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:
  - Vancouver Classification Fracture
  - Location
    - A Metaphysis
    - B Diaphysis
    - C Distal
  - Each subdivided in
    - 1 Perforation
    - 2 Nondisplaced Crack
    - 3 Displaced Fracture

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

Postoperative Fractures

- Things to remember:
    - Fracture location
    - Stability of the implant and fracture
    - Quality of the host bone stock
    - Patient physiology and age
    - Surgeon Experience
    - Alignment matters: Tadross et al, J Arthroplasty, 2000 - 9 periprosthtic fractures
        - 3 successes: no varus
        - 6 failures: all in varus
        - Must have **implant well aligned** and **not in varus**
- **Vancouver A**
    - If minimal displacement and stable implant - treat nonop
    - If displacement is unacceptable and/or osteolysis is present consider surgery
    - **AL**: Rare, avulsions from osteopenia and lysis
        - If large, displaced and include large portion of calcar, these can destabilize stem and neccessitate femoral revision
        - If involves calcar, be concerned for loose stem, especially in early post op period
            - May be indicator of missed intraop fracture
        - May have stable distal fixation – treat nonop
    - **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
    - Rarely non-op
    - 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
                - Intraoperative test may be needed
                - Exploit the fracture and try to move the stem.
                - 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.
                - 90/90 with plate/strut better.
    - ORIF with femoral component retention
        - High union rates with component retention
    - Fixation – struts / plates
- **B2** loose stem; good bone
    - Fixation alone will not work
    - Revise the femoral component ,+/- strut allograft, +/- plates
    - Best results seen with patients revised with uncemented, extensively porous coated femoral stems (proximal shieling long term?)
    - 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 propogation
- **B3** loose stem; poor bone – Revision +Allograft, plate
    - Uncemented Femoral Stem – bypass poor bone and get distal fixation.
        - Extensively porous coated,
        - Fluted, tapered stem
        - Allograft strut
        - Bone Graft
    - 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
    - Treat with standard fracture techniques, but consider overlap vs. stress riser
    - Rarely nonoperative
    - 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

- Locking plate not superior to regular plate
- Screws in proximal & distal fragments improve rotational stability
- Cables only if added stability required
    - use system "eyelets" that allows direct attachment to plate
- 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.
    - Periprosthetic fractures around well-fixed implants: use of cortical onlay allografts with or without a plate
    - 21 plates with struts and 19 struts only
    - 98% union
    - 1 infection
    - 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
- Agarwal et al, J Arthroplasty 2005.
  - Single lateral plate should be avoided
  - 4/16 complications
- Corten et al, JBJS, 2009.
  - 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
- Wood et al, J Arthroplasty, 2011. Locked plates in 16 pts.
  - 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
- Deghan, Schemitsch et al, 2011. Systematic review 285 B1 fractures
  - 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

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