

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 $\sim 130^\circ \pm 7^\circ$ with $\sim 10^\circ$ anteversion $\pm 7^\circ$
- Calcar
 - Dense bone posteromedial
- Cartilage- 3-4 mm cap
- Capsule
- Labrum

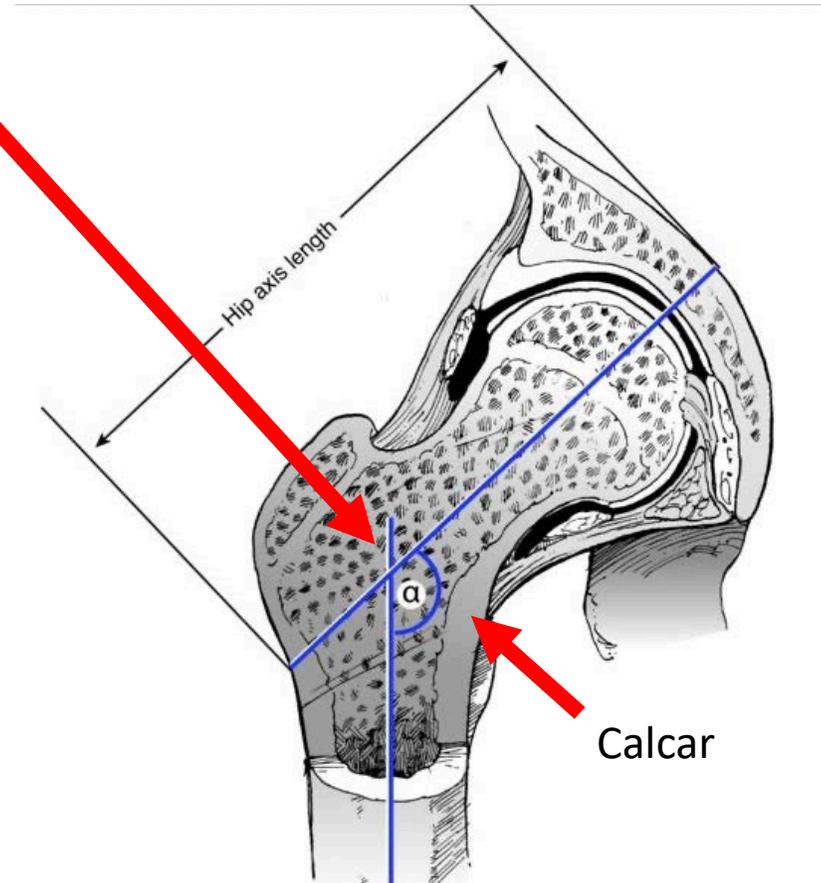


Image from: Court-Brown, C. et al. Rockwood & Greens Fractures in Adults. Philadelphia: Lippincott Williams & Wilkins, 2014

Anatomy- vascular

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

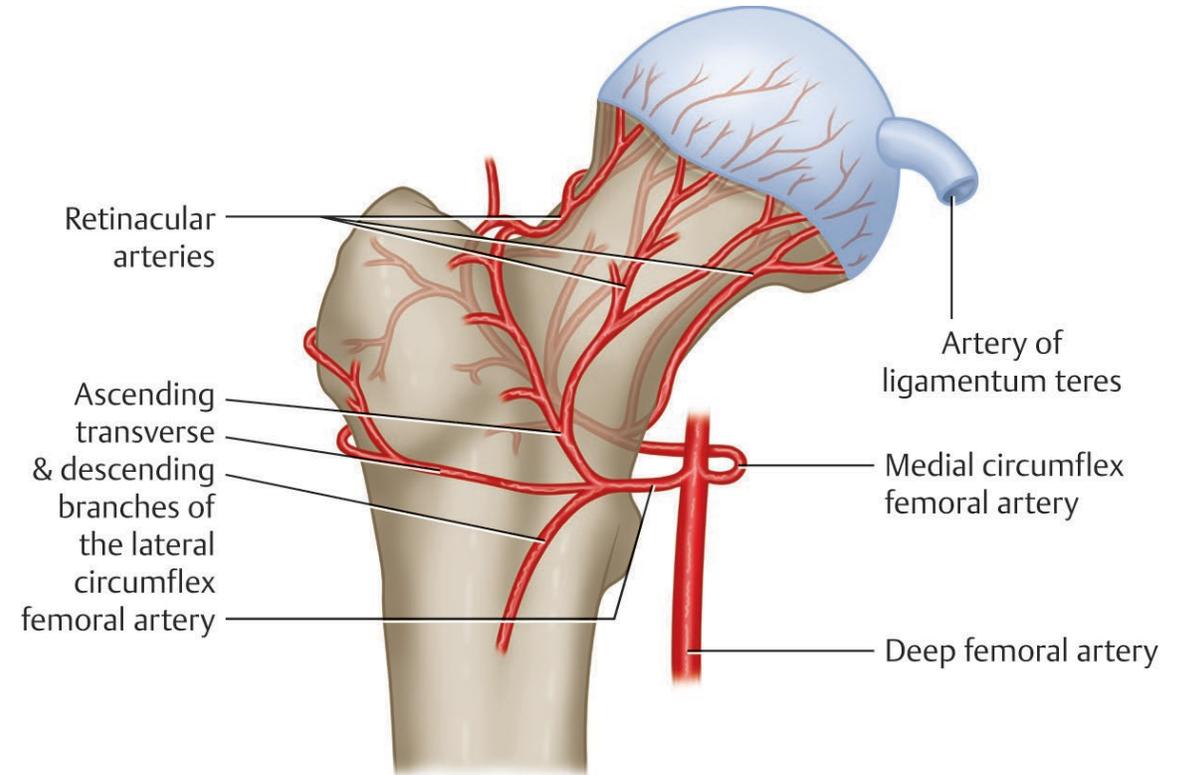


Image from: Mullis B, Gaski GE. *Synopsis of Orthopaedic Trauma*. Thieme Publishing. New York, New York. May 2020.

Imaging- basic

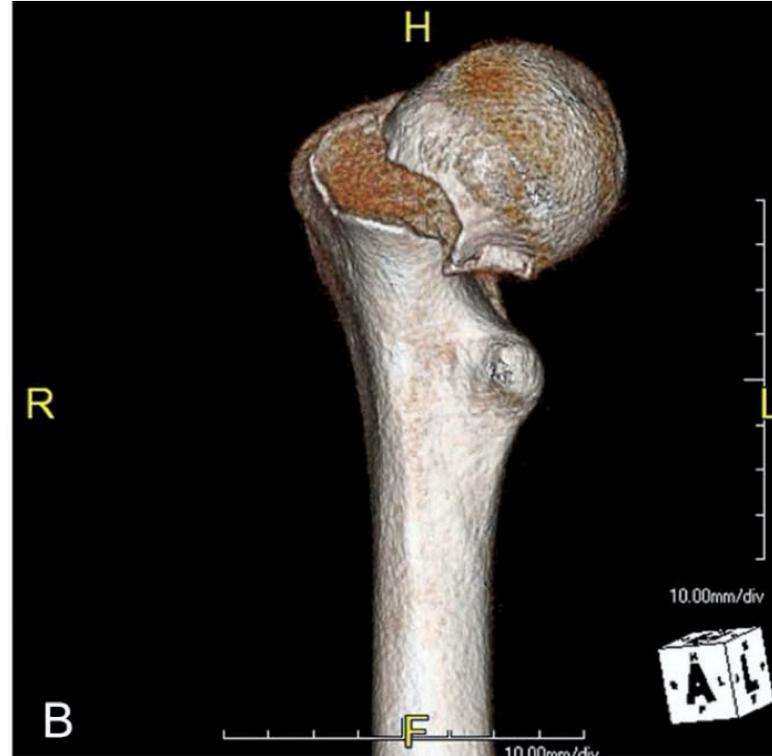
- **AP and lateral hip- evaluate fracture morphology and displacement**
- **AP pelvis- compare to contralateral side (neck shaft angle)**
- **Traction AP hip**
 - **Helps distinguish between femoral neck and intertrochanteric fracture in comminuted or significantly displaced fractures**



Medda S, Snoap T, Carroll EA. Treatment of Young Femoral Neck Fractures. *J Orthop Trauma*. 2019;33(1 Suppl):S1-S6

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



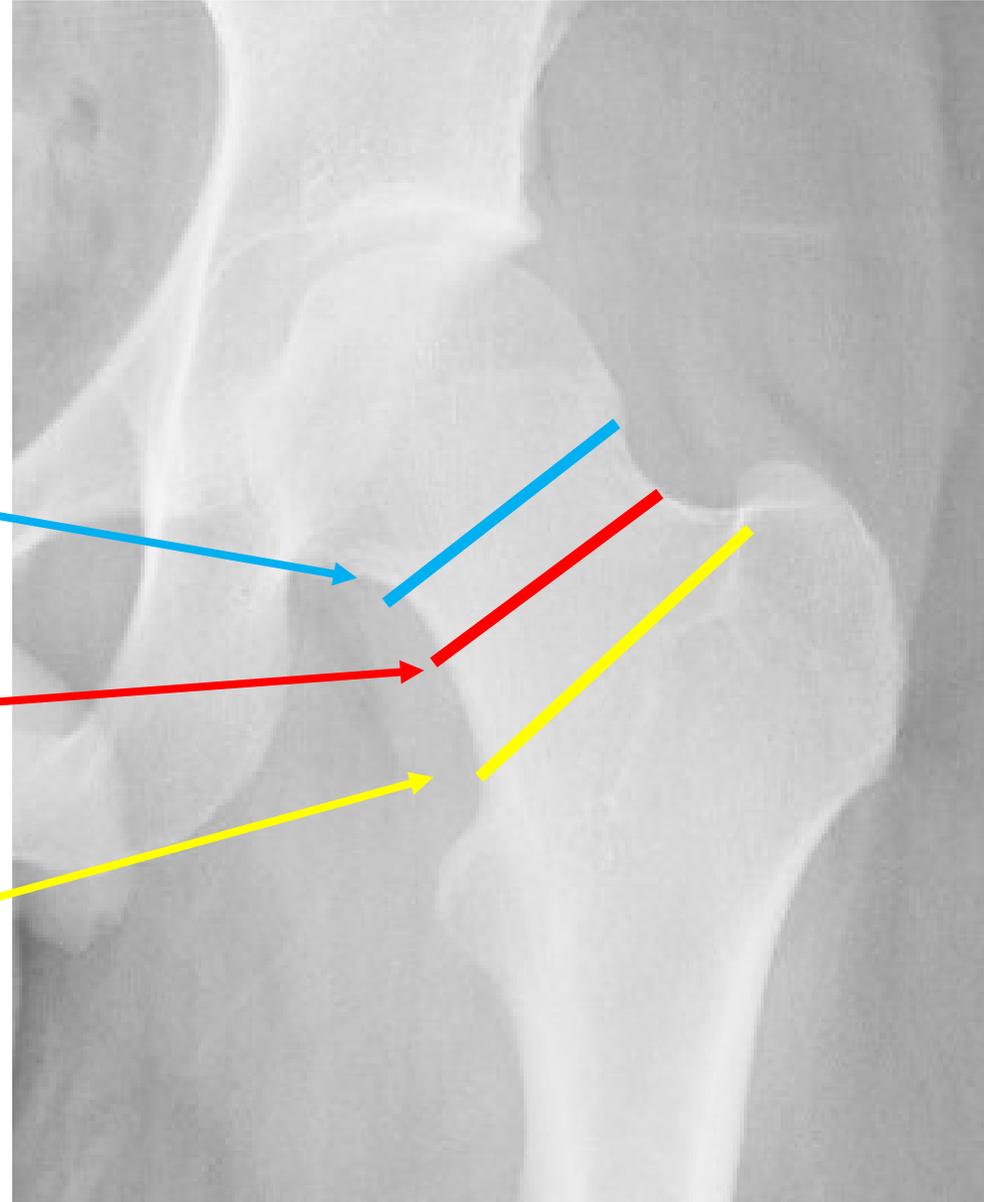
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Classification- anatomic description

Subcapital

Transcervical

Basicervical



Garden Classification

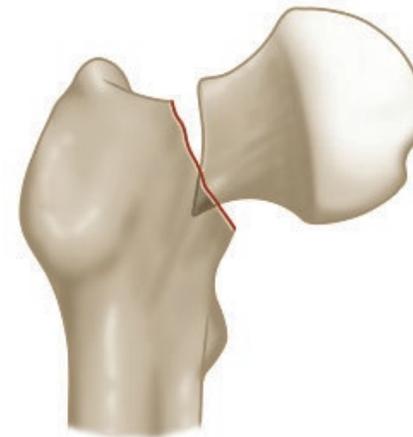
- **Type 1- Valgus impacted, incomplete**
- **Type 2- Nondisplaced**
- **Type 3- Complete, partially displaced**
- **Type 4- Completely displaced**



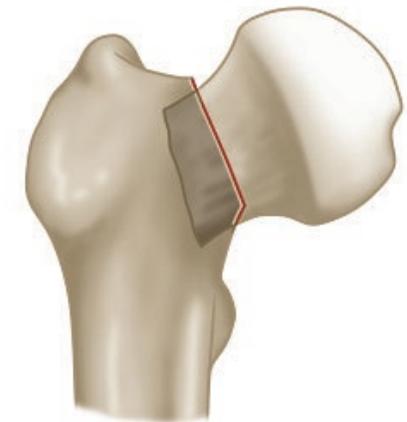
I – incomplete, valgus impacted



II – complete, nondisplaced



III – complete, partially displaced

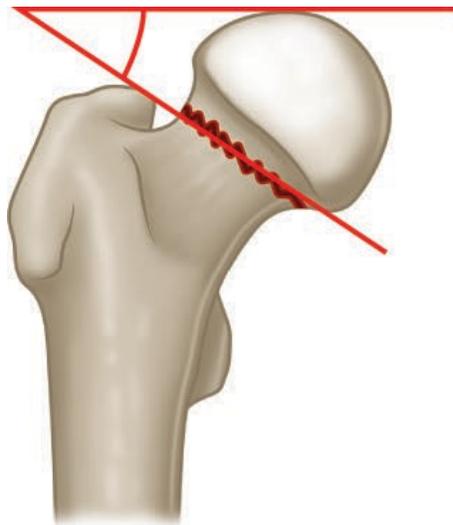


IV – complete, fully displaced

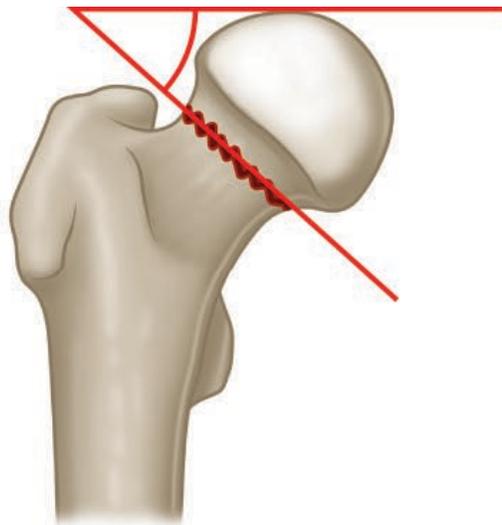
Pauwels Classification

- Based on fracture inclination with reference to the horizontal

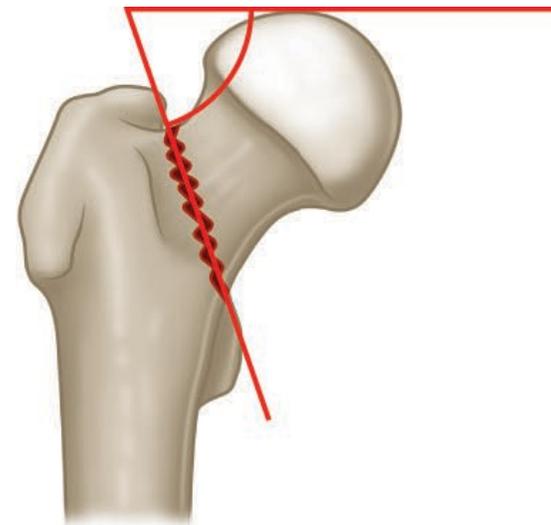
- More vertical fracture planes are associated with increased instability due to shear forces transferred with weight bearing



Type 1
< 30°



Type 2
30°-50°



Type 3
> 50°

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 \leq 60 yrs
 - 83 (68%) union; 39 complications (32%)
 - 7% nonunion; 12% AVN
 - > 24 hr to surgery = increased failure rate

NO DIFFERENCE

- Razik, et al. Intl Orthop. 2012
 - 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

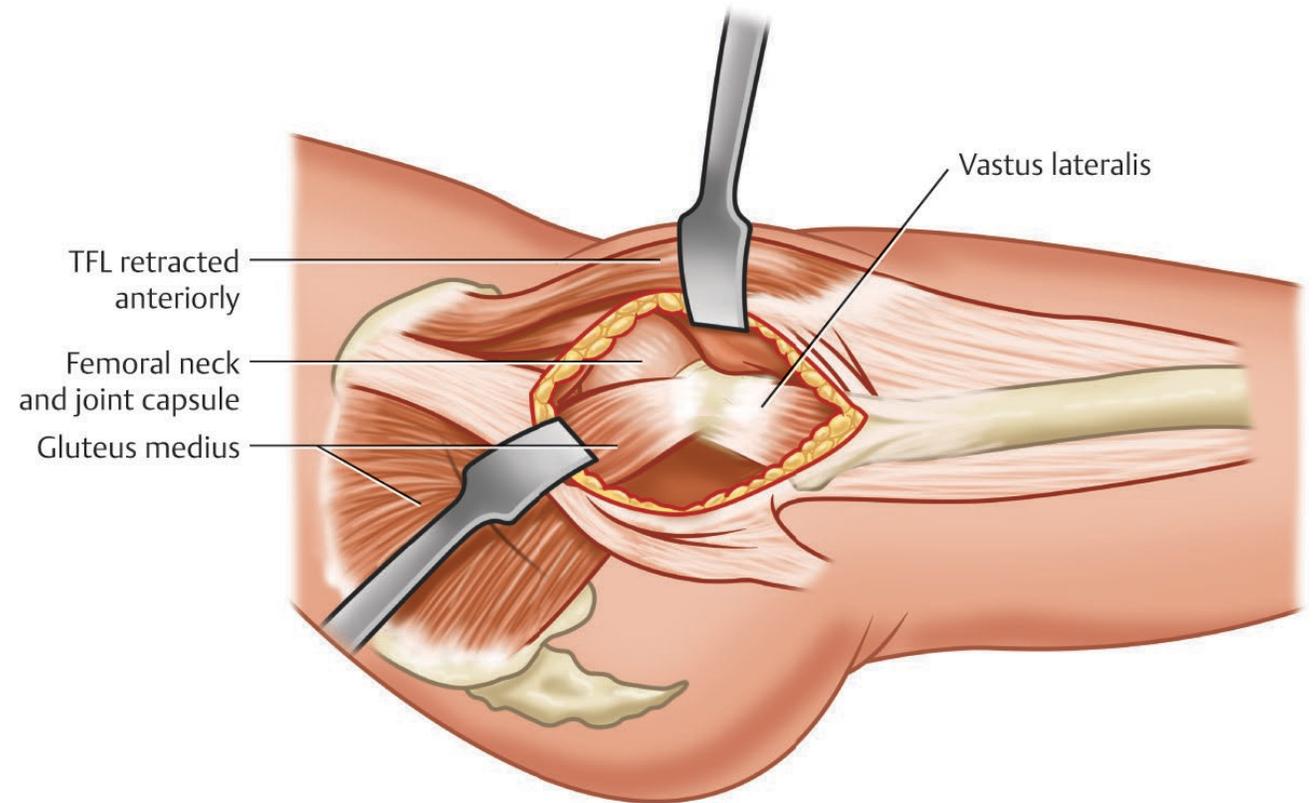
- **Trend 10-20 years ago toward open reduction**
- **Anatomic reduction (closed or open) and stable internal fixation gives the patient the best opportunity to avoid complications**
- **AVOID:**
 - **Varus**
 - **Posterior tilt**
- **Haidukewych, et al. JBJS 2004.**
 - **51 initially displaced fxs**
 - **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

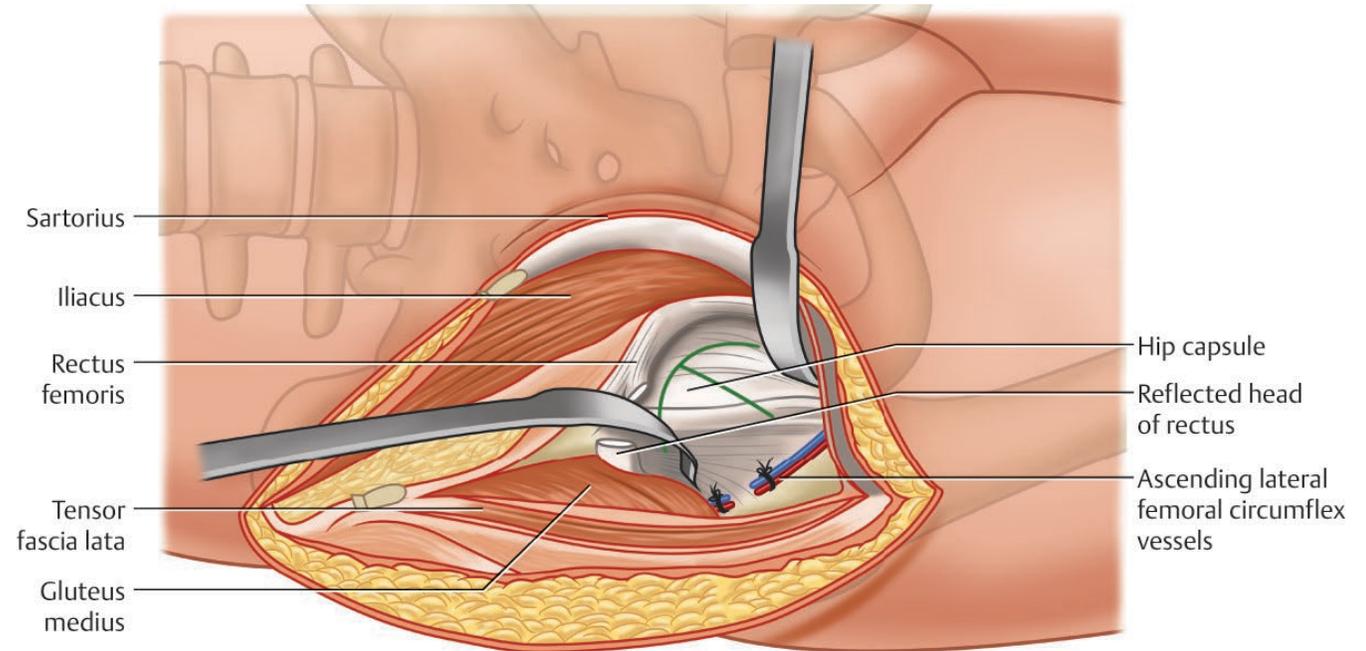
- Lateral incision over GT
- Superficial dissection: Incise ITB distally > continue toward anterior half of GT
- Incise fascia on posterior border TFL
- Deep dissection: between TFL (anterior) and gluteus medius (posterior) [both innervated by superior gluteal nerve]
- Externally rotate femur – capsulotomy
- 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 AIIIS) 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**

Image from: Mullis B, Gaski GE. *Synopsis of Orthopaedic Trauma*. Thieme Publishing. New York, New York. May 2020.

View of Fracture through Smith-Peterson Approach

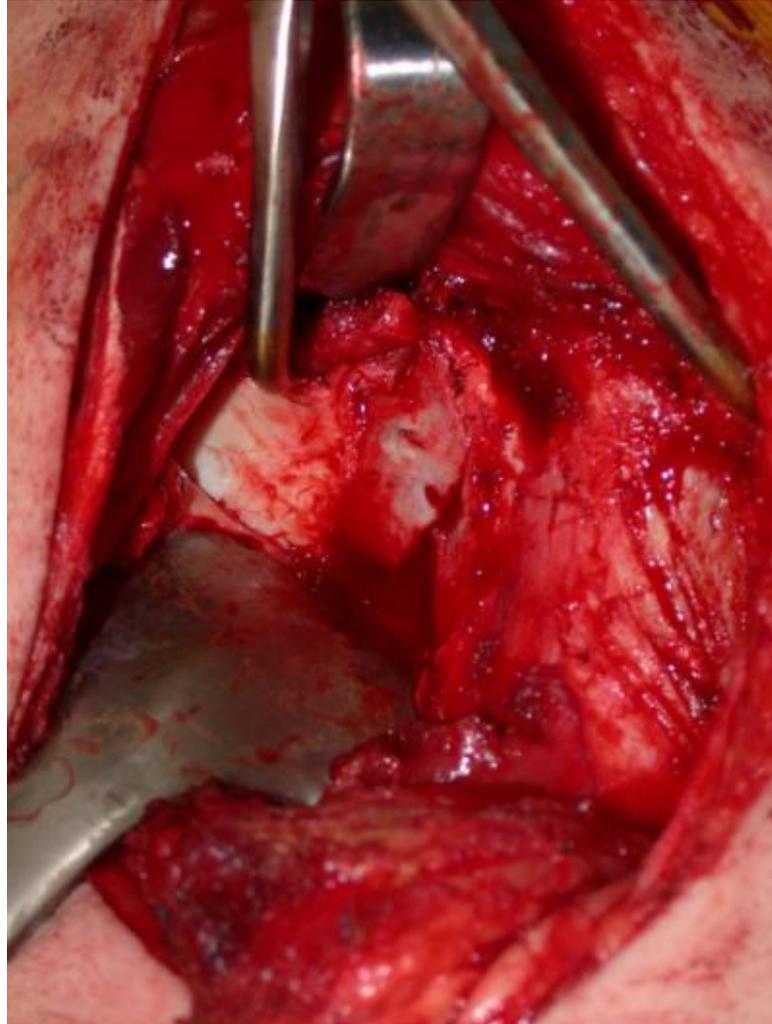


Image courtesy of Gaski, GE

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

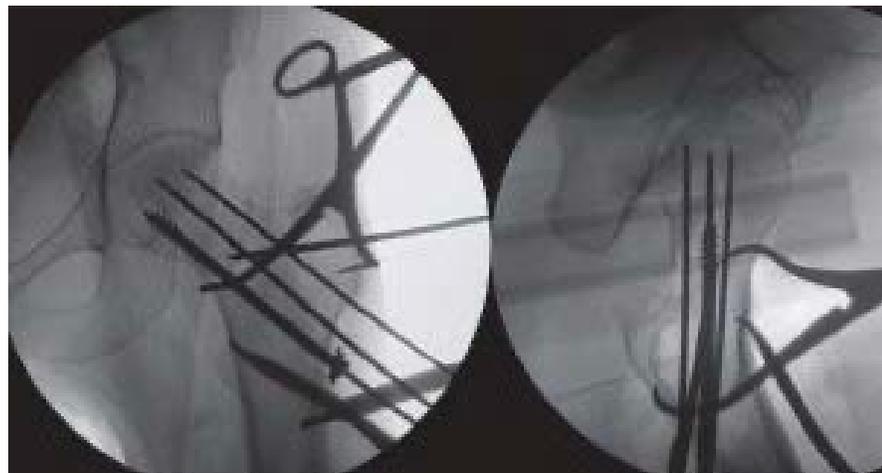
VIDEOS

ORIF femoral neck via Anterior Approach

- <https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/17980371/orif-femoral-neck-fracture-anterior-approach>

Reduction Techniques

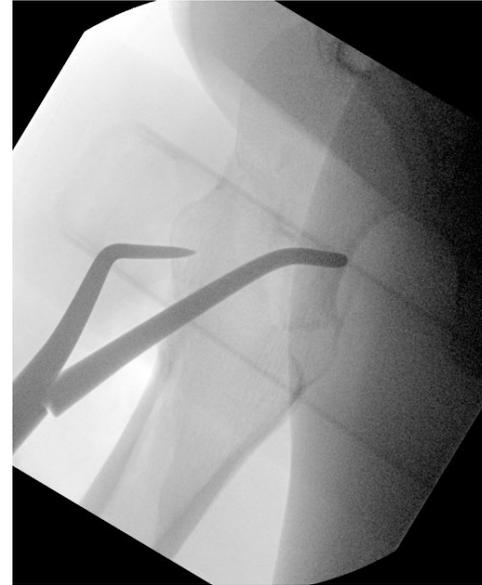
- Pointed reduction clamps
- Joysticks – K wires and Schantz pins
- Medial anti-glide / buttress plates
- Provisional wire fixation



Images courtesy of Gaski, GE

Reduction Techniques

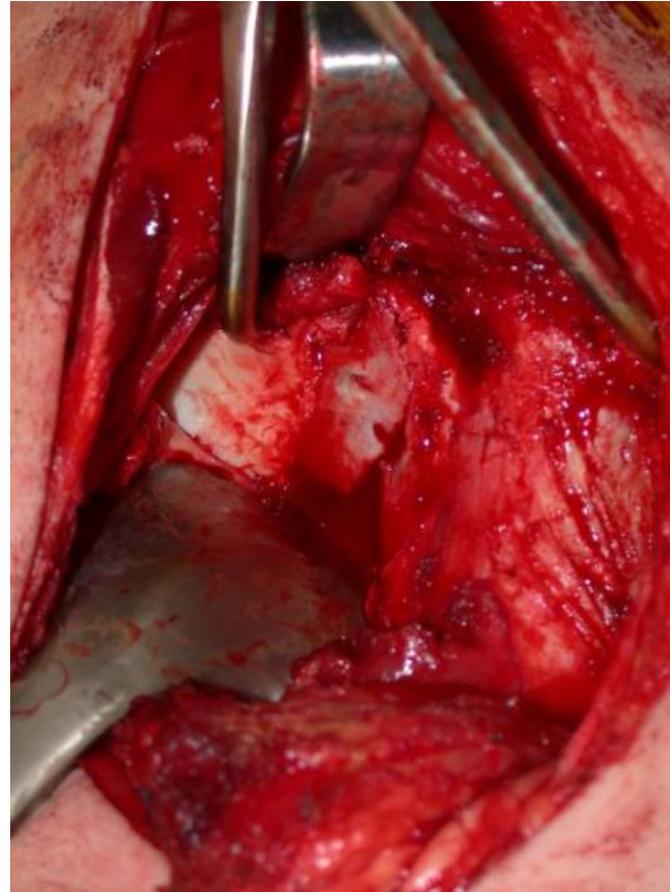
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Collinear Clamp

Reduction Techniques

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

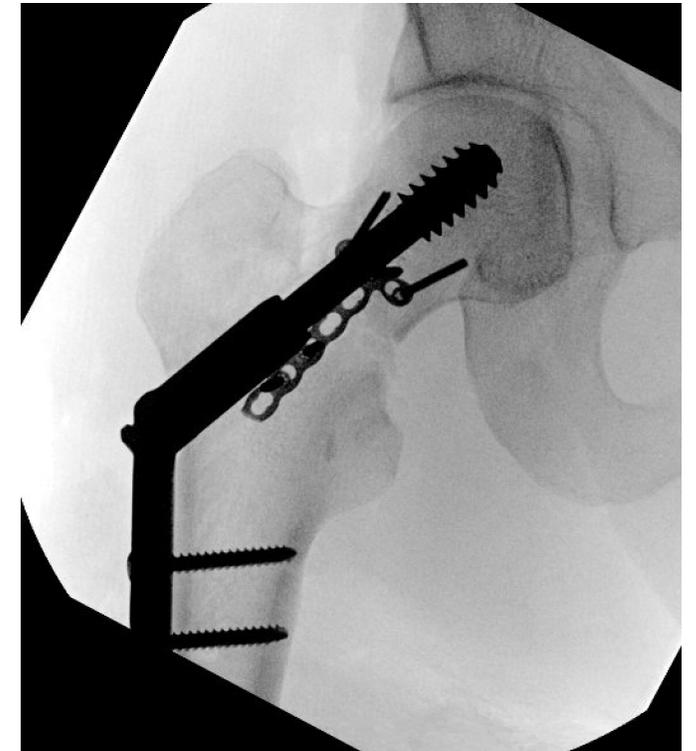


Reduction Techniques

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

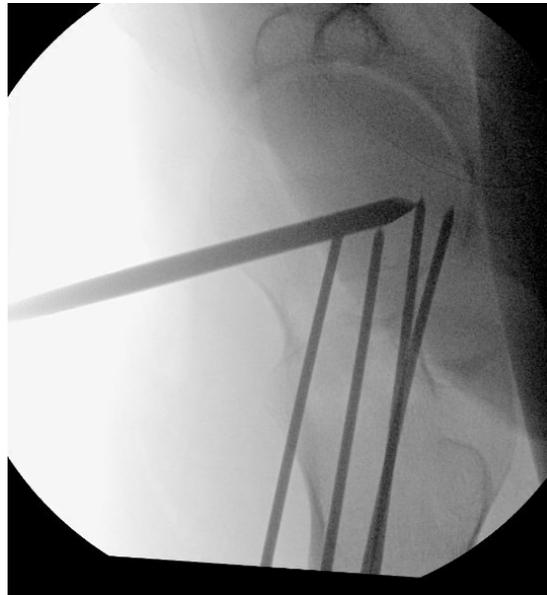
****TIP:** For in-depth details of this technique, consider reading:

Putnam SM, Collinge CA, Gardner MJ, et al. Vascular anatomy of the medial femoral neck and implications for surface plate fixation. *J Orthop Trauma*. 2019;33(3):111-115.



Reduction Techniques

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

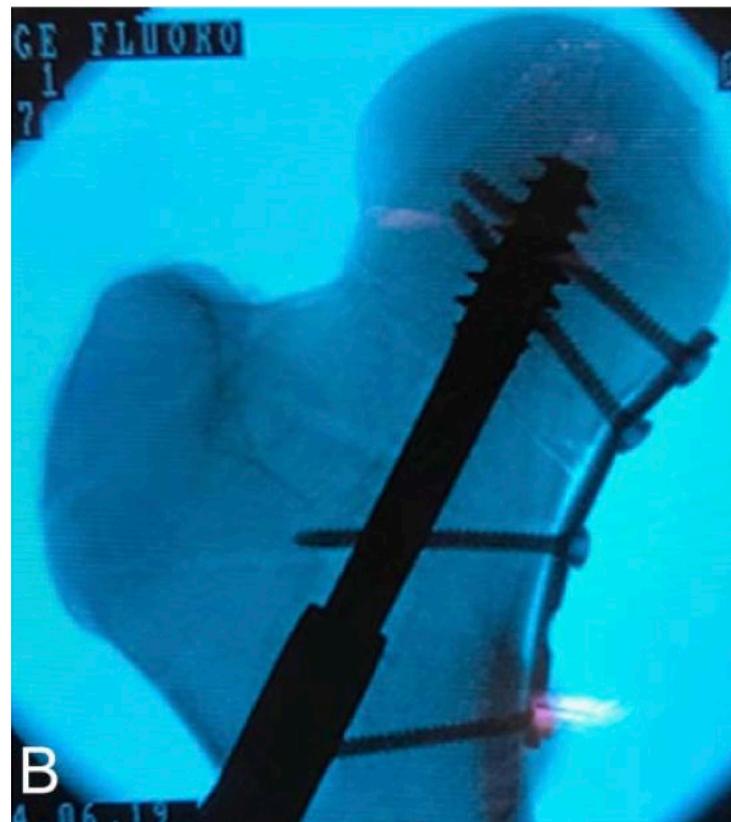


Sliding Hip Screw + Anti-rotation screw



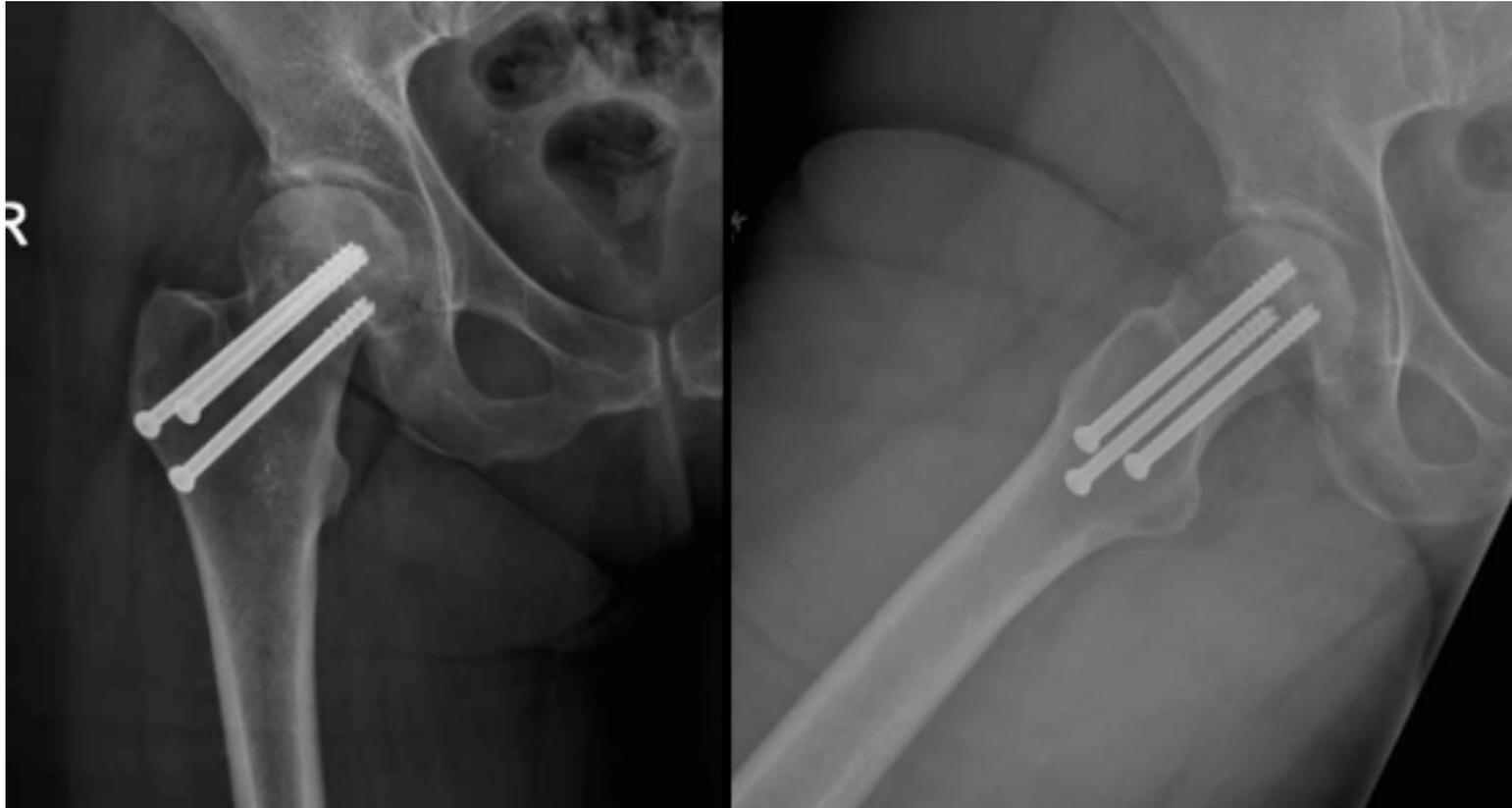
Cochran GK, Staeheli GR, Deafenbaugh BK, et al. Outcomes following the urgent surgical management of displaced femoral neck stress fractures. *J Orthop Trauma*. 2020;34(11):594-599.

Sliding Hip Screw + medial buttress plate



Nwankwo CD, Schimoler P, Greco V, et al. Medial plating of Pauwels Type III femoral neck fractures decreases shear and angular displacement compared with a derotational screw. *J Orthop Trauma*. 2020;34(12):639-643.

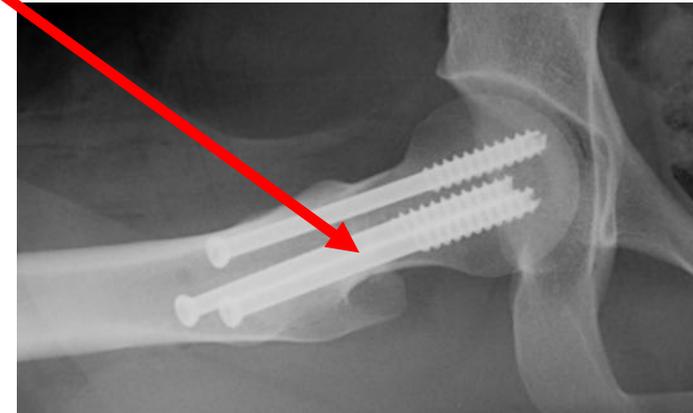
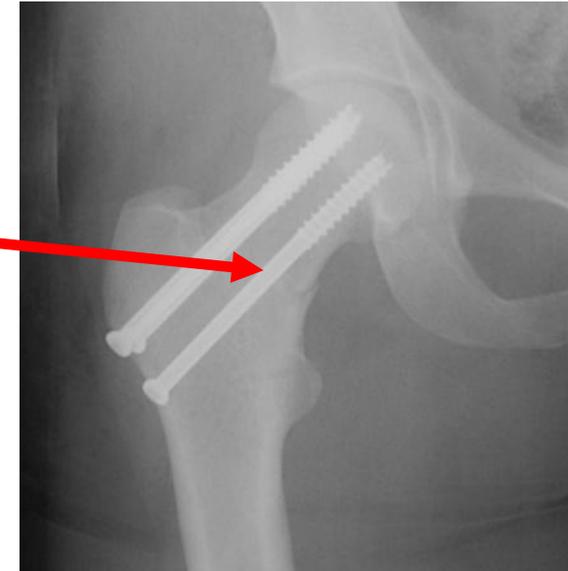
Cancellous Screws



Florschutz AV, Langford JR, Haidukewych GJ, Koval KJ. Femoral Neck Fractures: Current Management. *J Orthop Trauma*. 2015;29(3):121-129.

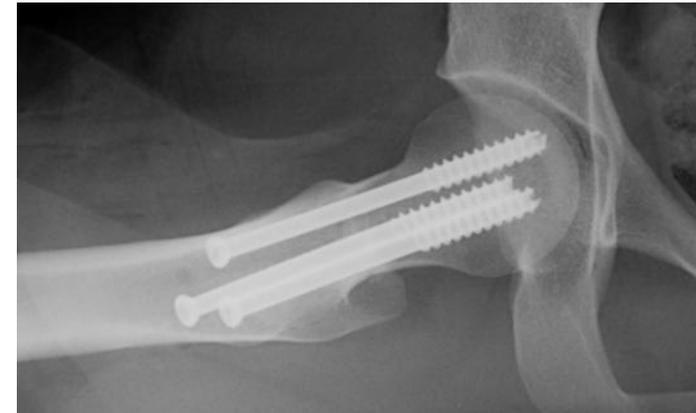
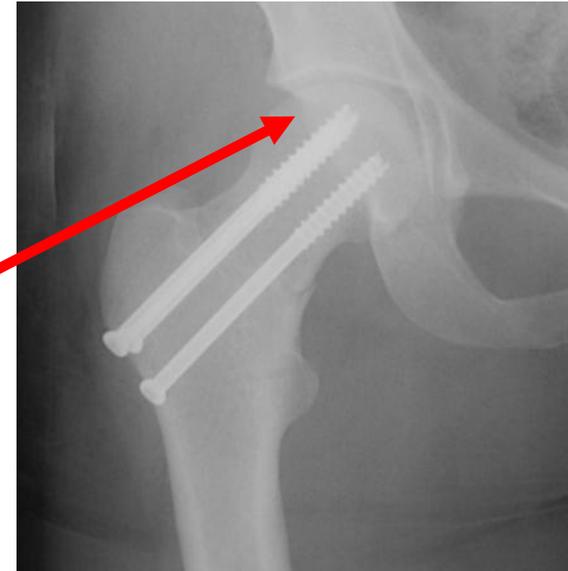
Cancellous Screw Fixation Concepts

- 'Inverted Triangle'
- Inferior screw within 3 mm of cortex/calcar
- Posterior screw within 3 mm of cortex
 - Booth et al. Orthopaedics 1998.
- 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



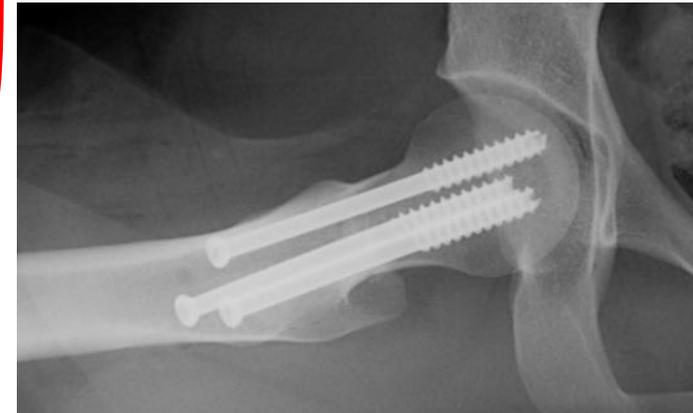
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Fully vs Partially Threaded Cancellous Screws

- Controversial
- Partially threaded screws
 - Allow interfragmentary compression at the fracture site
 - Can lead to excessive shortening and malunion
 - Abductor weakness, limp, and 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**

FAITH-2

- 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

Fixation Using Alternative Implants for the Treatment of Hip Fractures (FAITH-2): The Clinical Outcomes of a Multicenter 2 × 2 Factorial Randomized Controlled Pilot Trial in Young Femoral Neck Fracture Patients

*Gerard P. Slobogean, MD, MPH,^a Sheila Sprague, PhD,^{b,c} Sofia Bzovsky, MSc,^b Taryn Scott, MSW, MSc,^b Lehana Thabane, PhD,^c Diane Heels-Ansdell, MSc,^c Robert V. O'Toole, MD,^a Andrea Howe, BS,^a Greg E. Gaski, MD,^d Lauren C. Hill, BS, CCRC,^d Krista M. Brown, MS, CCRC,^d Darius Viskontas, MD,^e Mauri Zomar, CCRP,^f Gregory J. Della Rocca, MD, PhD, FACS,^g Nathan N. O'Hara, MHA,^a and Mohit Bhandari, MD, PhD, FRCSC,^{a,b} FAITH-2 Investigators**



FAITH-2

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.

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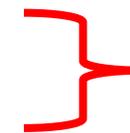
KEY TAKEAWAYS:

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



Similar to FAITH-1 study:
Fixation of femoral necks in
patients > 50 years old

3. Difficulty enrolling patients in this pilot study demonstrated that a larger scale RCT is not feasible

FAITH-2

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Fixation of femoral necks in patients > 50 years old

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



Broos PLO, Vercruyssen R, Fourneau I, et al. .Unstable Femoral Neck Fractures in Young Adults: Treatment with the AO 130 Degree Blade Plate. *J Orthop Trauma.* 1998;12(4):235-239.

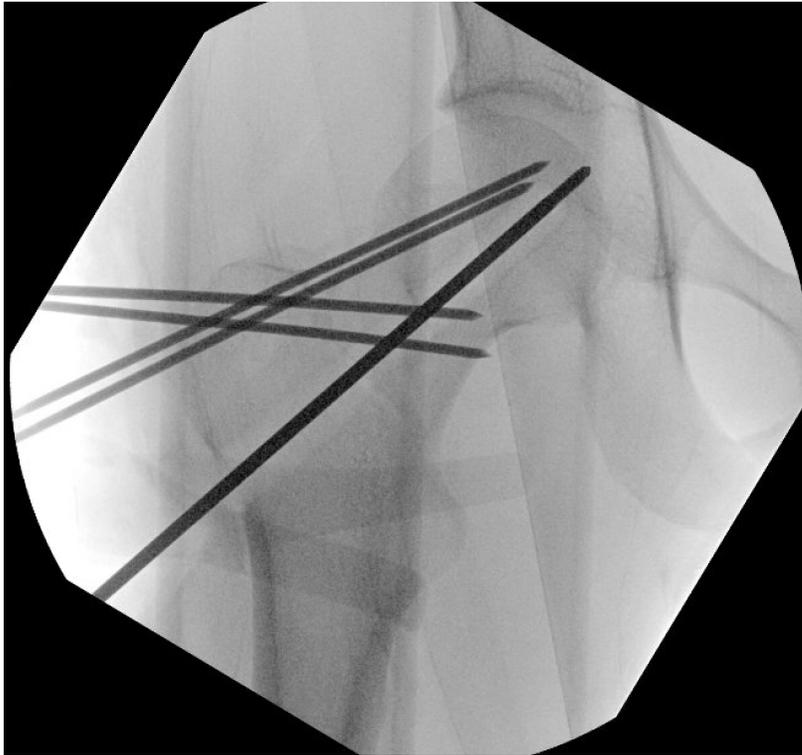
Case – 21 year old with displaced femoral neck



Reduction and provisional fixation



Definitive fixation



2 week Follow-up imaging



Arthroplasty

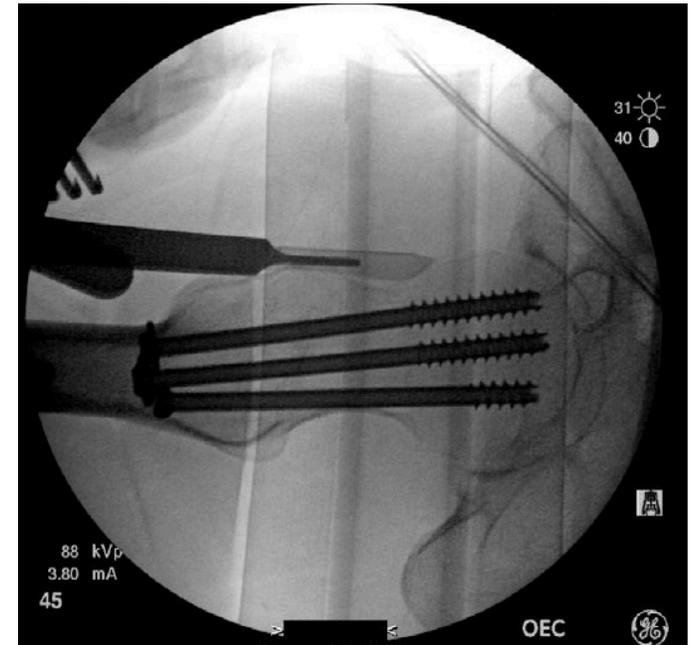
- Consider in patients with advanced age and non-reconstructable or extensively comminuted femoral neck fractures
- Higher risk of reoperation:
 - > 40 yrs of age
 - h/o renal disease
 - h/o liver disease
 - h/o respiratory disease
 - *Duckworth, et al. JBJS 2011.*



Florschutz AV, Langford JR, Haidukewych GJ, Koval KJ. Femoral Neck Fractures: Current Management. *J Orthop Trauma*. 2015;29(3):121-129.

Capsulotomy?

- Reduces intracapsular pressure from hematoma
 - Bonnaire, et al. CORR 1998
 - Harper, et al. JBJS Br 1991
 - Holmberg, et al. CORR 1987.
- 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**

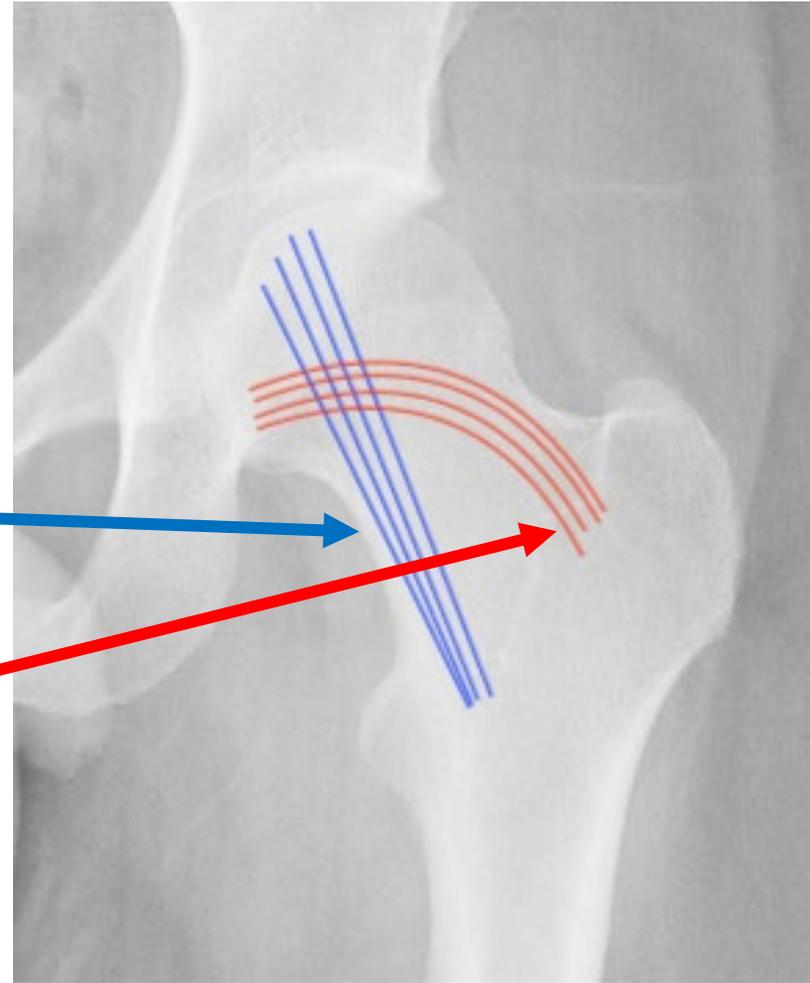


Example of displaced femoral neck stress fracture

Cochran GK, Staeheli GR, Deafenbaugh BK, et al. Outcomes following the urgent surgical management of displaced femoral neck stress fractures. *J Orthop Trauma*. 2020;34(11):594-599.

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

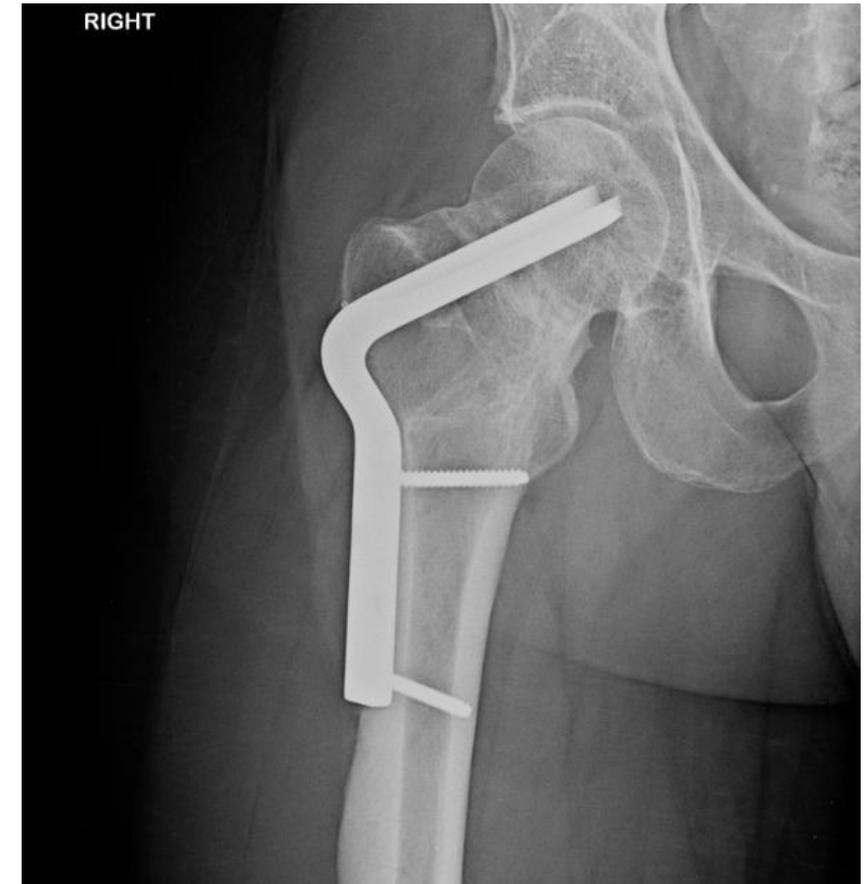
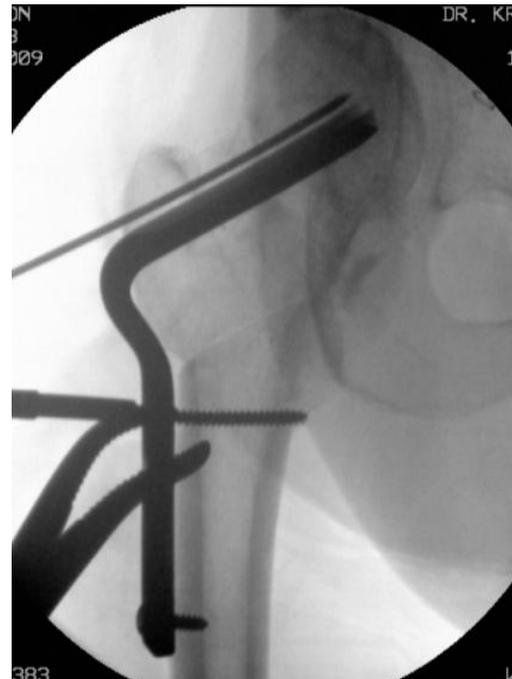
- No restriction on motion
- Non-weightbearing x 2-3 months
- Gradual progression of weightbearing at 2-3 months

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



Reconstruction Video

- **Valgus Intertrochanteric Osteotomy**
- **<https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/17165302/valgus-intertrochanteric-osteotomy-for-femoral>**

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

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