The Aseptic Total Hip: Work-Up and Diagnosis

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I have no disclosures
Learning Objectives

- Understand the appropriate clinical evaluation of a painful total hip arthroplasty
- Understand the appropriate radiographic evaluation of a painful total hip arthroplasty
- Understand the appropriate laboratory evaluation of a painful total hip arthroplasty
- Appropriately diagnose an aseptic total hip arthroplasty
Outline

- Clinical and Historical Evaluation
- Radiographic Evaluation
  - Imaging Studies
  - Femoral Bone Loss
  - Acetabular Bone Loss
- Laboratory Evaluation
Introduction

Why do we revise THA?

- Instability/Dislocation 1-3%
  - Improper positioning
  - Poly wear
- Pain
  - MoM/Pseudotumor
  - Improper positioning (Psoas Impingement)
  - Bipolar
- Infection ~1%
- Fracture (post-op) ~0.1-3%
- Aseptic Loosening/Bone Loss
  - Often due to Poly wear → Macrophage mediated inflammatory response stimulates osteoclastic bone resorption
- Implant Failure
  - Fatigue failure, corrosion, etc.
- Squeaking <0.5%
- Leg Length Inequality
History and Physical Exam
History

- Should include a detailed procedural history of the joint in question, including obtaining previous op notes
  - Indication for prior sx
    - OA, trauma, infection, etc
  - Approach
  - Current implants in place
- Treatment of any previous infections or issues with wound healing
- Instability or dislocation events
  - Which direction? How was it managed?
- Location, severity, intensity, duration of symptoms
  - Classic loosening c/o “start-up” pain in thigh (femoral component) or groin (acetabular component)
  - Started a day or two after root canal
  - Groin pain esp. during terminal stance → iliopsoas impingement
  - Pain around anterior approach incision and/or lateral thigh numbess → LFCN injury
- Back pain? Or any back surgery since THA?
Physical Exam

- Observe Gait
  - Antalgic ➔ Shortened stance phase on affected side
  - Trendelenberg

- Skin
  - Actually look at the bare skin!
    - Previous incisions?
    - Cellulitis/Draining Sinus?

- ROM
  - Normal: ER ~50, IR ~30, Add ~25, Abd ~45, F ~130, E ~25

- Contractures
  - Thomas Test

- Muscular Atrophy
Physical Exam

- Pulses
- Neurologic
  - Sensation, strength, reflexes
- Palpation
  - Greater trochanter bursitis
  - ITBS
- Leg Lengths
- FABER
- FADIR
- Ober’s Test
- Stinchfield Test
- Resisted seated hip flexion
- L-spine Exam
Imaging
Imaging: Radiographs

- Generally an excellent AP pelvis and hip and a shoot through lateral are adequate
  - Frog leg, false profile view, Judet views, Inlet/Outlet views?
- AP and Lateral of Femur
- Good quality radiographs are essential as implant stability and bone loss classification systems are based on them!
HO – Brooker classification

- I: Islands of bone in soft tissues
- II: > 1 cm between opposing surfaces
- III: < 1 cm
- IV: Radiographic Ankylosis
Imaging: CT Scans

- CT scan and 3-D model are useful in cases of acetabular bone deficiencies as XR tends to underestimate bone loss around/behind cup
- Also useful if concerned about acetabular component malpositioning → psoas impingement
Imaging: MRI

- Metal Artifact Reduction Sequence (MARS) MRI is useful if concerned about pseudotumor, mass, or to evaluate musculature
  - MARS is an umbrella term. Many specific types → VAT (View Angle Tilting), MAVRIC (Multi-Acquisition Variable Resonance Image Combination), SEMAC (Slice Encoding Magnetic Artifact Compensation)
  - If you don’t have access to these sequences, FSE and STIR sequences are often diagnostic and lower Tesla magnets often produce better quality images.
Imaging: Other

- **Bone Scan** can show indolent infection or loosening but rarely required
  - Often non-specific on its own
  - Helpful if you’re evaluating end of stem pain??

- **US** infrequently used in adult population due to obesity, but can be used to evaluate for fluid in/around hip or for aspiration

- **Fluoroscopy for EUA** can be useful
Femoral Component Stability
How to Determine Femoral Component Stability

- **Harris Criteria for Cemented Femoral Components**
  - **Definite:** radiographic evidence of migration
  - **Probable:** 100% radiolucent zone around cement mantle
  - **Possible:** 50-100% radiolucent zone around cement

- **Engh Criteria for Porous Femoral Components**
  - **Stable bony ingrowth**
    - Spot welds, no radiolucent lines around porous surface, calcar stress shielding
  - **Stable fibrous ingrowth**
    - Parallel sclerotic or RL lines around stem, no migration
  - **Unstable fibrous ingrowth**
    - Migration, progressive or divergent/non-parallel RLLs, pedestal formation
Radiographs of a 10.5 mm diameter fully porous-coated stem implanted into a 72-year-old woman with osteoarthritis. The immediate postoperative film (a) shows that the stem contacts the medial and lateral cortices with a press fit at the isthmus. Four years later (b) there is little change in the density and thickness of the bone around the implant except for the proximal medial aspect. The rounding of the edge of the medial femoral neck alone is classed as first degree stress shielding, but in this case, the additional loss of cortical density for about 2 cm distally resulted in classification as second degree stress shielding.

Figure 2 - Radiographs of a 30-year-old man at six months (a) and at two years (b), showing a 10.5 mm fully porous-coated stem which does not have a press fit at the isthmus. The two-year radiograph illustrates an apparent lateral shift in the position of the stem and the beginning of a radio-opaque line. At five years (c) a lateral radiograph shows complete encapsulation of the stem by a thin radio-opaque line. The stem is stable within the shell of new bone and this radiographic appearance has not changed. This appearance is typical of fibrous tissue fixation (see Fig. 10) as confirmed by histology in similar cases.

Figure 3 - Radiograph of a 55-year-old woman with rheumatoid arthritis two years after operation. A 10.5 mm fully coated stem has been used and there is a large mismatch between the size of the implant and the medullary canal. Divergent radio-opaque lines are visible laterally in the intertrochanteric region and medially near the stem tip (arrowheads). Periosteal hypertrophy is present near the stem tip indicating high load transfer and lack of uniform stress distribution more proximally. This was classified as an unstable stem.
Femoral Bone Loss

Gruen Zones

Classification helps to guide surgical decision making and implant choice
Femoral Bone Loss - AAOS Classification

- **Type I (segmental):** Loss of bone of the supporting shell of femur
- **Type II (cavitary):** Loss of endosteal bone with intact cortical shell
- **Type III (combined):** Combination of segmental bone loss and cavitary deficiency
- **Type IV (malalignment):** Loss of normal femoral geometry due to prior surgery, trauma, or disease
- **Type V (stenosis):** Obliteration of the canal due to trauma, fixation devices, or bony hypertrophy
- **Type VI (femoral discontinuity):** Loss of femoral integrity from fracture or nonunion
Femoral Bone Loss - Paprosky Classification

- Type I: Minimal metaphyseal bone loss
- Type II: Extensive metaphyseal bone loss with intact diaphysis
- Type IIIa: Extensive metadiaphyseal bone loss, minimum of 4 cm of intact cortical bone in the diaphysis
- Type IIIb: Extensive metadiaphyseal bone loss, less than 4 cm of intact cortical bone in the diaphysis
- Type IV: Extensive metadiaphyseal bone loss and a nonsupportive diaphysis
Femoral Bone Loss in Revision Total Hip Arthroplasty: Evaluation and Management

Abstract
Primary total hip arthroplasty (THA) is one of the most effective procedures for managing end-stage hip arthritis. The burden of revision THA procedures is expected to increase along with the rise in number of primary THAs. The major indications for revision THA include instability, aseptic loosening, infection, osteolysis, wear-related complications, periprosthetic fracture, component malposition, and catastrophic implant fracture. Each of these conditions may be associated with mild or advanced bone loss. Careful patient evaluation and bone loss classification guide preoperative planning and overall patient care. Historically, uncemented fixation has provided the best results, but cemented fixation is required in some cases.
<table>
<thead>
<tr>
<th>Type</th>
<th>Definition</th>
<th>Proximal Metaphysis</th>
<th>Diaphysis</th>
<th>Proximal Remodeling</th>
<th>Reconstruction Options</th>
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<tbody>
<tr>
<td>I</td>
<td>Minimal proximal metaphyseal bone loss</td>
<td>Intact</td>
<td>Intact</td>
<td>None</td>
<td>Uncemented fixation; proximal fitting (ie, S-ROM [DePuy]) or extensively porous-coated stem</td>
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<tr>
<td>II</td>
<td>Moderate to severe proximal metaphyseal bone loss</td>
<td>Absent</td>
<td>Intact</td>
<td>Slight</td>
<td>Extensively porous-coated stem</td>
</tr>
<tr>
<td>IIIA</td>
<td>Severe proximal metaphyseal bone loss with diaphysis intact for some distance</td>
<td>Absent</td>
<td>$\geq 4 \text{ cm}$ of isthmus</td>
<td>Significant</td>
<td>Extensively porous-coated stem if $&lt;19 \text{ mm}$ in diameter. If $\geq 19 \text{ mm}$ in diameter, then modular tapered stem</td>
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<td>IV</td>
<td>Complete loss of metaphyseal and diaphyseal bone</td>
<td>Absent</td>
<td>Absent</td>
<td>Slight</td>
<td>Allograft prosthetic composite, cemented stem, or impaction grafting plus cemented stem</td>
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Figure 1

A, Illustration of a Paprosky type I femoral defect. Preoperative (B) and postoperative (C) AP radiographs of a patient treated with an extensively porous-coated stem at the time of two-stage reimplantation to manage periprosthetic infection and Paprosky type I bone loss. (Panel A courtesy of DePuy, Warsaw, IN.)

Figure 2

A, Illustration of Paprosky type II femoral defect. Preoperative (B) and postoperative (C) AP radiographs of a patient treated with an extensively porous-coated femoral stem to manage a loose cemented stem and Paprosky type II bone loss. (Panel A courtesy of DePuy, Warsaw, IN.)
A, Illustration of a Paprosky type IIIA femoral defect. B, Preoperative AP radiograph of a Paprosky type IIIA defect with >4 cm of isthmus remaining for diaphyseal fixation. C and D, Postoperative AP radiographs of a patient treated with a size 20 modular tapered stem to manage an aseptically loose cemented femoral component. An extensively porous-coated stem was not chosen because of the large diameter needed for femoral reconstruction. (Panel A courtesy of DePuy, Warsaw, IN.)
**A**, Illustration of a Paprosky type IIIB femoral defect. **B**, Preoperative AP radiograph demonstrating a loose cemented femoral stem with Paprosky type IIIB bone loss. **C**, AP radiograph following implantation of a modular tapered stem with <4 cm of isthmus remaining for diaphyseal fixation. (Panel A courtesy of DePuy, Warsaw, IN.)
**A**, Illustration of a Paprosky type IV femoral defect. **B**, Preoperative AP radiograph demonstrating Paprosky type IV bone loss secondary to periprosthetic infection. **C** and **D**, Postoperative AP radiographs following reimplantation with an allograft-prosthesis construct to manage the bone loss. (Panel A courtesy of DePuy, Warsaw, IN.)
Acetabular Bone Loss

DeLee and Charnley Zones

Classification more of an academic exercise
Acetabular Bone Loss - AAOS Classification

- **Type I (segmental):** Loss of part of the acetabular rim or medial wall
- **Type II (cavitary):** Volumetric loss in the bony substance of the acetabular cavity
- **Type III (combined deficiency):** Combination of segmental bone loss and cavitary deficiency
- **Type IV (pelvic discontinuity):** Complete separation between the superior and inferior acetabulum
- **Type V Arthrodesis**
Acetabular Bone Loss – Paprosky Classification

- **Type I**: Minimal deformity, intact rim
- **Type IIA**: Superior bone lysis with intact superior rim
- **Type IIB**: Absent superior rim, superolateral migration
- **Type IIC**: Localized destruction of medial wall
- **Type IIIA**: Bone loss from 10am-2pm around rim, superolateral cup migration
- **Type IIIB**: Bone loss from 9am-5pm around rim, superomedial cup migration
Acetabular Bone Loss – Saleh and Gross Classification

- **I**: Conventional components or retention with bone grafting
- **II**: Large cup (high hip center) usually with bone graft
- **III**: Same as II but may require column graft and/or augment also
- **IV**: Structural grafting or metal augments
- **V**: Same as IV but requires more metallic fixation

<table>
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<th>Table III: Saleh classification of acetabular bone loss</th>
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<tr>
<td>Type</td>
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<td>-------</td>
</tr>
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<td>Type V</td>
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Acetabular Bone Loss – Maloney

- Different than all other systems
- Based on radiographically stable cup

*For Type-I cups, six criteria must be met to perform a liner exchange: (1) the cup must not be malpositioned, (2) the locking mechanism for the modular acetabular component must be intact, (3) the metal shell must not be damaged secondary to head penetration, (4) the polyethylene liner replacement must be of adequate thickness, (5) the implant should be one with an acceptable track record, and (6) the implant should be a modular implant.† Type-II cups do not meet at least one of the Type-I criteria, but the cup is radiographically stable.
Laboratory Evaluation
Laboratory Studies

- **ESR, CRP, and IL-6**
  - Current guidelines don’t give an actual value. Persistently high or not trending down is suspicious.
  - Generally, <30mm/hr, <10mg/L, and <10pg/mL, respectively, are considered normal if over 6 weeks from surgery.
  - Sooner than 6 weeks, ESR not helpful. CRP <100mg/L is considered normal.

- **CBC**
  - Not sensitive or specific for infection.
  - Important for hemoglobin and platelet count though. Also important in the presence of a “bloody tap.”

- **Metal Ions → Cobalt and Chromium**
  - Generally over 5 and 17 µg/L, respectively, are the upper limits of normal in serum.

- **Metal allergy testing?**
Laboratory Studies

- Joint aspiration warranted if labs equivocal but infection is suspected
  - Synovial WBC <3,000 cells/µL and PMN <80% considered aseptic if over 6 weeks from surgery
    - Sooner than 6 weeks, <10,000 cells/µL and <90% considered aseptic
  - In the presence of a bloody aspiration, it is recommended to “correct” the WBC count based on serum RBC and WBC values
    - $WBC_{Adjusted} = WBC_{Fluid} - \left(\frac{WBC_{Blood} \times RBC_{Fluid}}{RBC_{Blood}}\right)$
  - In the presence of metal-on-metal bearings, a manual cell count is recommended

- Synovial fluid cultures
  - Hold for at least 5 days and up to 14+ days if a low virulence organism is suspected

- Alpha-defensin immunoassay?
Other Considerations

- Lumbar Spine evaluation
- EMG/NCS if concerned about nerve injury
- Diagnostic/Therapeutic Psoas tendon/bursa injection
Thank you!

Questions?

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