed angle, not statistically significant
  - Hoshino et al., OTA 2013 paper 54
    - Higher reoperation rate with cannulated screw (paucal's configuration)

- Open vs Closed reduction = no diff
- *Quality of reduction is key

**TREATMENT ISSUES: YOUNG PATIENT**

- Open reduction
  - Improved accuracy
  - Decompresses capsule
  - May have greater risk of infection

- Closed reduction
  - Less surgical morbidity

- Capsulotomy not correlated with risk of AVN
- Increased capsular pressure not clinically associated with AVN
  - Maruvenda et al., CORR 1997
  - 80% of patients with AVN had low intracapsular pressure
  - Vascular damage at time of injury may be more important
Implant Choice = ? Fixed angle devices when posterior comminution present or high Pauwels angle

Screw position matters
- Inferior within 3 mm of cortex
- Posterior within 3 mm of cortex
- Avoid posterior/superior to avoid iatrogenic vascular damage

Nondisplaced fractures

Screw position matters
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Young patient
- Approaches
- Closed Reduction
- Smith-Peterson
- Watson-Jones

Fixation options
- Percutaneous screws
- Fixed angle device

Fixation options
- Percutaneous screws
- Fixed angle device

Initial displacement
- Quality of reduction
- Stable fixation
- Time to surgery
- Open vs. Closed reduction
- Capsulotomy
- Implant Choice

Summary
- Non-emergent surgery
- Stable Anatomic fixation
- Implant choice dictated by fracture pattern
- Anticipate complications in highly displaced fractures

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