Indications

- **Acute**
  - Displaced intracapsular transcervical fracture in old patient
  - Intracapsular transcervical fracture with concomitant hip pathology e.g. pre-existing avascular necrosis of femoral head
  - Delayed presentation of displaced intracapsular transcervical fracture in young patient (> 48 to 72 hours)
  - Pathological fracture of femoral head or neck
  - Abnormal sized femoral canal (too wide or too narrow)
Subcapital #NOF
Subcapital #NOF with pre-existing AVN
- Late
  - Complications of previous endoprosthesis
    - Loosening
    - Infection
    - Acetabular protrusio
  - Complications of previous internal fixation
    - Screw protrusion into hip joint
    - Avascular necrosis of femoral head
    - Non-union of fracture
Acetabular protrusio
Post-traumatic AVN
Non-union after #NOF
Pathological #NOF
Types of arthroplasty in hip fracture

- Hemiarthroplasty
  - Austin Moore Hemiarthroplasty
  - Thompson’s prosthesis
- Unipolar and Bipolar hemiarthroplasty
  - Cemented vs. cementless
- Total hip arthroplasty
  - Cemented, cementless or hybrid
  - Different bearing surfaces
    - Metal or ceramic on polyethylene
    - Ceramic-on-ceramic
    - Metal-on-metal
Hemiartroplasty

**Advantages**

- Cheap
- Less technical demanding
- Low dislocation rate (large head)
- Suitable in fragile, old patients

**Disadvantages**

- Insecure fixation of femoral stem
- Acetabular erosion and protrusio
- High reoperation rate in relatively young patient (between 60 to 80 yo)
Unipolar hemiarthroplasty
Bipolar Hemiarthroplasty
Unipolar and bipolar hemiarthroplasty

- **Advantages**
  - Low dislocation rate
  - More secure femoral stem fixation
  - Low reoperation rate
  - One more motion interface in bipolar hemiarthroplasty
  - Conversion to THA is simple (if femoral stem is well fixed, can perform acetabular side only)

- **Disadvantages**
  - Acetabular erosion and protrusio
  - Technical demanding
Hybrid THA
THA

- **Advantages**
  - Low reoperation rate
  - Secure femoral stem fixation
  - Less acetabular protrusio

- **Disadvantages**
  - Technical demanding
  - Higher dislocation rate than hemiarthroplasties
    (small femoral head)
  - Disruption of relatively normal acetabular cartilage
Cemented THA
Bone cement
Polymethylmethacrylate (PMMA)

- in use for 40 years
- popularized by Charnley
- advances in cementing technique
- toxic effects
Contents of cement

- **Packet**
  - PMMA powder
  - 10% Radiopaque barium sulphate (occ. Zirconium dioxide)
  - Polymerization initiator (1% benzoyl peroxide)

- **Vial of liquid**
  - Methylmethacrylate monomer
  - Activator (3% DMP toluidine)
  - Trace amount of retardant to prevent monomer polymerization during storage
Cement mixing

- **Dough time**
  - Beginning of mixing until cement not stick to gloves
  - ~ 2 – 3 minutes

- **Working time**
  - Time from the end of dough time to until cement too stiff to manipulate
  - ~ 5 – 8 minutes

- **Setting time**
  - Dough time + working time
  - ~ 8 – 10 minutes
### Table 5-1 Factors Affecting PMMA Bone Cement Strength*

<table>
<thead>
<tr>
<th>Factors</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNCONTROLLED FACTORS</strong></td>
<td></td>
</tr>
<tr>
<td>Aging after implantation changes</td>
<td>Gradual 10% loss of strength resulting from postcuring chemical</td>
</tr>
<tr>
<td>Environmental temperature</td>
<td>10% weaker at body temperature than at room temperature</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Fatigue strength ($10^6$ cycles) 20%-25% of single-cycle strength</td>
</tr>
<tr>
<td>Moisture content</td>
<td>Loss of 3%-10% strength because of water absorption</td>
</tr>
<tr>
<td>Strain rate</td>
<td>Significant increase in strength with increasing strain rate</td>
</tr>
<tr>
<td><strong>PARTIALLY CONTROLLABLE FACTORS</strong></td>
<td></td>
</tr>
<tr>
<td>Cement thickness</td>
<td>Intermediate cement thicknesses minimize both fatigue stresses and shrinkage effects</td>
</tr>
<tr>
<td>Constraint</td>
<td>Cement far stronger in compression than tension</td>
</tr>
<tr>
<td>Inclusion of blood or tissue</td>
<td>Up to 70% loss of strength, depending on amount</td>
</tr>
<tr>
<td>Stress risers (bony bed, implant)</td>
<td>Cement is quite notch sensitive</td>
</tr>
<tr>
<td><strong>FULLY CONTROLLABLE FACTORS</strong></td>
<td></td>
</tr>
<tr>
<td>Antibiotic inclusion</td>
<td>5%-10% loss of strength</td>
</tr>
<tr>
<td>Centrifugation/vacuum degassing</td>
<td>10%-25% increase in strength, possible increase in fatigue strength</td>
</tr>
<tr>
<td>Insertion pressurization</td>
<td>Delay may produce up to 40% loss of strength, whereas increases strength by up to 20% by reduction of porosity</td>
</tr>
<tr>
<td>Mixing speed</td>
<td>Up to 21% loss of strength because of too slow or too rapid mixing</td>
</tr>
<tr>
<td>Radiopaque fillers</td>
<td>5% weaker than unfilled</td>
</tr>
</tbody>
</table>


*Strength and fatigue strength are in tension; behavior in compression is different and less sensitive to external conditions.*
Cement Mixer
Cementing technique

- First generation (Charnley)
  - unplugged medullary canal
  - finger-packing

- Second generation
  - medullary plug
  - cement gun
Third generation (Harris)

- medullary plug
- cement gun
- pulsatile lavage
- reduction of cement porosity (vacuum mix)
- pressurization
- precoating
Toxic effect of Methylmethacrylate

- **Animal studies**
  - dose-dependent depression of left ventricular function → ↓ blood pressure and pulse rate
  - induces pulmonary hypertension and increases lung vascular permeability
Human studies

Wenda K et al Arch Ortho Trauma Surg
107:316,1985

- MMA found in pulmonary artery, radial artery and SVC
- BP ↓ during first 3 min
- Pulmonary arterial pressure ↑ during first to 10 min
- No correlation between MMA concentration & ↓ BP or ↑ pulmonary arterial pressure
Cementless THA
Alternate bearing surfaces

Ceramic-on-ceramic
Ceramic-on-ceramic
Metal-on-metal
Results of arthroplasty in hip fracture
Outcome of intracapsular transcervical fracture

- **Non-union**
  - 5% in undisplaced fracture
  - 21 – 32% in displaced fracture

- **Avascular necrosis**
  - 10% in undisplaced fracture
  - 12 – 16% in displaced fracture
Problems encountered during conversion of failed osteosynthesis to arthroplasty

- Bone loss caused by implant protrusio
- Medullary cavity sclerotic especially previous intra-medullary device
  - Difficult to insert cementless prosthesis and prone to femoral shaft fracture
  - Cement interdigitation very difficult
- Multiple holes in proximal femur
  - Difficult to achieve good pressurization of cement
Osteosynthesis vs. primary arthroplasty in displaced femoral neck fracture


- Meta-analysis of 14 RCTs, 2289 patients
- Primary arthroplasty has significantly less major method-related complications and reoperations
- Better function and less pain after primary arthroplasty
- 70 to 80 yo should have THA
- >80 yo should have hemiarthroplasty

- 228 osteosynthesis, 455 bipolar hemiarthroplasty, all had displaced #NOF
- 2% revision surgery after bipolar hemiarthroplasty
- 24% revision surgery after osteosynthesis
- No significant difference in mortality between 2 groups at 30 days post-op
Parker et al *JBJS* 84B:1150-5, 2002

- RCT
- 226 osteosynthesis, 229 hemiarthroplasty
- Av age 82 yo
- Significantly less patient require reoperation after hemiarthroplasty
- Tendency for improved survival in patients > 90 yo
- Osteosynthesis reserved for old fragile patient
Results of AMA

  - Compare 100 failed hip screws with conversion to AMA (group 1) and 730 primary hip fracture with AMA done (group 2)
  - Significantly higher revision surgery in group 1
  - Group 1 has significantly more dislocation, infection and pain
Yau WP, Chiu KY *Injury* 35(10):1020-4, 2004

- 44 patients
- Age < 73 at the time of operation has significantly more subsidence
- <70% fill of prosthesis within proximal femur was associated with subsidence
AMA vs. cemented Thompson’s prosthesis

  - 54 hip fractures, 25 Thompson’s prosthesis, 29 AMA
  - Patients with Thompson’s prosthesis has significantly less pain and shorter hospital stay than patients with AMA
Results of unipolar hemiarthroplasty

  - 162 patients, average age 84 yo
  - Modular Müller self-locking straight stem
  - Prosthesis survival
    - 98% at 1 year
    - 94% at 5 and 10 years
  - Patient survival
    - 73% at 1 year
    - 23% at 5 years
    - 6% at 10 years
- Overall complication rate requiring repeat surgery was 10%
- Preferred for patient older than 70 years
Results of bipolar hemiarthroplasty

  - 168 patients, cementless stem
  - Av age: 77, av FU 3.5 years
  - 5% need revision surgery
    - 6 patients revised due to acetabular erosion
    - 2 patients revised due to femoral stem loosening
Dixon et al. *Injury* 35(2): 152-6, 2004

- 53 patients, cemented bipolar hemiarthroplasty
- Av FU 32 months
- No dislocation
- 2 revision surgeries
  - 1 with femoral stem loosening
  - 1 with acetabular erosion
Unipolar vs. bipolar hemiarthroplasty

  - RCT
  - 40 unipolar, 38 bipolar, all had cemented stem
  - No significance difference in functional outcome and quality of life at 1 year post-op
Results of primary THA in displaced
#NOF

  - 38 patients, av FU 21 months
    - Av. age 75 yo
    - Cemented THA
    - 30 patients no pain
    - 2 dislocation
    - 2 deep infection with Girdle Stone operation
    - No aseptic loosening

- 51 patients, av FU 33 months
- Av age 74 yo
- Cemented THA
- 2 revision surgeries
  - 1 recurrent dislocation
  - 1 deep infection with Girdle Stone operation
Osteosynthesis vs. THA

  - RCT, 145 patients
  - Socioeconomic comparison between primary THA and osteosynthesis in displaced #NOF
    - Significantly more patients after osteosynthesis need reoperation than THA
    - No significant difference in socio-economic cost between 2 groups
Unipolar hemiarthroplasty vs. THA


  - RCT, 41 hemiarthroplasties, 40 THAs
  - Av. FU 3 years, all had cemented stem
  - 66% of unipolar hemiarthroplasty showed acetabular erosion radiographically, none in THA
  - More dislocation after THA
  - Revision surgery
    - 14.6% in unipolar group
    - 2.5% in THA group
Bipolar hemiarthroplasty vs. THA

- **Narayan et al.** *Arch Orth Trau Surg* 126: 545-8, 2006
  - 29 THAs, 32 bipolar hemiarthroplasties
  - Av FU 58.5 months
  - No difference in function and pain between 2 groups
  - More dislocation after THA than bipolar hemiarthroplasty
Preference of surgeons

- Bhandari et al. *JBJS* 87A: 2122-30, 2005
  - International survey of 298 North America and European surgeon
    - <60 yo
      - 89% opted for osteosynthesis in Garden type III
      - 75% opted for osteosynthesis in Garden type IV
    - >80 yo
      - 6% opted for osteosynthesis in Garden type III
      - 4% opted for osteosynthesis in Garden type IV
Patients between 60 to 80 yo

- Garden type III
  - 34% opted for bipolar hemiarthroplasty
  - 28% opted for unipolar hemiarthroplasty
  - 15% opted for THA
  - 25% opted for osteosynthesis

- Garden type IV
  - 41% opted for bipolar hemiarthroplasty
  - 32% opted for unipolar hemiarthroplasty
  - 17% opted for THA
  - 11% opted for osteosynthesis
Conclusion
Displaced femoral neck fracture

- **Young patient (< 65 yo)**
  - Try osteosynthesis
  - If osteosynthesis fail, convert to bipolar hemiarthroplasty ± THA

- **Relatively young patient (65 to 80 yo)**
  - Bipolar hemiarthroplasty ± THA

- **Old, fragile patient (>80 yo)**
  - Hemiarthroplasty (AMA or Thompson’s prosthesis)
Thank you