Femoral Neck Fractures in Patients Younger than 50 years

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OBJECTIVES/QUESTIONS

- How urgent are femoral neck fractures in young patients?
- Is there a difference in outcomes between open and closed reduction?
- Describe the pros and cons of different surgical approaches?
- What is the best implant for femoral neck fixation?
- Are complications common after this injury?
OUTLINE

• History and Physical
• Anatomy
• Imaging
• Classification
• Initial Management
• Definitive Management
  • Timing
  • Approaches
  • Fixation Techniques
• Complications
• Rehabilitation
• Outcomes
History & Physical

- **HIGH** energy injury in patients < 50 years with normal bone physiology
- Affected extremity shortened and externally rotated (when displaced)
- Pain with hip ROM

- **LOW** energy injury (fall from standing) in:
  - Elderly patients (not covered in this chapter)
  - Abnormal underlying bone physiology
    - Crohn’s, malnutrition
    - chronic kidney disease
    - cancer/chemotherapy
    - early onset osteoporosis
  - Pathologic fractures
  - Stress fractures
Anatomy- osseous, ligamentous

- Neck shaft angle $\sim 130^\circ +/- 7^\circ$
  with $\sim 10^\circ$ anteversion +/- 7$^\circ$
- Calcar
  - Dense bone posteromedial
- Cartilage- 3-4 mm cap
- Capsule
- Labrum

Image from: Court-Brown, C. et al. Rockwood & Greens Fractures in Adults. Philadelphia: Lippincott Williams & Wilkins, 2014
Anatomy- vascular

- Medial femoral circumflex artery > Lateral epiphyseal artery = predominant blood supply to the femoral head
- Greater fracture displacement = greater risk of vascular disruption

Imaging- basic

• AP and lateral hip- evaluate fracture morphology and displacement

• AP pelvis- compare to contralateral side (neck shaft angle)

• Traction AP hip
  • Helps distinguish between femoral neck and intertrochanteric fracture in comminuted or significantly displaced fractures

Imaging- advanced

• CT hip
  • May help establish diagnosis in rare circumstances
    • nondisplaced fracture
  • Aid in fracture characterization and treatment decisions

• MRI
  • Higher sensitivity than CT for diagnosis of occult femoral neck fracture
  • Rarely required

Classification - anatomic description

Subcapital

Transcervical

Basicervical
Garden Classification

- **Type 1- Valgus impacted, incomplete**

- **Type 2- Nondisplaced**

- **Type 3- Complete, partially displaced**

- **Type 4- Completely displaced**

Pauwels Classification

- Based on fracture inclination with reference to the horizontal

- More vertical fracture planes are associated with increased instability due to shear forces transferred with weight bearing

Initial Management

• Traction typically contraindicated
  • Due to concern for increased intraarticular pressure and possible tamponade

• Surgical urgency, not emergency
  • Accuracy of reduction more important than time to surgery
  • Earlier generally better; Goal within 12-24 hours
Time to Surgery - becoming less controversial?

DIFFERENCE

• Jain, et al. JBJS Am 2002
  • < 60 y/o.
  • 0/15 AVN if fixed < 12 hr
  • 6/38 (16%) AVN if fixed > 12 hr

• Duckworth, et al. JBJS Br 2011
  • 122 px ≤60 yrs
  • 83 (68%) union; 39 complications (32%)
    • 7% nonunion; 12% AVN
  • > 24 hr to surgery = increased failure rate

NO DIFFERENCE

  • Retro study 92 px < 60 y/o
  • 13% AVN. NO difference on timing.

• Swiontkowski, et al. JBJS Am 1984
  • 27 px < 50 yrs
  • 20% AVN in <8 hr and >36 hr groups

• Haidukewych, et al. JBJS Am 2004
  • 73 fractures < 50 y/o
  • 24 hr cut-off
  • 20% AVN in both groups
  • Initial displacement and reduction most important
Definitive Management

**ORIF**
- Sliding Hip Screw
  - +/- anti-rotation screw
- Cancellous Screws
- Blade plate
- Modern Plating Systems

**OPEN vs CLOSED REDUCTION**

**APPROACH**
- Anterior approach to hip (Smith-Peterson) + Lateral approach
  - supine position
- Anterolateral approach to hip (Watson-Jones)
  - Lateral or supine position
Open vs Closed Reduction

- Trend 10-20 years ago toward open reduction
- Anatomic reduction (closed or open) and stable internal fixation gives the patient the best opportunity to avoid complications
- AVOID:
  - Varus
  - Posterior tilt
  - 51 initially displaced fxns
    - 46 px with good/excellent reduction = 13 (28%) AVN or nonunion
    - 5 px with fair/poor reduction = 4 (80%) AVN or nonunion
Open vs Closed Reduction

• Recent data to favor closed reduction?

• Patterson, et al. JOT 2020
  • Open reduction associated with greater risk of reoperation
  • 234 px 18-65 yrs with displaced femoral neck fxs
  • 106 (45%) open reduction = 35 (22%) reoperation
  • 128 (55%) closed reduction = 28 (22%) reoperation
  • 2.4-fold greater risk of reoperation with open reduction without improvement in reduction quality compared to the closed group
Anterolateral Approach

- **Lateral incision** over GT
- **Superficial dissection**: Incise ITB distally > continue toward anterior half of GT
- Incise fascia on posterior border TFL
- **Deep dissection**: between TFL (anterior) and gluteus medius (posterior) [both innervated by superior gluteal nerve]
- Externally rotate femur – capsulotomy
- Incise 1-2 cm of anterior g. medius insertion and v. lateralis origin to improve visualization
- **Limited visualization of subcapital fractures**

Anterior Approach (Smith-Peterson)

- Anterior incision from iliac crest just proximal to ASIS > 10 cm distal (aim toward lateral patella)
- Superficial dissection: between sartorius medially (femoral nerve) and TFL laterally (superior gluteal nerve)
- Avoid lateral femoral cutaneous nerve that pierces fascia near ASIS
- Ligate branches of ascending branches of the lateral femoral circumflex artery/vein
- Deep dissection: between rectus femoris medially (femoral n.) and gluteus medius laterally (superior gluteal n.)
  - Mobilize direct (straight) head of rectus (origin on AIIS) medially
  - Indirect (reflected) head of rectus (origin on superior acetabulum) may need to be detached for improved visualization of subcapital fractures
- Adduct and externally rotate femur – capsulotomy
- Lateral approach to proximal femur (sub-vastus lateralis vs vastus split) for implant insertion also required

View of Fracture through Smith-Peterson Approach

Image courtesy of Gaski, GE
Comparison of surgical approaches

**Anterior Smith-Peterson**
- Excellent visualization of all femoral neck fractures
- Easier application of anterior or medial buttress plate
- Requires separate lateral incision for implant insertion

**Anterolateral Watson-Jones**
- Limited visualization of subcapital fractures
- Good visualization of basicervical fractures
- Difficult to place medial or superior buttress plate
- Implants conveniently placed through the same approach
VIDEOS

ORIF femoral neck via Anterior Approach

Reduction Techniques

• Pointed reduction clamps
• Joysticks – K wires and Schantz pins
• Medial anti-glide / buttress plates
• Provisional wire fixation

Images courtesy of Gaski, GE
Reduction Techniques

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Reduction Techniques

• Pointed reduction clamps
• Joysticks – K wires and Schantz pins
• Medial anti-glide / buttress plates or Anterior plate
• Provisional wire fixation

**TIP: For in-depth details of this technique, consider reading:**
Reduction Techniques

• Pointed reduction clamps
• Joysticks – K wires and Schantz pins
• Medial anti-glide / buttress plates
• Provisional wire fixation

Images courtesy of Gaski, GE
Sliding Hip Screw + Anti-rotation screw

Sliding Hip Screw + medial buttress plate

Cancellous Screws

Cancellous Screw Fixation Concepts

• ‘Inverted Triangle’
• Inferior screw within 3 mm of cortex/calcar
• Posterior screw within 3 mm of cortex
• Threads > 5 mm from subchondral bone
  • Anticipate some collapse
• Multiple ‘around the world’ fluoroscopic views to ensure screws are not intra-articular
• Avoid posterior/superior (iatrogenic vascular injury)
• Do not start below the lesser trochanter
  • Avoid stress riser
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Fully vs Partially Threaded Cancellous Screws

• Controversial

• Partially threaded screws
  • Allow interfragmentary compression at the fracture site
  • Can lead to excessive shortening and malunion
    • Abductor weakness, limp, and limb dysfunction

• Fully threaded screws
  • Limit compression = concern for nonunion
  • May prevent excessive fracture collapse, especially in femoral neck fractures with posterior comminution (common)
What went wrong? Why?

What went wrong? Why?

- Varus collapse
- Shortening

- Due to varus malreduction?

Conflicting Evidence:

Sliding hip screw vs. Cancellous screws

- Better for basicervical fractures?
- Improved stability in comminuted fractures?

- FAITH-1 (> 50 y/o)
  - Failure via screw cut-out
  - Better for basicervical fxs
  - Better in smokers
  - Better for displaced fractures
  - Higher rate AVN
  - More patients converted to THA

- Less invasive?
- Improved rotational control?

- FAITH-1 (>50 y/o)
  - Failure via varus collapse and hardware prominence
  - Higher incidence of implant removal
Conflicting Evidence:

Retrospective cohort studies

• Liporace et al, JBJS Am 2008
  • Fixed angle (mix of devices) – 9% nonunion
  Versus
  • Cannulated screws (multiple configurations) – 19% nonunion

• Hoshino et al, Injury 2016
  • Fixed angle (sliding hip screws- standard and dynamic)- 21% failure
  Versus
  • Cancellous screws in Pauwels configuration (2 or 3 screws + horizontal screw nearly perpendicular to fracture line lateral troch > inferomedial neck – 60% failure
86 patient pilot multi-center RCT of femoral neck fractures in patients < 60 years old comparing:

1) Sliding hip screw vs Cancellous screws
2) Vitamin D supplementation vs none

2x2 Factorial Design
KEY TAKEAWAYS:
1. Complication rate remains high- 28% (Consistent with previous studies)
2. SHS and CS have similar complication profile
   a. SHS fail via screw cut-out
   b. CS fail via varus collapse and hardware prominence
3. Difficulty enrolling patients in this pilot study demonstrated that a larger scale RCT is not feasible

Similar to FAITH-1 study: Fixation of femoral necks in patients > 50 years old
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| TABLE 3. Primary Clinical End Point Composite by the Treatment Group |
|-------------------------|----------------|----------------|----------------|----------------|----------------|
| End Point                | Overall, N = 86 | CS, N = 43     | SHS, N = 43    | Vitamin D, N = 45 | Placebo, N = 41 |
| Primary clinical end point, n (%)* | 24 (27.9)     | 13 (30.2)     | 11 (25.6)     | 11 (24.4)     | 13 (31.7)     |
| Individual end points   |                |                |                |                |                |
| Reoperation, n (%)†     | 15 (17.4)     | 6 (14.0)      | 9 (20.9)      | 7 (15.2)      | 8 (19.5)      |
| Femoral head osteonecrosis, n (%)‡ | 9 (10.5) | 7 (16.3) | 2 (4.7) | 5 (10.9) | 4 (10.0) |
| Severe femoral neck malunion, n (%)§ | 8 (9.3) | 6 (14.0) | 2 (4.7) | 5 (10.9) | 3 (7.5) |
| Nonunion, n (%)¶       | 7 (8.2)       | 3 (7.0)       | 4 (9.3)       | 4 (8.7)       | 3 (7.5)       |

*For the primary clinical end point, 1 event per patient was counted.
†Three patients underwent 2, 2, and 3 separate reoperations, respectively. Therefore, breakdown of reoperations totals to 19 instead of 15.
‡Three patients with femoral head osteonecrosis also underwent a reoperation.
§Three patients with severe femoral neck malunion also underwent a reoperation; 2 patients with severe femoral neck malunion also had femoral head osteonecrosis, and 1 patient with severe femoral neck malunion had a nonunion.
¶All 7 patients with a nonunion also underwent a reoperation.
Ipsilateral Femoral Shaft Fractures

• 5-10% femoral shaft fractures are associated with a femoral neck fractures
  • Frequently a vertical neck fracture
  • Missed in up to 30% of cases

• MRI (short coronal T2 sequencing) described as a screening tool
  • Not practical at the vast majority of institutions
  • Cost prohibitive?
Blade Plate

- Fixed angle
- Minimal risk of rotation during insertion
- Technically difficult
- Tough to remove

Modern Fixed Angle Plating Systems Available

Images courtesy of Gaski, GE
Case – 21 year old with displaced femoral neck
Reduction and provisional fixation
Definitive fixation
2 week Follow-up imaging

Images courtesy of Gaski, GE
Arthroplasty

- Consider in patients with advanced age and non-reconstructable or extensively comminuted femoral neck fractures
- Higher risk of reoperation:
  - > 40 yrs of age
  - h/o renal disease
  - h/o liver disease
  - h/o respiratory disease

Capsulotomy?

- Reduces intracapsular pressure from hematoma
  - Bonnaire, et al. CORR 1998

- BUT, is it clinically relevant?

- Increased capsular pressure NOT associated with AVN
  - Maruenda et al. CORR 1997
  - 80% patients with AVN had low intracapsular pressure
Stress Fractures of the Femoral Neck

- Insidious onset of pain
- Repetitive loading of femoral neck
  - Stress reaction / microscopic fracture
- Diagnosis
  - Xray, CT, MRI- higher sensitivity

Example of displaced femoral neck stress fracture

Stress Fractures of the Femoral Neck

• Types and Treatment
  • Compression side (incomplete)- limited WB vs cancellous screw fixation
  • Compression side (complete)- cancellous screw fixation
  • Tension side- cancellous screw fixation
Rehabilitation

• No restriction on motion
• Non-weightbearing x 2-3 months
• Gradual progression of weightbearing at 2-3 months
Complications

• Malunion / Shortening
  • 54% patients 5-10 mm shortening
  • 32% patients > 10 mm shortening
  • **Significantly worse function with moderate to severe shortening (SF-36 and EuroQol)**
    • 39% patients > 5 degrees varus
• Avascular necrosis- 5-15%
• Nonunion- 10-35%
• Infection
• Hardware failure
• REOPERATION ~ 15-20%
• Complications overall 20-40%
Reconstruction

- Valgus Intertrochanteric Osteotomy +/- Bone Graft
  - Convert vertical shear forces into compressive forces

Images courtesy of Gaski, GE
Reconstruction Video

• Valgus Intertrochanteric Osteotomy

SUMMARY

• Choice of approach based on fracture pattern and location
• Anatomic reduction critical
• Ideally fix within 24 hours but correlation with AVN controversial and timing is less important than ‘Accuracy of Reduction’
• Open vs Closed reduction less important than ‘Accuracy of Reduction’
• SHS vs Cancellous screws- conflicting evidence. Likely similar outcomes
  • Mode of failure different
  • Basicervical- SHS more ideal?
• Counsel patients early regarding significant risk of complications and reoperation
References


