Femoral Neck Fractures

Ammar Karim, DO

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Epidemiology

- Substantial cause of morbidity and mortality in the elderly

- >250,000 hip fractures in US every year
  - Over 6 million world-wide by 2050
  - Split evenly between femoral neck and intertrochanteric fractures

- Mainly in geriatric population
  - 98% in individuals > 50 years
  - 90% low energy mechanism
  - 75% in women

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Epidemiology

- Risk Factors:
  - Female sex
  - Caucasian
  - Elderly
  - Poor overall general health
  - Tobacco
  - Alcohol
  - History of falls
  - Previous fragility fracture
  - Diminished estrogen levels

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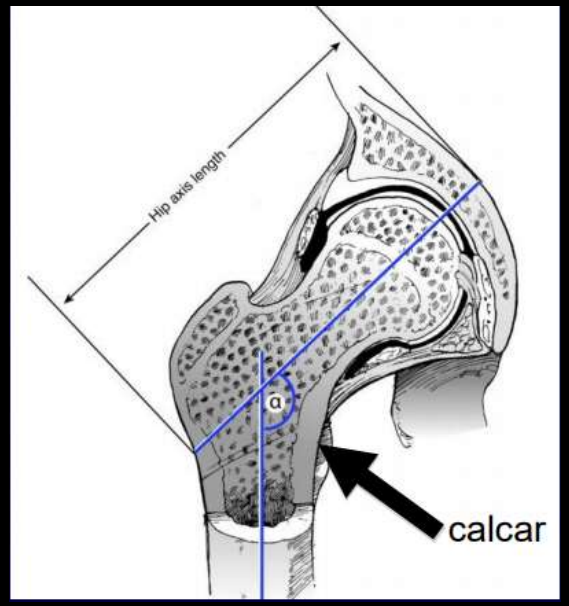
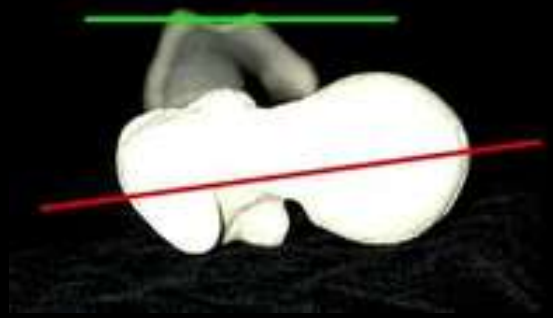
Anatomy of the Proximal Femur

- Neck shaft angle
  - 130 degrees +/- 7
- Anteversion
  - 10 degrees +/- 7
- Femoral Neck is intracapsular
- Femoral neck lies anterior to femoral shaft
- Calcar consists of posteromedial dense bone





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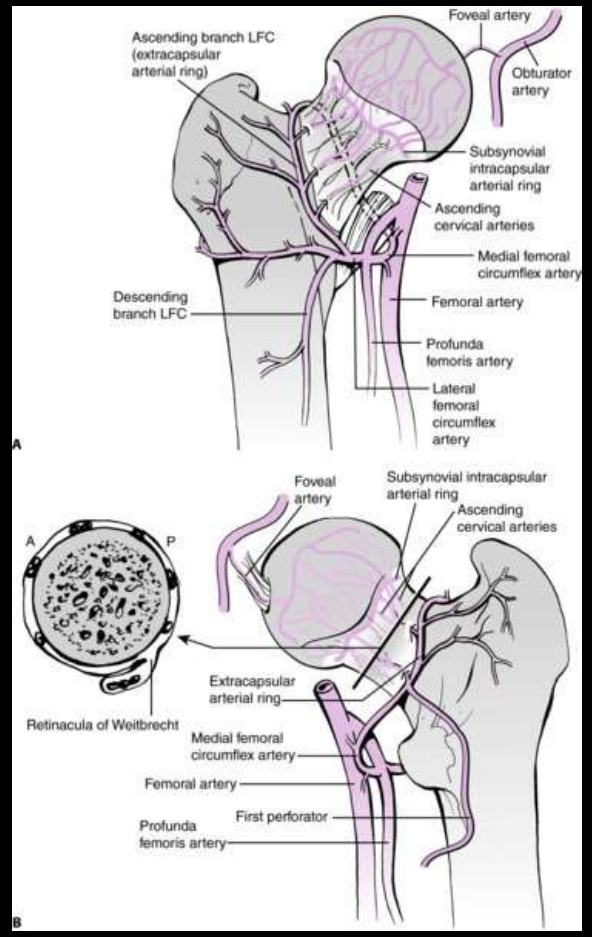
Anatomy of the Proximal Femur

- Blood supply
  - Retinacular vessels
  - Intramedullary vessels
  - Foveal vessels entering in the ligamentum teres



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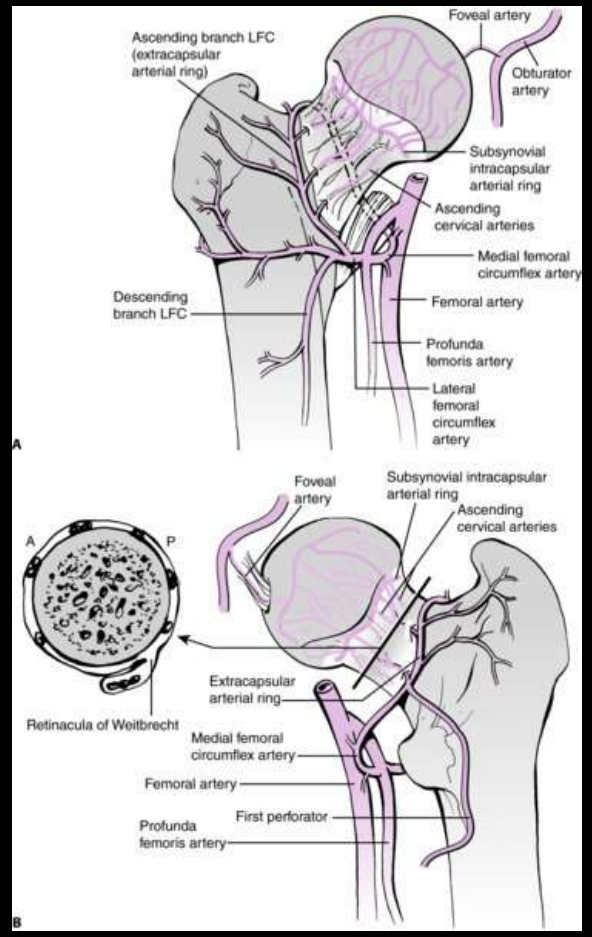
Anatomy of the Proximal Femur

- Blood supply
  - Retinacular vessels
    - Predominant blood supply femoral head
    - Branch off of the Lateral Epiphyseal Artery
      - Branch off of Medial Femoral Circumflex Artery



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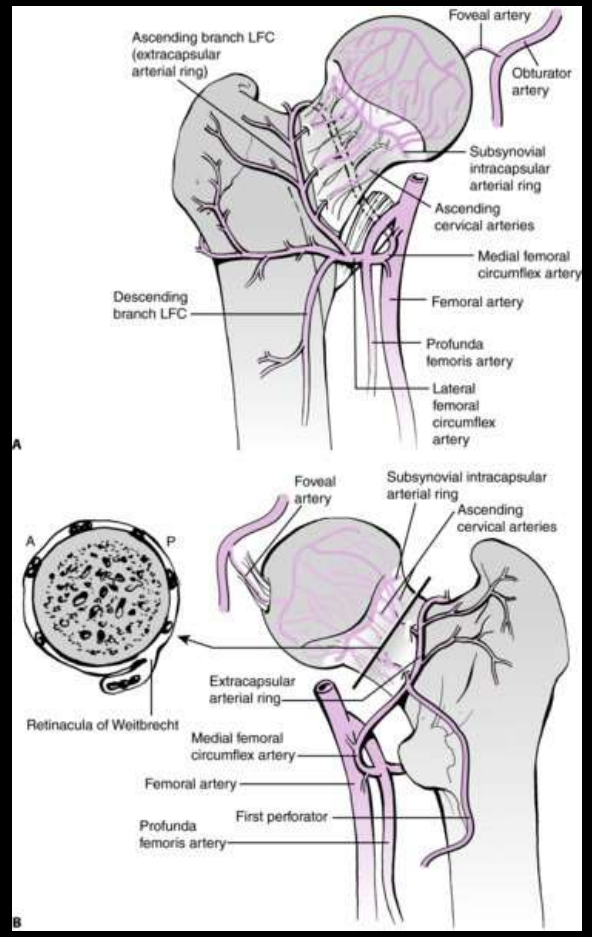
Anatomy of the Proximal Femur

- Blood supply
  - Retinacular vessels
    - After fracture these vessels are kinked/disrupted
    - Greater fracture displacement = greater risk of retinacular vessel disruption



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Clinical Evaluation

- Groin pain
- Cannot weight bear
- Limb typically shortened and externally rotated

- High energy fractures in young patients should be treated per ATLS protocols

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Radiologic Evaluation

- AP Pelvis
- AP and cross table lateral hip

- Traction View
  - Helpful in determining morphology of fractures
  - Traction and internal rotation

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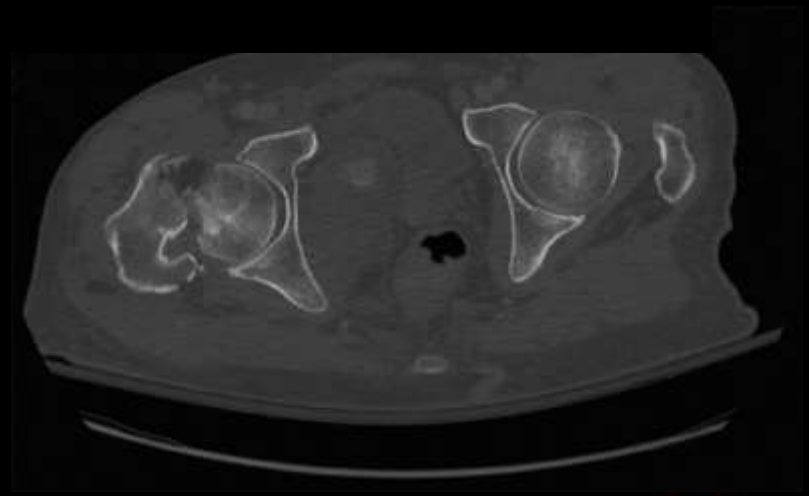
Radiologic Evaluation

- CT scan
  - Helpful in determining fracture morphology
  - Occult femur fracture
    - Not the best imaging study…
    - 86% sensitivity
    - 98% specificity



Sadozai Z, Davies R, Warner J. The sensitivity of CT scans in diagnosing occult femoral neck fractures. Injury. 2016;47;2769–2771.

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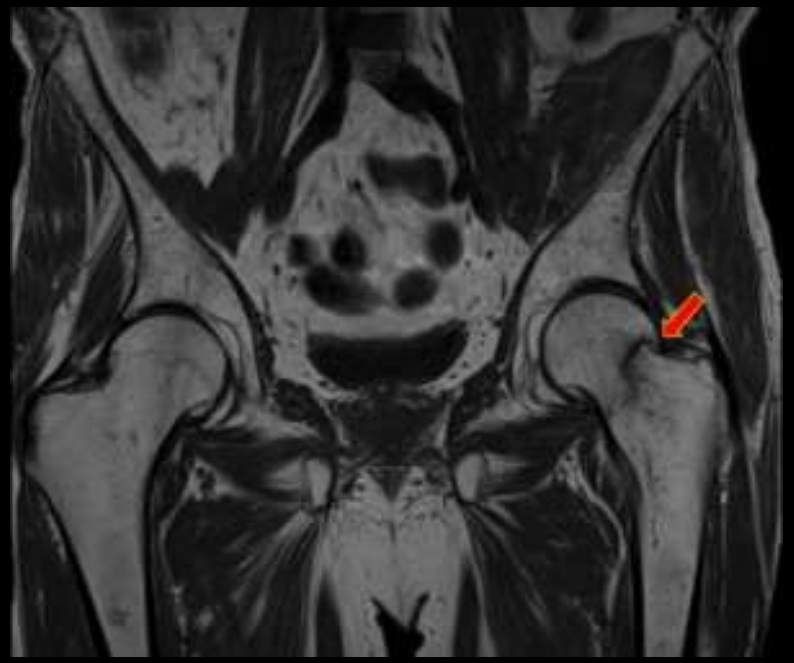
Radiologic Evaluation

- MRI
  - Preferred imaging for occult hip fractures
  - 100% sensitive and specific

- Technetium Bone Scan
  - Takes 72 hours
  - Consider if MRI contraindicated



Verbeeten KM, Hermann KL, Hasselqvist M, Lausten GS, Joergensen P, Jensen CM, Thomsen HS. The advantages of MRI in the detection of occult hip fractures. Eur Radiol. 2005 Jan;15(1):165-9. Epub 2004 Jul 27. PubMed PMID: 15647955.

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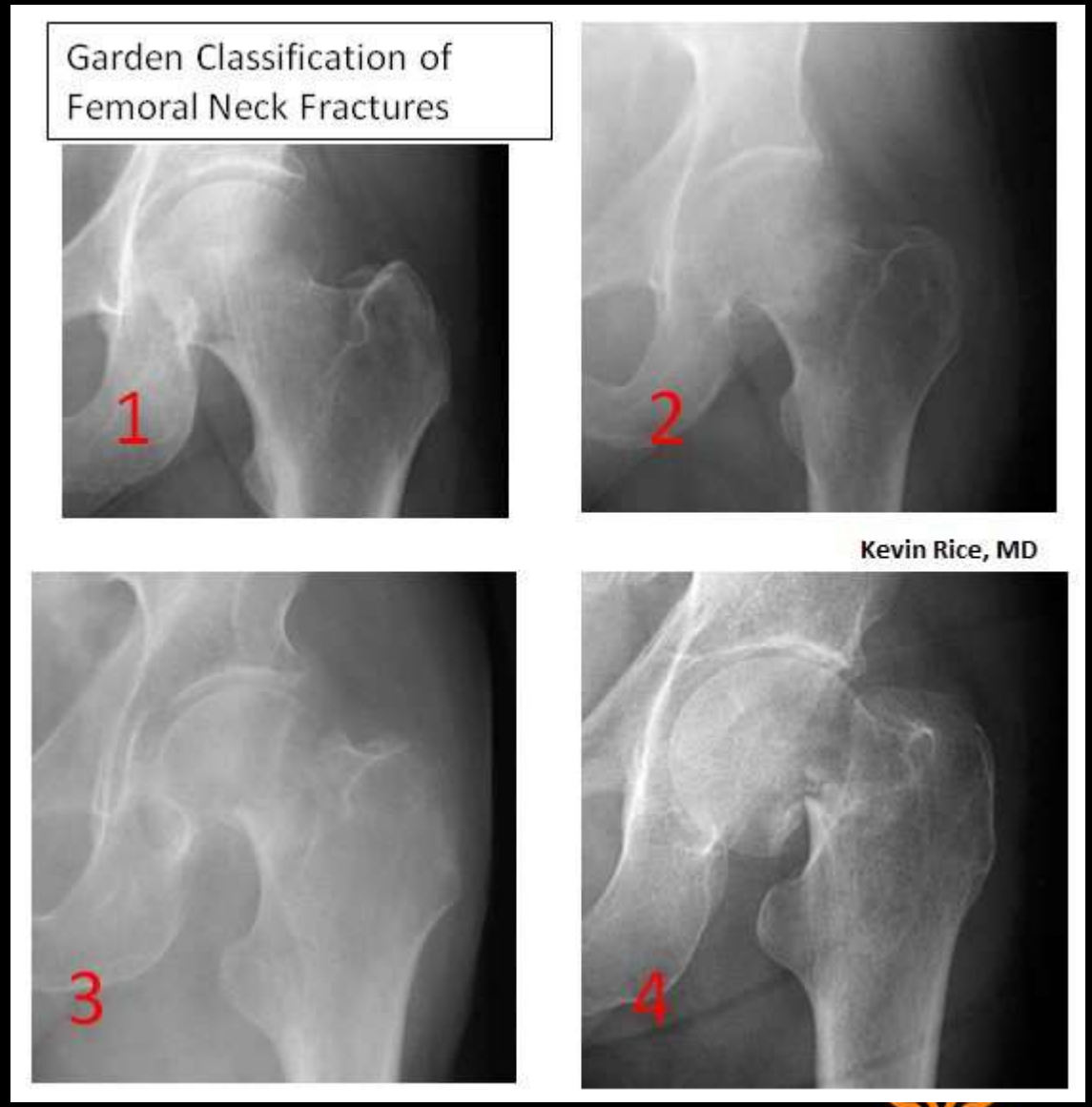
Classification

- Garden (1961)
  - Relates to degree of displacement
  - ↑ displacement = ↑ vascular insult!

  - 1 – Valgus impacted
  - 2 – Complete but nondisplaced
  - 3 – Partial displacement
  - 4 – Complete displacement



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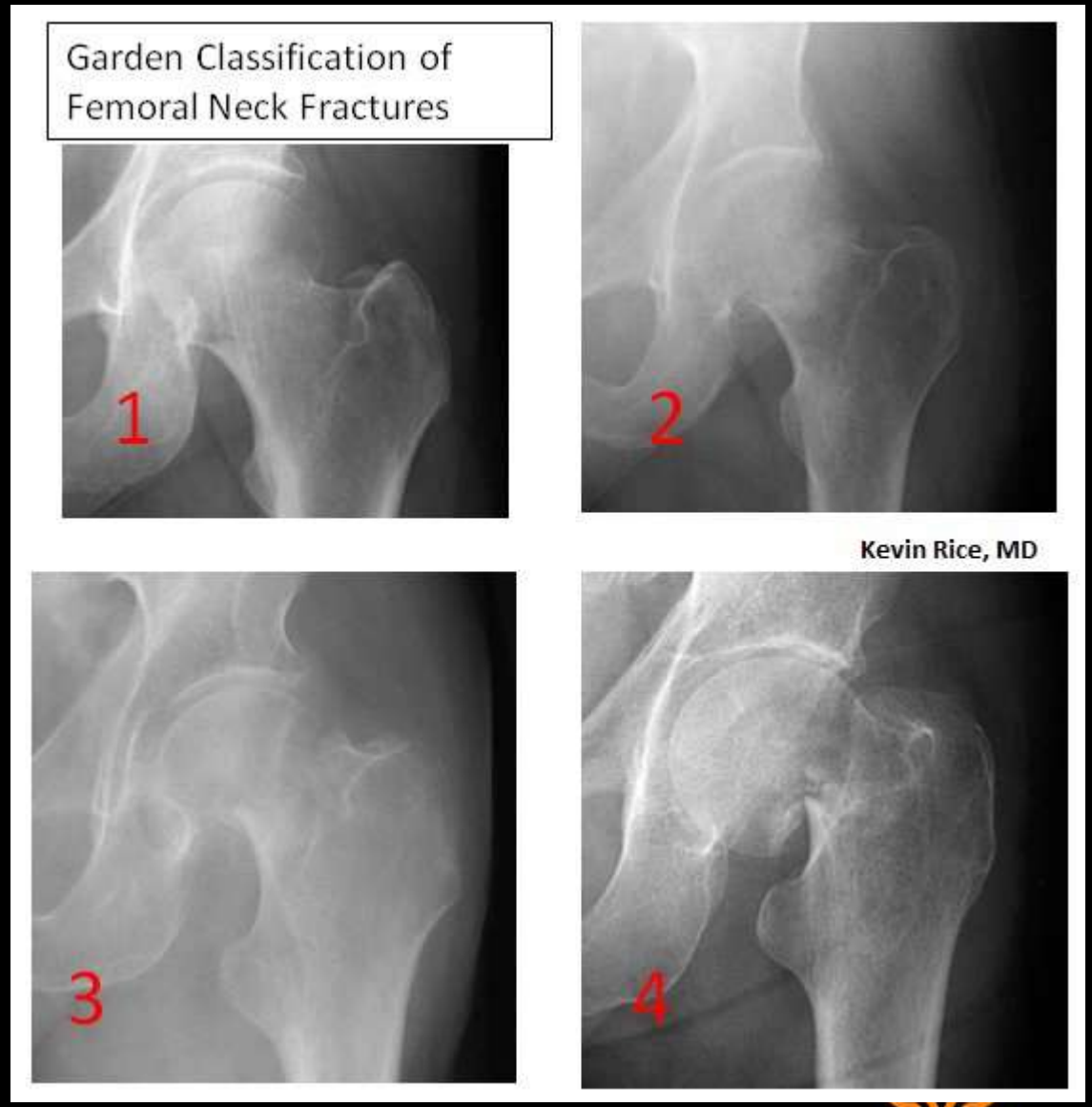
Classification

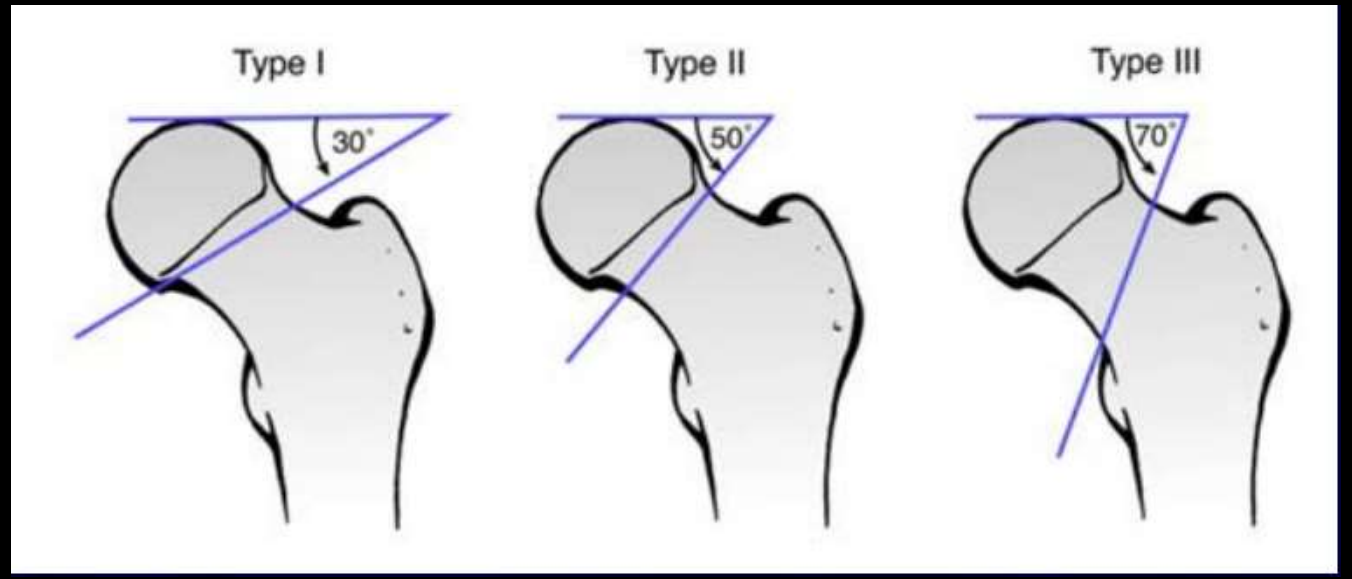
- Garden (1961)
  - Relates to degree of displacement
  - ↑ displacement = ↑ vascular insult!

  - Simplified to:
    - Nondisplaced – blood supply OK
    - Displaced – blood supply NOT OK



Classification

- Pauwel (1935)
  - Relates to degree fracture angle
  - ↑ angle = ↑ shear forces and fracture instability!



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Management

- For the majority of femoral neck fractures management in surgical

- Relieve pain (even in nonambulatory patients)
- Early mobilization
- Progressive return to pre-injury functional level

- Nonoperative management should only be considered if patient is seriously ill or risk of surgey far exceeds potential benefits

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Timing of Surgery

- Elderly
  - Urgency – Best if done within 24 hours
  - Risk of 30 day mortality compared to fixation before 12 hours[1]:
    - > 12 hours – 1.45 times increased mortality
    - > 24 hours – 1.34 times
    - > 48 hours – 1.56 times
  - Greater than 4 day delay results in 2.25 times increased mortality[2]

1. Nyholm AM, Gromov K, Palm H, Brix M, Kallemose T, Troelsen A; Danish Fracture Database Collaborators. Time to Surgery Is Associated with Thirty-Day and Ninety-Day Mortality After Proximal Femoral Fracture: A Retrospective Observational Study on Prospectively Collected Data from the Danish Fracture Database Collaborators. J Bone Joint Surg Am. 2015 Aug 19;97(16):1333-9.

2. Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? J Bone Joint Surg Am. 2005 Mar;87(3):483-9. PubMed PMID: 15741611.

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Timing of Surgery

- Young
  - Urgency – Best if done within 24 hours
  - Used to be considered a surgical emergency
  - Concern for increased AVN due to kinking of blood supply

Timing of Surgery

- Young
  - A delay of more than 48 hours before surgery did not influence the rate of union or the development of AVN when compared with operation within 48 hours of injury[1]
  - Razik et al – 92 patients younger than 60 years with 13 developing AVN; time to surgical fixation WAS NOT a predictor in the development of AVN[2]

1. Upadhyay A, Jain P, Mishra P, Maini L, Gautum VK, Dhaon BK. Delayed internal fixation of fractures of the neck of the femur in young adults. A prospective, randomised study comparing closed and open reduction. J Bone Joint Surg Br. 2004 Sep;86(7):1035-40. PubMed PMID: 15446534.

2. Razik F, Alexopoulos AS, El-Osta B, Connolly MJ, Brown A, Hassan S, Ravikumar K. Time to internal fixation of femoral neck fractures in patients under sixty years--does this matter in the development of osteonecrosis of femoral head? Int Orthop. 2012 Oct;36(10):2127-32.

Preoperative Considerations

- Cardiac Clearance

J Orthop Trauma. 2015 Nov;29(11):500-3. doi: 10.1097/BOT.0000000000000381.

Adherence to Preoperative Cardiac Clearance Guidelines in Hip Fracture Patients.

Stitgen A[1], Poludnianyk K, Dulaney-Cripe E, Markert R, Prayson M.

  - In a study of 266 patients, only 29% of those met ACC/AHA guidelines for needing preop clearance
  - Those who received a preoperative cardiac consult had a significantly longer average time to surgery (43.9 vs. 23.1 hours) (P = 0.005)
  - Significantly longer hospital length of stay (7.9 vs. 5.3 days) (P = 0.010).
  - There were no significant differences in postoperative complications or disposition.

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Preoperative Considerations

- Coagulopathy

J Clin Orthop Trauma. 2020 Feb;11(Suppl 1):S93-S99. doi: 10.1016/j.jcot.2019.10.004. Epub 2019 Oct 15.

Is anticoagulation reversal necessary prior to surgical treatment of geriatric hip fractures?

Meinig R[1], Jarvis S[2], Orlando A[2], Nwafo N[3], Banerjee R[4], McNair P[5], Woods B[6], Harrison P[7], Nentwig M[8], Kelly M[9], Smith W[10], Bar-Or D[2].

  - 270 patients with hip fracture on anticoagulation
  - No significant difference in blood loss between those who had reversal of their anticoagulation vs those who did not
  - No significant difference in transfusions
  - Significantly longer hospital length of stay in those with anticoagulation reversal

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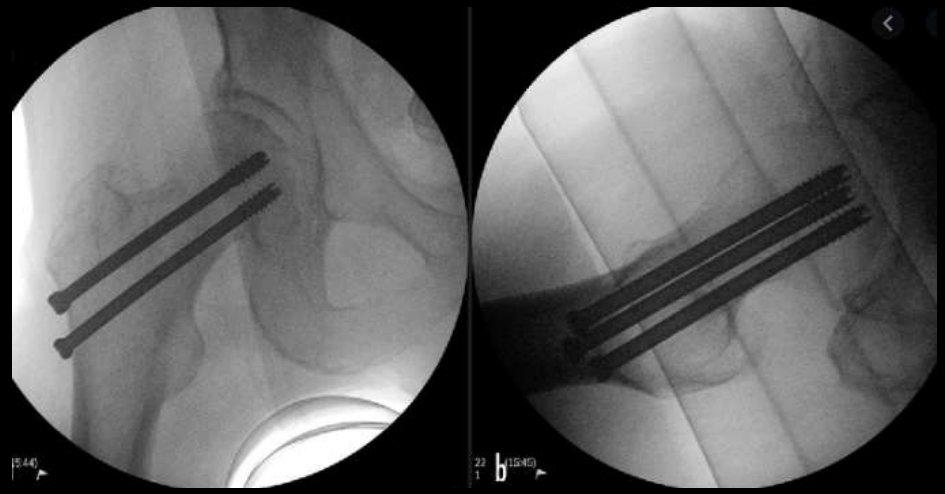
Preoperative Considerations

- Traction not beneficial
  - No effect on fracture reduction
  - No difference in analgesic use
  - Pressure sore/ skin problems
  - Increased cost
  - Traction position decreases capsular volume
  - Capsule volume greatest in flexion/external rotation
  - Potential detrimental effect on blood flow by increasing intracapsular pressure

Treatment Options

- Stable Femoral Neck Fractures
  - Valgus impacted or nondisplaced (Garden I & II)
  - In situ fixation
  - Cannulated Screw Fixation versus Sliding Hip Screw



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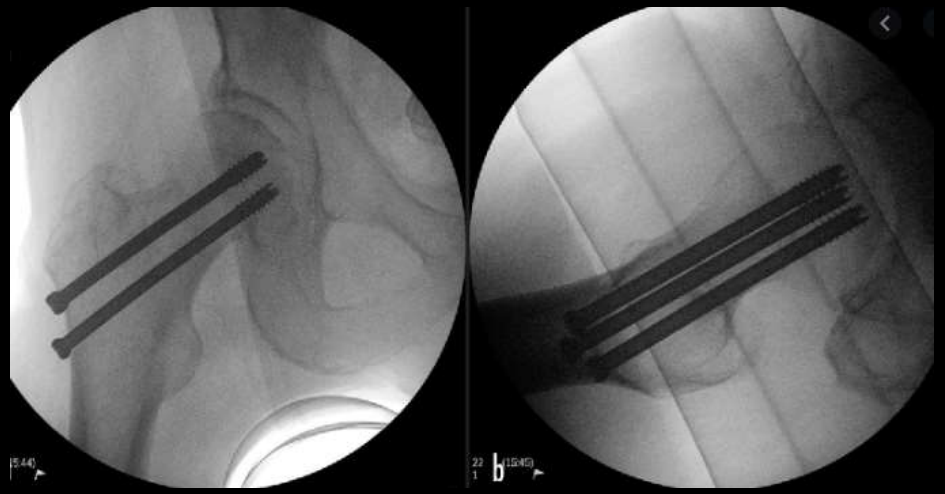
Cannulated Screw Construct

- Screw position matters
  - Booth et al, Orthopedics 1998
    - Inferior within 3 mm of cortex
      - Resists inferior femoral head displacement
    - Posterior within 3 mm of cortex
      - Resists posterior displacement
    - Need a screw resting on calcar



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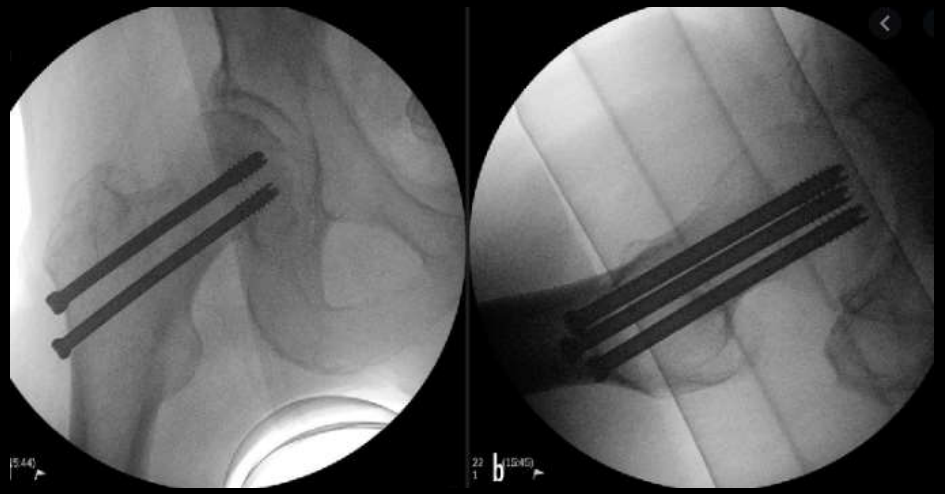
Cannulated Screw Construct



- Screw position matters
  - Threads should end at least 5mm from subchondral bone
  - Threads should be passed the fracture site
    - Ensure lag effect and fracture compression
  - Multiple “ around the world views to check appropriate depth
  - Avoid posterior/superior
    - to avoid iatrogenic vascular damage
  - Should not start below level of lesser trochanter
    - Avoid stress riser

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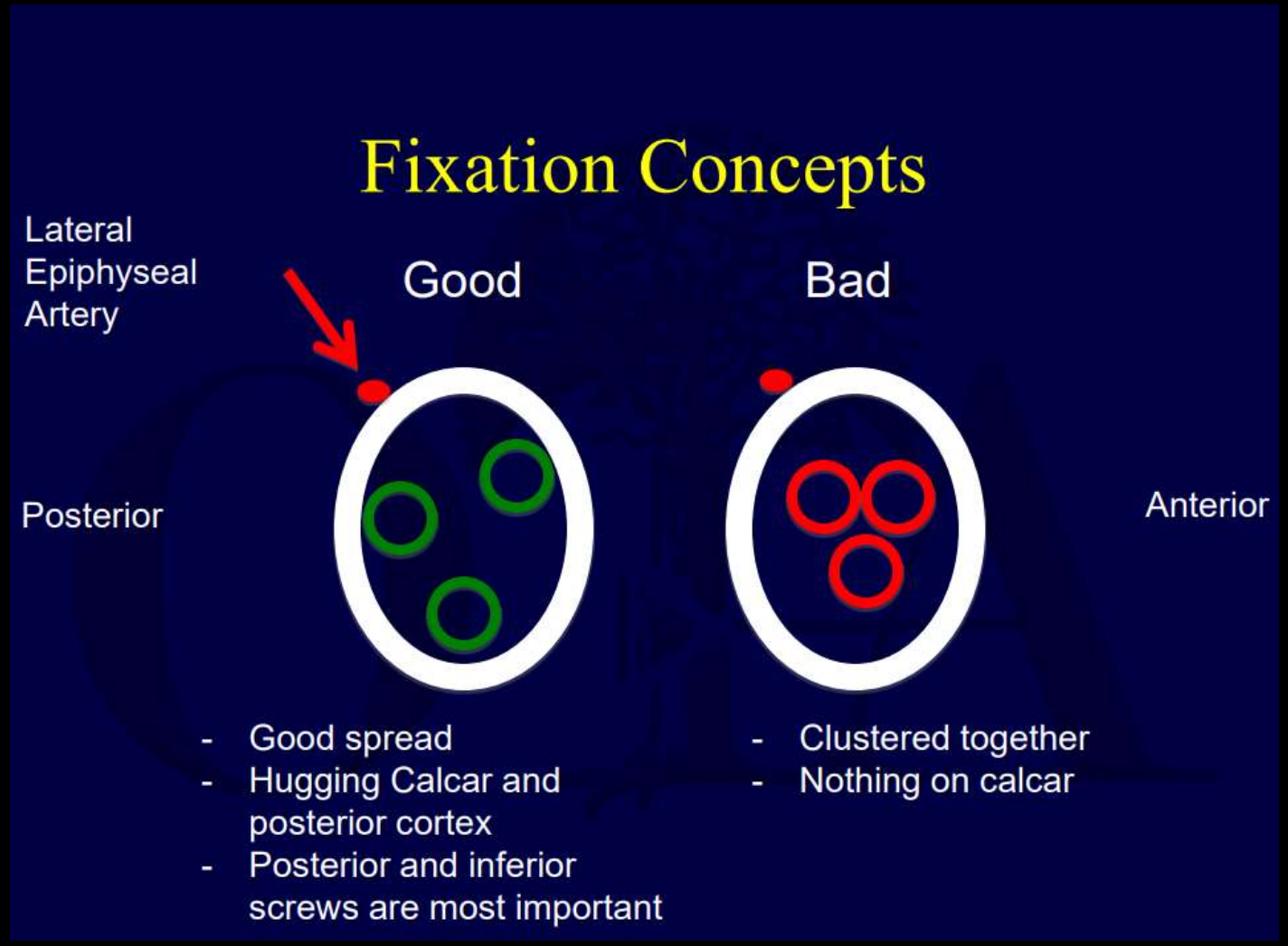
Cannulated Screw Construct



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Sliding Hip Screw

- Mechanically stronger than Cannulated Screws
- Preferable in basicervical femoral neck fractures
- High shear (Pauwel III) fractures
- Comminuted fractures

- Potentially longer surgical times and blood loss

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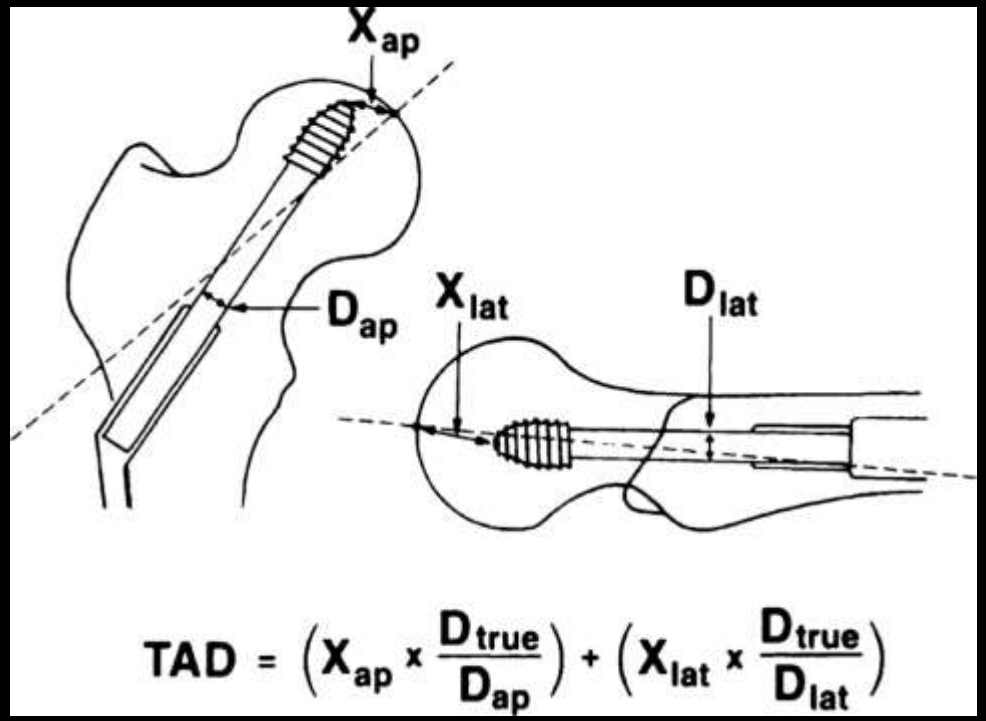
Sliding Hip Screw

- Tip to Apex Distance
  - Should be </= 25 mm
  - Tip of screw 10 mm from subchondral surface
  - Should be center-center
  - Avoid anterior and superior location of screw
    - Increased cut out

The value of the tip-apex distance in predicting failure of fixation of peritrochanteric fractures of the hip

MR Baumgaertner, SL Curtin, DM Lindskog and JM Keggi
J Bone Joint Surg Am. 1995;77:1058-1064.



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Sliding Hip Screw

- High torque from lag screw can malrotate fracture
- Consider antirotation screw!

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Cannulated Screws vs Sliding Hip Screw

Lancet. 2017 April 15; 389(10078): 1519–1527. doi:10.1016/S0140-6736(17)30066-1.

Fracture fixation in the operative management of hip fractures (FAITH): an international, multicentre, randomised controlled trial

- 1108 patients randomized to receive a sliding hip screw (n=557) or cancellous screws (n=551)
- No significant difference in reoperation rate after 24 months
  - 22% in CS vs 20% in SHS (p=0.18)
- In terms of reoperation rates the sliding hip screw shows no advantage
- Avascular necrosis was more common in the sliding hip screw group (9%) than in the cancellous screws group (5%); p=0.0319
- Smokers and those with displaced or base of neck fractures tended to do better with a sliding hip screw than with cancellous screws

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Treatment Options

- Unstable Femoral Neck Fractures
  - Displaced (Garden III & IV)
  - Fixation vs Hemiarthroplasty vs Total Hip Arthroplasty

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Treatment Options

- Cemented Stem
  - Standard (in literature*)
  - Improved mobility/function[1]
  - Decreased thigh pain[1]
  - Lower costs
  - Indicated in osteoporotic bone
    - Less risk periprosthetic fracture![1]
    - Acts as “grout” – better initial fixation
  - Decreased revisions compared to uncemented[2]
- Uncemented/Press-Fit Stem
  - Increased thigh pain
  - Intra- or peri-op femur frature risk higher![1]
  - Shorter OR times[1]

1. Lin FF, Chen YF, Chen B, Lin CH, Zheng K. Cemented versus uncemented hemiarthroplasty for displaced femoral neck fractures: A meta-analysis of randomized controlled trails. Medicine (Baltimore). 2019 Feb;98(8):e14634

2. Jameson SS, Jensen CD, Elson DW, Johnson A, Nachtsheim C, Rangan A, Muller SD, Reed MR. Cemented versus cementless hemiarthroplasty for intracapsular neck of femur fracture--a comparison of 60,848 matched patients using national data. Injury. 2013 Jun;44(6):730-4.

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Treatment Options

- Cemented Stem
  - No difference in mortality, dislocation, general complications, and intraoperative blood loss compared to uncemented[1]
  - Risk of sudden intra-op cardiac death increased slightly
    - Parvizi et al – 23 intraoperative deaths in 23,077 arthroplasties[2]
    - Due to intra-op cardiorespiratory disturbances from cement pressurization
    - Bone marrow microemboli
    - Modern surgical techniques 3x reduction in mortality rate
      - Pressurized lavage of intramedullary contents
      - Cement restrictor
      - Suction catheter with retrograde cement application

1. Lin FF, Chen YF, Chen B, Lin CH, Zheng K. Cemented versus uncemented hemiarthroplasty for displaced femoral neck fractures: A meta-analysis of randomized controlled trails. Medicine (Baltimore). 2019 Feb;98(8):e14634

2. Parvizi J, Holiday AD, Ereth MH, Lewallen DG. The Frank Stinchfield Award. Sudden death during primary hip arthroplasty. Clin Orthop Relat Res. 1999 Dec;(369):39-48. PubMed PMID: 10611859.

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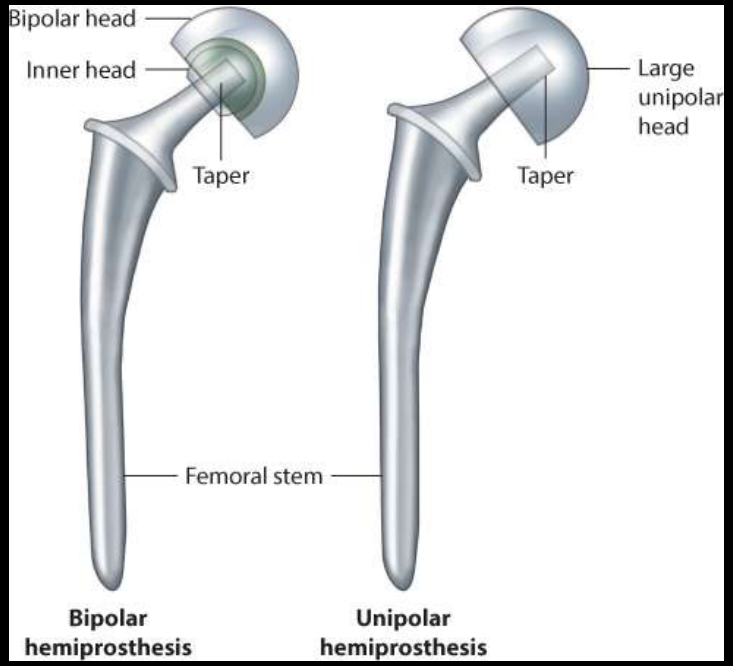
Treatment Options

- Bipolar
  - Theoretically less wear
  - More modular
  - More expensive
  - Can dissociate
  - No proven advantage
    - Functions as unipolar after 1 year[1]

- Unipolar
  - Lower Cost
  - Simple



1. Bhattacharyya T, Koval KJ. Unipolar versus bipolar hemiarthroplasty for femoral neck fractures: is there a difference? J Orthop Trauma. 2009

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Treatment Options

- Hemiarthroplasty
  - Excellent pain relief and mobility
  - Lower demand
  - Elderly
  - Smaller operation
    - Less blood loss
    - Only replace femoral component

- Total Hip Arthroplasty
  - Healthier
  - Active
  - Relatively younger (~65 years)
  - More invasive
    - Replace femur and acetabulum component

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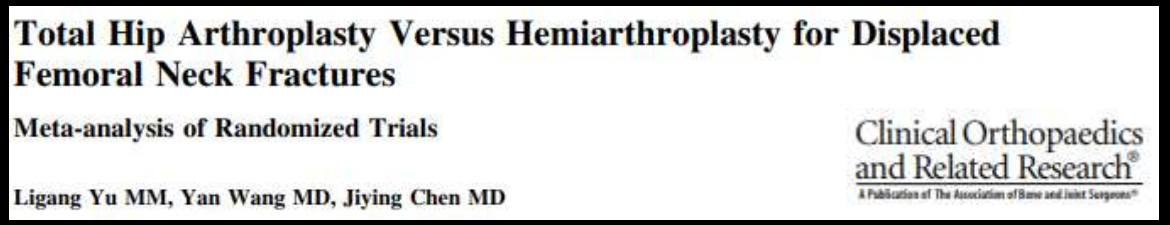
Total Hip Arthroplasty for Femoral Neck Fracture

- Meta-analysis of 12 RCTs comparing THA versus HA



- THA associated with:
  - Lower reoperation rate
  - Higher risk of dislocation
  - No difference in mortality
  - No difference in infection or general complications
  - Higher Harris Hip Scores at 1, 3, and 4 years

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Treatment Options

- Posterior Approach
  - Utilitarian
  - Well known
  - Higher dislocation rate[1]
- Lateral Harding Approach
  - Splits the gluteus medius
  - Trendelenburg gait/limp
  - Decreased dislocation rate
- Direct Anterior Approach
  - Earlier functional recovery
  - Higher learning curve
  - Risk of proximal femur fracture

1. Rogmark C, Fenstad AM, Leonardsson O, Engesæter LB, Kärrholm J, Furnes O, Garellick G, Gjertsen JE. Posterior approach and uncemented stems increases the risk of reoperation after hemiarthroplasties in elderly hip fracture patients. Acta Orthop. 2014 Feb;85(1):18-25.

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Fixation vs Hemi vs THA

J Bone Joint Surg Am. 2006 Feb;88(2):249-60.

Randomized comparison of reduction and fixation, bipolar hemiarthroplasty, and total hip arthroplasty. Treatment of displaced intracapsular hip fractures in healthy older patients.

Keating JF[1], Grant A, Masson M, Scott NW, Forbes JF.

- Prospective, randomized study ORIF vs. cemented bipolar hemi vs. THA
- ambulatory patients > 60 years of age
  - 37% failure in fixation group (AVN/nonunion)
  - similar dislocation rate hemi vs. THA (3%)
  - ORIF 8X more likely to require revision surgery than hemi and 5X more likely than THA
  - THA group best functional outcome

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Complications – Nonunion

- 0-5% in nondisplaced fractures
- 9-35% in displaced fractures
- Increased incidence with:
  - Posterior comminuted
  - Increased initial displacement
  - Imperfect reduction
  - No compression during fixation

Complications – Osteonecrosis (AVN)

- 5-8% in nondisplaced fractures
- 20-45% in displaced fractures
- Increased incidence with:
  - Associated hip dislocation
  - Increased initial displacement
  - ? Time to reduction
  - Imperfect reduction
  - ? Increased incidence with sliding hip screw

Complications – Mortality

- One-year mortality 14-50%
  - Increased risk:
    - Medical comorbidities
    - Surgical delay > 3 days
    - Institutionalized / demented patient
    - Arthroplasty (short term / 3 months)
    - Posterior approach to hip

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Summary

- Important musculoskeletal injury that affects a large proportion of growing population
- Management varies depending on age of patient, activity level, and displacement of the fracture
- Significant effect of morbidity and mortality

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Thank You! Questions/Comments?

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