Periprosthetic Fractures Around THA – When/How to fix, When to Revise
Boot Camp 2013
Phoenix, AZ

**Burden of illness**
- Increasing prevalence
- Growing population with arthroplasties
- Increasing survival of patients
- More active life-style following arthroplasties
- Increased risk following revision surgery
- Incidence
  - Between 0.1-18% (JAAOS 2009)
  - 3rd most common reason for THA reoperation 9.5%
  - 5th most common reason for revision 5%
  - Fracture risk after Primary THA 0.4%-1.1%
  - Fracture risk after Revision THA 2.1%-4%
- High mortality rate (post THA) at 1 yr:
  - 11% vs hip fracture (16%) vs primary arthroplasty (2.9%)
- High Complication rate: Bhattacharyya et al, JBJS, 2007
  - High complication rate (up to 48%) and re-operation rate (up to 52% in Vancouver C fractures)
- Risk Factors: Zurmond et al, Injury, 2010
  - Osteoporosis
  - Increased age, BMI
  - Surgical technique
  - Revision procedures
  - High energy trauma in young patients
- Other factors:
  - Osteolysis/Aseptic Loosening
  - Multiple Revisions
  - Index diagnosis of hip Fracture at arthroplasty
  - Implant and Surgeon specific issues

**Important Considerations**
- Location of fracture
- Intra-op vs post-op?
- Primary vs Revision
- Well fixed vs loose implant
- Pre-injury status of implant
- Rule out infection
- Assessment of bone stock

Prevention:
- Avoid intraoperative cracks, defects or windows
- Bypass stress risers
- Avoid cement extravasation
- Cerclage nondisplaced fractures
- Cerclage before reaming or impacting in high risk situations
- Bone graft defects
- Postoperative Surveillance: osteolysis, change in pain or function
- Better outcomes when revise for loosening than fracture

Preop Evaluation:
- Patient
  - Co-morbidities
  - Consultation (anaesthesia, medicine)
  - Need for peri-operative monitoring
- Quality radiographs
  - Status of implant
  - What implant? Get records.
  - Location of fracture
  - May need CT scan to evaluate
    - Fracture - extent
    - Bone quality/ integrity of femur
    - Status of implant

Goals and Principles of treatment:
- Accurate diagnosis
• Optimize long term function of patient and implant
• Obtain fracture union
• Maintain or obtain stability of implant components
• Ensure adequate pre-op planning
• Minimize soft tissue trauma
• Ensure satisfactory fracture reduction
• Ensure stability of implants intra-op and have revision components available if necessary
• Have plates with locked and non locked options available
• Have cables available as necessary
• Manage bone stock deficiency with allograft
• Implants should be long enough to bypass fracture by at least two cortical diameters
• Avoid stress risers

Questions to address
• Stem in varus?
• Stem loose or fixed?
• No stem revision vs revision
• Single lateral plate vs 90/90 fixation
• Plate fixation: screws vs cables
• Plates alone vs plates + allograft struts
• What is ideal plate fixation construct?
• Does type of plate matter?

Classification
• Intraoperative:
  o Vancouver Classification Fracture
  o Location
    ▪ A Metaphysis
    ▪ B Diaphysis
    ▪ C Distal
  o Each subdivided in
    ▪ 1 Perforation
    ▪ 2 Nondisplaced Crack
    ▪ 3 Displaced Fracture
• Postoperative
  o Vancouver Classification:
    ▪ A. Peri trochanteric
      • AL: Fractures at lesser trochanter
      • AG: Fractures at Greater Trochanter
    ▪ B. Periprosthetic tip of the stem
      • B1: Well fixed stem
      • B2: Loose stem, adequate bone stock
      • B3: Loose stem, inadequate bone stock
    ▪ C. Distal to the stem

Treatment Algorithms
Intraoperative Fractures
• Calcar
  o A1  Bypass, bone grafting
  o A2  Removal Stem, Cerclage reinsertion same stem
  o A3  Implant Stability Affected, Bypass with Diaphyseal Fitting Stem Cerclage
• Trochanteric
  o A1  BoneGraft
  o A2  Protected Weightbearing, Brace (Have low Threshold for fixing)
  o A3  ORIF Trochanteric Claw
• Diaphyseal
  o B1  Bypass, onlay cortical graft
  o B2  Distal Split –
    ▪ cerclage if seen intraop,
    ▪ if seen postop, TDWB 6 weeks
  o B3  - Displaced Diahyseal Fracture
    ▪ If unstable, bypass with longer stem into stable isthmus
    ▪ If implant stable then cerclage, consider onlay graft to bypass.
• Distal
  o C1  Bypass, onlay cortical graft
  o C2  Cerclage, onlay cortical graft
  o C3  Cerclage, ORIF, proximal femoral replacement if proximal femur also
        deficient, imperative to obtain implant stability

Postoperative Fractures
• Things to remember:
  o Fracture location
  o Stability of the implant and fracture
  o Quality of the host bone stock
  o Patient physiology and age
  o Surgeon Experience
  o Alignment matters: Tadross et al, J Arthroplasty, 2000 - 9 periprosthetic fractures
    ▪ 3 successes: no varus
    ▪ 6 failures: all in varus
    ▪ Must have implant well aligned and not in varus

• Vancouver A
  o If minimal displacement and stable implant - treat nonop
  o If displacement is unacceptable and/or osteolysis is present consider surgery
  o AL: Rare, avulsions from osteopenia and lysis
    ▪ If large, displaced and include large portion of calcar, these can destabilize stem and necessitate femoral revision
    ▪ If involves calcar, be concerned for loose stem, especially in early postop period
      • May be indicator of missed intraop fracture
    ▪ May have stable distal fixation – treat nonop
  o AG: More common, often due to trauma (direct blow) or osteolysis.
    ▪ Does not usually affect implant stability
    ▪ Morbidity related to displacement and abductor deficiency
    ▪ Minimal displacement
      • Treat closed x 3 months
      • Revise later if needed to remove the particle generator, debride defects and bone graft
    ▪ Displaced with good host bone stock
      • Consider early ORIF and bone grafting

• Vancouver B is the Problem
• B1 solid stem; good bone
  o Rarely non-op
  o Need to carefully identify stem fixation
• Lindhall, JBJS, 2006 – 1049 fractures / 245 re-operations
  • B2’s (loose stem) classified as B1’s are doomed to fail
    o Intraoperative test may be needed
    o Exploit the fracture and try to move the stem.
    o If it moves, revise the stem
  • B1’s correctly identified treated with plate, allograft struts or both
  • Treatment with single plate a risk factor for failure.
    o 90/90 with plate/strut better.
  o ORIF with femoral component retention
    ▪ High union rates with component retention
  o Fixation – struts / plates
• **B2** loose stem; good bone
  o Fixation alone will not work
  o Revise the femoral component ,+/- strut allograft, +/− plates
  o Best results seen with patients revised with uncemented, extensively porous coated femoral stems (proximal shielding long term?)
  o May also consider use modular, fluted taper stems
    ▪ Need good quality intact diaphyseal bone to engage the taper.
    ▪ The more proximal the intact diaphysis the better
    ▪ Consider placing a cerclage around intact bone to prevent propagation
• **B3** loose stem; poor bone – Revision + Allograft, plate
  o Uncemented Femoral Stem – bypass poor bone and get distal fixation.
    ▪ Extensively porous coated,
    ▪ Fluted, tapered stem
    ▪ Allograft strut
    ▪ Bone Graft
  o Bone stock is by definition inadequate here.
    ▪ Proximal femoral replacement/Tumor prosthesis
    ▪ Allograft Prosthetic Composite (APC)
• **Vancouver C** - fracture distal to the tip of the stem
  o Treat with standard fracture techniques, but consider overlap vs. stress riser
  o Rarely nonoperative
  o Fixation options
- Cerclage
- Strut Allograft
- Plate fixation – screws/cables, locked/nonlocked
- Retrograde IM nail (rare)
- Combination of above
  - Avoid stress risers between implants
    - Bypass (overlap) fixation
    - Or consider allowing 2.5 cortical diameters between devices
    - Newer periprosthetic plate designs are long (entire length of femur) for this reason.

**Technique**
- Surgical strategy
  - Implant selection
    - greater trochanter – few long term studies, but overall poor success rates, regardless of design
      - claw system to capture greater trochanter
      - may need extended claw plate
        - longer cable ready plate if fracture extends to metaphysis
    - diaphyseal fracture
      - plate system
        - usually locked plate, though studies to support nonlocked
        - options for conventional and locked fixation
        - options for cable attachment to plate
        - newer designs allow for placement of balanced fixation with polyaxial locked or nonlocked screws and are cable ready.
        - biomechanical and clinical studies support combination of cables and screws superior to screws alone (conventional or locked unicortical)
        - "eyelets" that attach cable to plate superior
        - 90/90 fixation superior in most studies with conventional plating using strut graft as well.
Biomechanical studies support dual allograft struts as viable option. Peters et al., Orthopedics, 2003

Newer plate designs allow for placement of balanced fixation with polyaxial locked or nonlocked screws and are cable ready.

- **Implant for revision**
  - Revision stem must extend 4 – 6 cms past the fracture (2 cortical diameters)
  - 4cm of scratch fit for distal fixation
  - Stems >190 mm must be curved
  - Cementless stem preferred because of problems with fracture healing with cement

- **position of patient: lateral**
  - allows for revision if implant unstable

- **Flat radiolucent table**
- **Fluorointensifier**
- **Femoral distractor in delayed cases or fracture shortening**
- **articulated tensioning device (“A TD”) if compression required (transverse fracture)**

- **Fixation strategy**
  - Routine fracture fixation techniques.
    - Respect the biology
      - Expose whole length of involved femur but minimize soft tissue stripping
      - If cerclage - use wire passer
  - Use fracture to access canal + prosthesis
  - Remove all granulation tissue, membrane or cement
  - Reduce fracture & get provisional fixation (cerlcage, plate + clamps)
  - With fracture reduced, prepare femur
  - Long plates with “balanced fixation”
  - Conventional screws distal to implant (diaphysis)
    - Can augment with locked screws
    - Bicortical or unicortical locked screws in area of implant / greater trochanter
  - Prosthesis alone does not control rotation / shortening
o Locking plate not superior to regular plate
o Screws in proximal & distal fragments improve rotational stability
o Cables only if added stability required
  • use system “eyelets” that allows direct attachment to plate
o Allograft will incorporate and will add bone stock
  • Allograft struts in cases of bone loss/ comminution or consider in revision cases
    • respect biology
    • avoid violating medial soft tissues

Biomechanical Evidence
• A combination of a non locked plate with an allograft strut remains an optimal configuration in the treatment of periprosthetic fractures around THA’s (Use 90/90 configuration)
• Locked plates should be used with caution as a stand alone treatment of periprosthetic fractures around THA’s
• Screw-plates provide either greater or equal stiffness compared to cable- plates in almost all cases.
• Spaced fixation of screws and cables NB
• Plate type plays a small role ie no difference between onlay cables, inlay cables and wire mounts.
• Newer periprosthetic plate designs – balance proximal to distal and within rows of available holes (in one row of holes, place one anterior then one posterior, don’t leave unbalanced).

Clinical evidence
• Haddad et al, JBJS, 2002.
  o Periprosthetic fractures around well-fixed implants: use of cortical onlay allografts with or without a plate
  o 21 plates with struts and 19 struts only
  o 98% union
  o 1 infection
  o Routine use of struts is suggested
• Buttaro et al, JBJS 2007.
- 14 Locking plates at 20 mo. f/u
- 6/14 failures: 3 plate fractures / 3 plate pulloff’s
- No advantages to locking plate
- Should use allograft struts
  - Single lateral plate should be avoided
  - 4/16 complications
  - 45 B1 fractures
  - Joint dislocated and stability of femoral component evaluated
  - Identified B2 in 9 (20%) hips (unstable implant when thought stable)
  - Single plate and cable fixation by direct reduction if integrity of the medial cortex could be restored.
  - Union in 29/30 (97%) at avg 6.4 mos
- Ricci et al, JBJS, 2006. in 50 pts (41 w/ f/u)Vancouver B1 fractures
  - Plating of periprosthetic femur fractures with indirect reduction
  - No allograft
  - No bone grafts
  - Average time to union = 3 months (range 7-23 weeks)
  - One deep infection
  - 30/41 returned to baseline ambulatory status
  - ORIF around well fixed hip/knee implants
  - 14/16 union by 6 months
  - 13/16 ambulatory at 6 months
  - Recommendations:
    - Minimum number of cortices 10 above and 10 below fracture
    - Cortical struts when failed hardware or revision fixation cases
  - Cable plates / struts vs LP’s
    - Union: 97 vs 86%, p<0.07
    - Hardware failure: 2%vs 14%, p<0.07
    - Complications: 28% vs 45%, p<0.09
Conclusions

- Periprosthetic fractures after THA are increasing and present technical challenges
- Must confirm prosthesis stability
- Revision if loose or varus stem
- Plate fixation + allograft struts best with standard plates
- Variable results seen with locked plates
  - May be technique dependent
  - Newer designs may offer more fixation options
    - ? clinical outcomes
- Screw fixation better than cables alone
References

• Duncan CP, Masri BA. Fractures of the femur after total hip replacement. Inst Course Lect. 1995;45:293.