

Periprosthetic Knee Fractures

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Objectives

- **Epidemiology**
- **Preoperative Planning**
- **Fixation strategies**
- **Cases**
- **Postoperative Management**
- **Summary**

Epidemiology

- **0.3% to 2.5% of all TKA**
 - **Increasing number of TKA (>700,000 in US)**
 - **Increasing survivorship of implants**
 - **Increasing aging population**



Factors that increase Prosthetic Fractures

- Mismatch between bone density and implant
- Aging and Osteoporosis
- Fragility fractures



Bone Stock after TKA

- **TKA leads to decrease in periprosthetic bone mineral density (BMD) for up to 7 years postoperatively, with the greatest decline 3 months after surgery due to following factors:**
 - **Stress shielding**
 - **Osteolysis as result abrasion with periprosthetic bone**
 - **Loosening of the implant**
 - **Osteonecrosis**

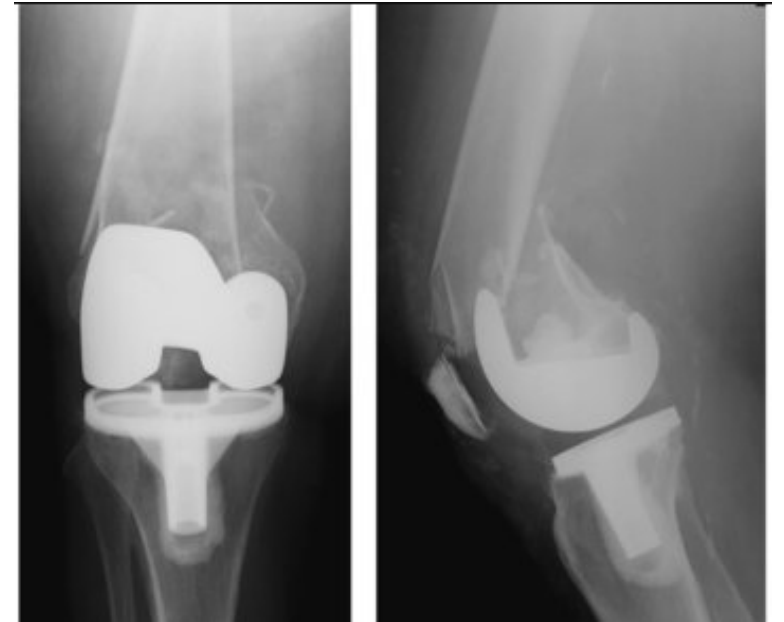
Preoperative Planning

- **History and Physical Exam**
 - Exclude other injuries
 - Preinjury pain
 - Complete neurovascular exam

- **Preoperative assessment**
 - Index procedure
 - Type of implant
 - Comorbidities
 - Pre-operative ambulatory status

Radiographic Work Up

- Radiographs
 - Proper AP and Lateral of Knee
 - Full length femur and tibia films
 - Previous x-rays if possible
- CT Scan
 - Fracture and component stability
 - Implant dimensions (eg size of implant)
 - Open box: opening in femoral component of TKA that allows for possible passage of femoral nail
 - Artifact sparing cuts



Is the implant loose?

- Pain
- Radiographic changes from index procedure
- Lab values (ESR, CRP, CBC for WBC, ect)
- Pre-injury mobility
- Instability
- Fracture

Classification Systems

Location of fracture

- Femur, Tibia, Patella

- Neer Classification

- Rorabeck Classification

- Su Classification

- Unified Classification System for periprosthetic fractures

Figure 1
Rorabeck

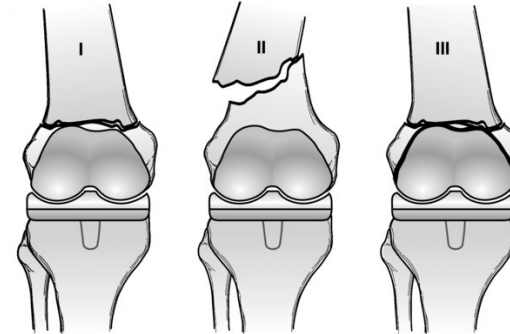


Figure 2
Su

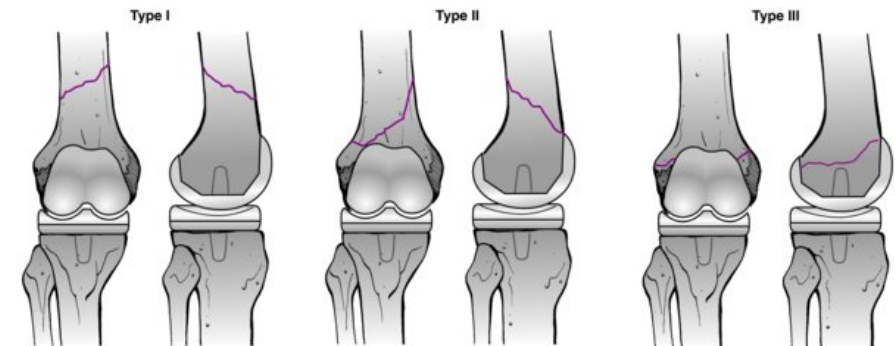


Figure 1 and Figure 2 from: Ricci WM. Lower Extremity Periprosthetic Fractures. In: Tornetta P, Ricci WM, eds. Rockwood and Green's Fractures in Adults, 9e. Philadelphia, PA. Wolters Kluwer Health, Inc; 2019

Unified Classification System

- **The Unified Classification System allows for simplified classification and treatment algorithm for any bone and joint that is involved. The core principles include:**
 - **The location of the fracture**
 - **The fixation of the component**
 - **The adequacy of bone stock around the implant**

Unified Classification System

UCS is based on Location and Type

Location

- I: Shoulder
- II: Elbow
- III: Wrist
- IV: Hip
- V: Knee
- VI: Ankle

Types

- A: Apophyseal
- B: Bed of Implant
- C: Clear of implant
- D: Dividing the bone between two implant
- E: Each of two bone supporting one arthroplasty
- F: Facing and articulating with hemiarthroplasty

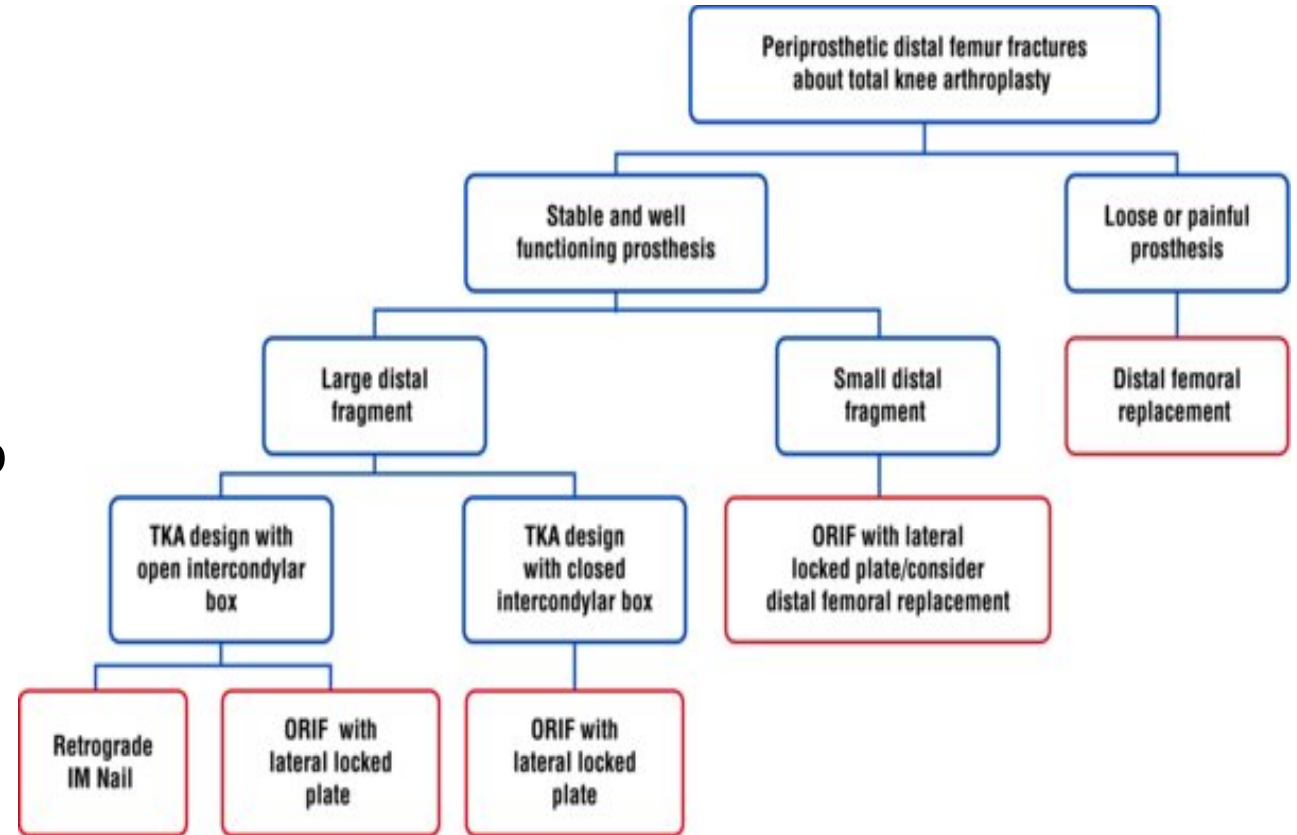
Unified Classification System

Field testing the Unified Classification System for periprosthetic fractures of the femur, tibia and patella in association with knee replacement: an international collaboration. Van der Merwe JM, Haddad FS, Duncan CP.

- 10 fellowship trained orthopedic surgeons (experts) and 10 residents of orthopedic surgery in last two years of training (pre-experts)
- 15 radiographs for evaluation to measure inter and intra-observer reliability
- Kappa value for inter-observer reliability for experts and pre-experts is 0.741 and 0.765 and intra-observer for experts and pre-experts is 0.898 and 0.878.

Fixations Strategies: Revision or ORIF

- Factors for Revision: implant instability, insufficient bone stock, location of fracture
- Indications for ORIF: well fixed implant, minimal bone loss, able to handle multiple operations
- Indications for DFA: loose implant, significant bone loss, unable to handle multiple operations



Fixations Strategies: Revision or ORIF

Primary Versus Secondary Distal Femoral Arthroplasty for Treatment of Total Knee Arthroplasty Periprosthetic Femur Fractures. Antonia F. Chen et al.

- Retrospective Study, 48 patients, 35 with primary DFA, 13 with secondary DFA
- Increased postoperative complications (infections, dislocation, and effusions) for secondary DFA patients
- Increased number of surgeries for secondary DFA patients

ORIF Principles

- Fracture location helps determine LP vs IMN (or Nail Plate Combination)
- TKA implant must be stable
- Restore mechanical and joint line axis
- Achieve stable fixation to allow immediate weight bearing if able
- Span the femur, plating or nailing



Locked Plating vs IMN

- **Equivalent union rates between intramedullary nail and locked plate fixation for distal femur periprosthetic fractures - a systematic review.** Jay K Shah, Patrick Szukics, Arianna L Gianakos, Frank A Liporace, Richard S Yoon
 - Meta analysis: 38 studies with 1,188 patients
 - No difference in IMN, and LCP when analysis union rate or time to union
 - LP significant lower complication and reoperation rate
 - IMN with higher percentage and quicker time to full weightbearing (100% and 7.6 weeks) when compared to plating (94% and 15.8 weeks)
 - IMN with higher percentage to preinjury activity when compared to those treated with plating (70.8% vs. 61.6%)

Locked and Hybrid-locked Plating

- Indications: Stable implant, closed box TKA, low, distal fracture
- Approach: Midline or lateral parapatellar
 - Midline allows TKA assessment, easy to transition to DFR if needed
- Important Techniques:
 - Span the femur
 - Utilize hybrid fixation (locking and non locking screws)
 - Ensure proper length, alignment, and rotation before leaving OR



Lateral Approach for Plating Periprosthetic Fracture

- <https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/16731389/lateral-distal-femur-plate-for-periprosthetic>
- *Note locking and nonlocking hybrid fixation for lateral plate

Intramedullary Nail

- Indications: Stable implant, proximal enough for distally locked screw
 - Confirm open box implant and size; important to have the operative report, implant and nail mismatch possible
 - Periprosthetic Supracondylar Femoral Fractures Above A Total Knee Replacement: Compatibility Guide for Fixation With Retrograde Intramedullary Nail. Thompson et al. *Arthroplasty* 2014.
- Antegrade vs Retrograde: Depends on proximal or distal fracture
- Important Techniques:
 - Utilize plate for hybrid fixation if needed
 - Remove/replace polyethylene
 - Ensure proper length, alignment, and rotation before leaving OR



Technique Pearls for Nail placement with TKA

- Know preexisting implants (secure previous operative reports if possible)
- Implant measurement specifics from TKA and IMN can be obtained
- Starting point is key to prevent valgus and recurvatum deformities
- Service et al, JOT 2015: Much higher change of having a starting point posterior to Blumensaat's line on TKA implants (when compared to native knees) and CR implants (when compared to PS implants)
- Start point too posterior may cause extension deformity and injury to PCL

Retrograde Intramedullary Nail through a Total Knee Arthroplasty

- OTA Technique Video for Retrograde IMN for Distal Femur Fracture through a Total Knee Arthroplasty
- <https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/18826480/retrograde-intramedullary-nail-for-distal-femur>

Box and Implant sizes

- Box implants, sizes and compatibility with supracondylar nails
- Currall et al; *Retrograde nailing for supracondylar fracture around total knee replacement: A compatibility study using the Trigen supracondylar nail, 2007*
- Thompson et al.; *Periprosthetic Supracondylar Femoral Fractures Above a Total Knee Replacement: Compatibility Guide for Fixation With a Retrograde Intramedullary Nail, 2014*
- Jones et al; *Retrograde femoral nailing of periprosthetic fractures around total knee replacements, 2016*

Revision or Distal Femoral Replacement

Revision TKA: Ensure proper bone stock and implants for TKA

DFA

Indications: loose implant, significant bone loss, unable to perform partial weight bearing, unable to handle multiple operations

- Techniques:
 - May require tibial reconstruction
 - Mark rotation before removal of distal femur
 - Joint line restoration with patella
 - Trialing to evaluation soft tissue tension, patellar tracking and stability of flexion gap



DFR Outcomes

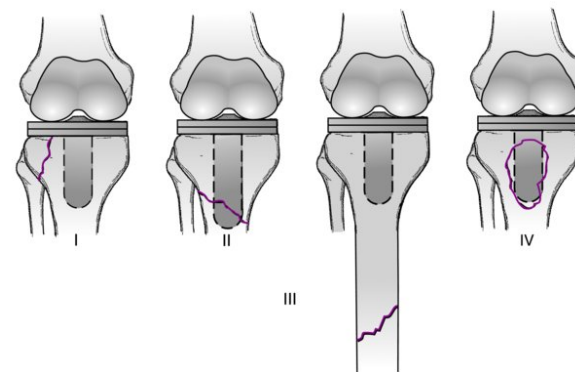
- **“Distal Femoral Replacements for Acute Comminuted Periprosthetic Knee Fractures: Satisfactory Clinical Outcomes at Medium-Term Follow-Up.”** Matar, Hosam E, et al. *Arthroplasty Today*, vol. 7. February 2021.
 - Retrospective study of 31 patients measuring clinical outcomes of DFRs from 2010 – 2018
 - 81 average age of patients, all Rorabeck type II/III fractures, 7.4% complication rate with 1 reoperation (polyethylene insert), avg length of hospital stay 17.8 days, 3 passed away due to multiple commodities. No cases of infection
 - DFRs allow for early mobilization and rehabilitation to restore function in a challenging group of patients

DFR Outcomes

- **Long-Term Results of Total Knee Arthroplasty with Contemporary Distal Femoral Replacement.** Wyles et al. *The Journal of Bone and Joint Surgery*: January 2, 2020.
 - Retrospective study of 144 patients who underwent TKA with DFR from 2000 to 2015 with greater than 2 years of follow up
 - 10 year cumulative complication rates: aseptic loosening (17%), all-cause revision (27.5%), and any reoperation (46.3%), increased risk of re-operation for patients who underwent index DFR for aseptic loosening compared to periprosthetic or native femoral fractures. KSS (Knee society score) increased from 45 pre-op to 75 post op; 7 AKA at time of final followup
 - Great clinical improvement indicated by KSS, but high changes of revision and reoperation for end stage revision procedure

Revision/ORIF with Proximal Tibia Fractures

- Incidence: 0.4% -0.9%, uncommon
- Classically described by Felix Classification
- Indications:
 - ORIF: Displaced fractures with stable implants and adequate bone stock
 - Revision: long stem revision for loose implants



Revision/ORIF with Proximal Tibia Fractures

- Techniques:
 - Utilize medial and lateral locked plates if unable to place more proximal screws
 - Use of multiple incisions
 - Maintain adequate skin bridges

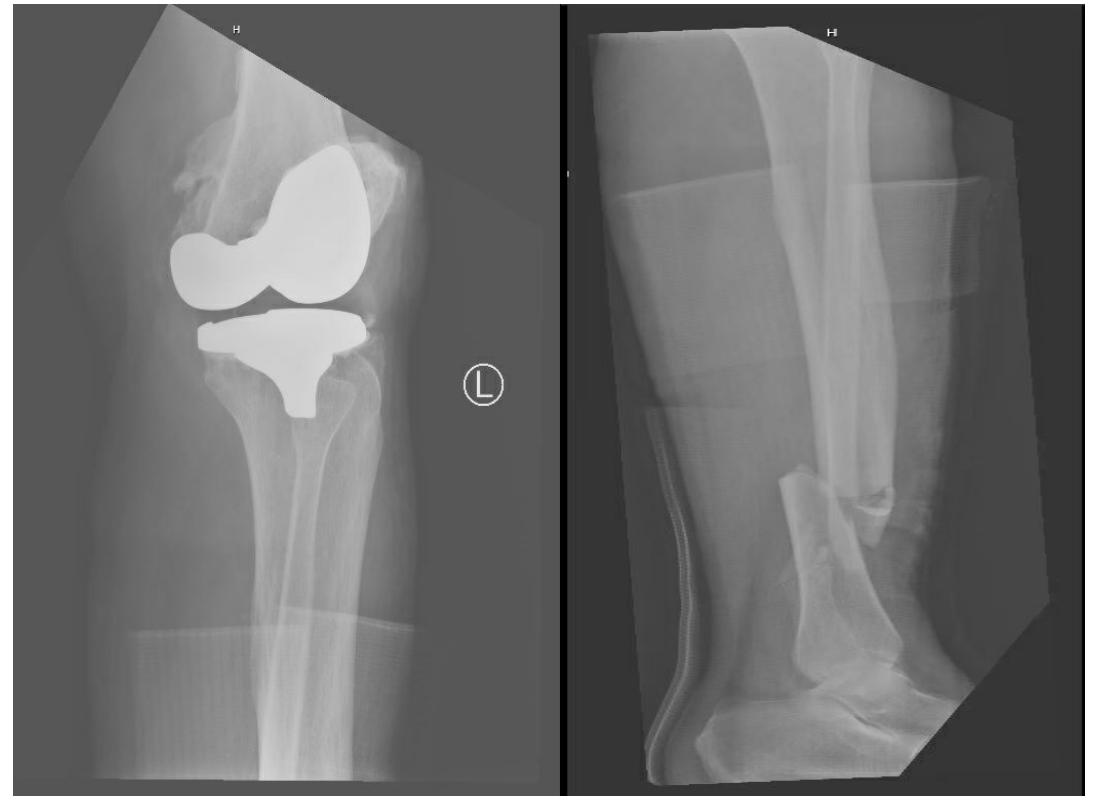


Case Comparison

Case 1, 68 yo M MCC; Open fx



Case 2, 79 yo M MVC; Poly trauma, Open fx



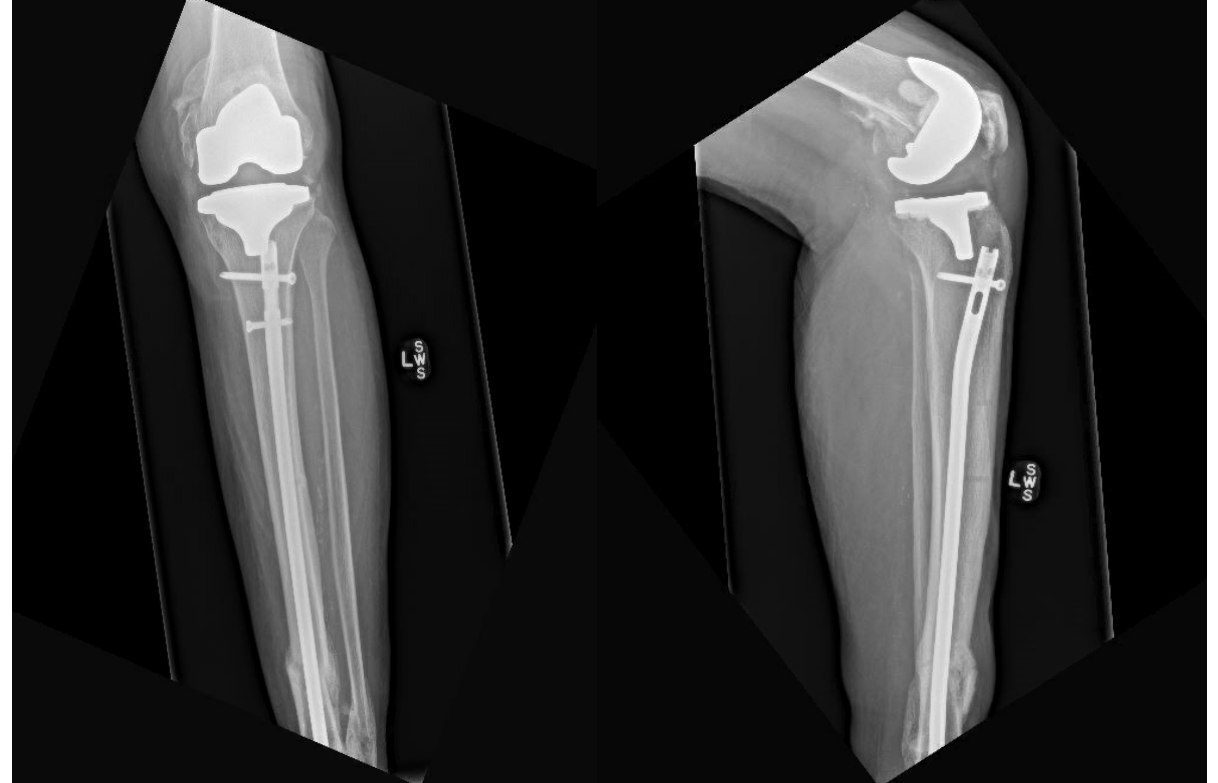
Case Comparison

Case 1 con't



RIA due to nonunion 5 months post op
9 months post op

Case 2 con't



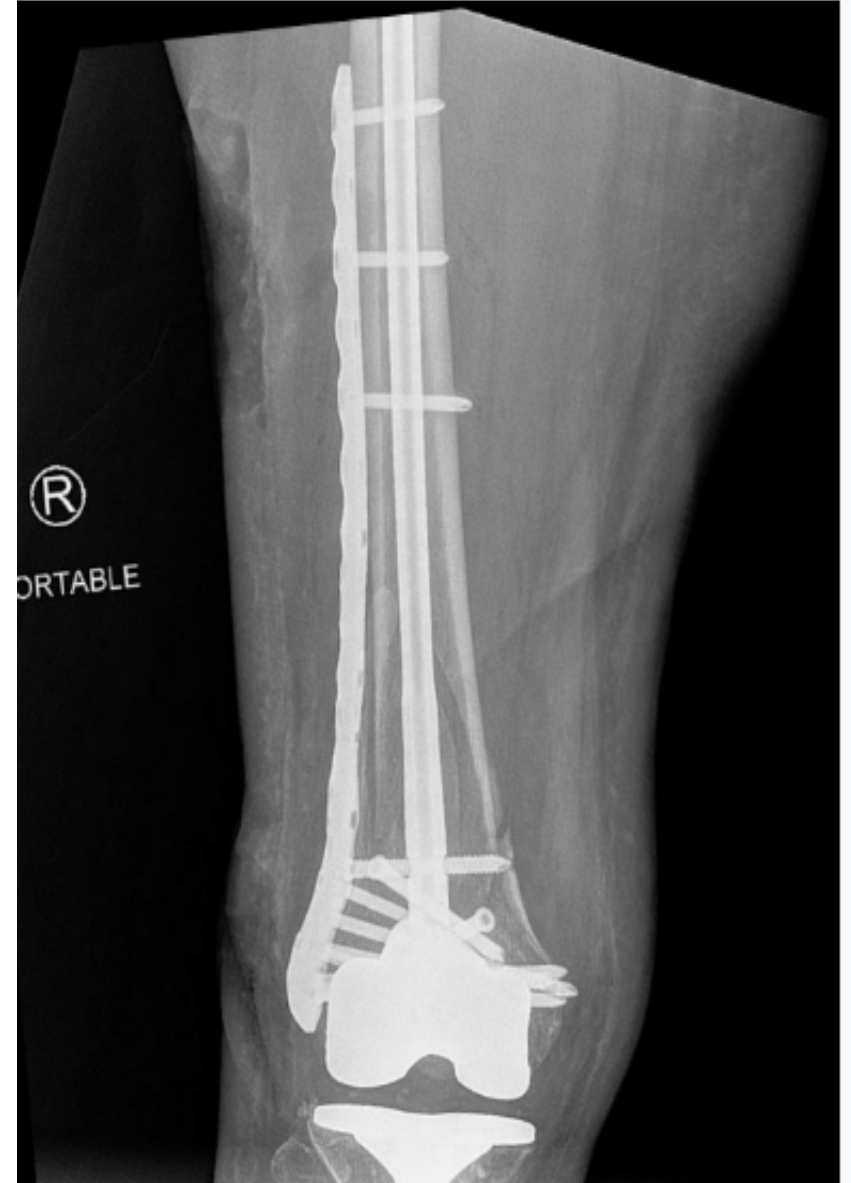
8 months post op

Case 3 (courtesy of Samir Mehta MD, University of Pennsylvania)

**77 yo F
Community
ambulator,
Parkinson's**



Case 3



Nail-Plate combination for added strength and immediate weight-bearing

Nail-Plate Combination Outcomes

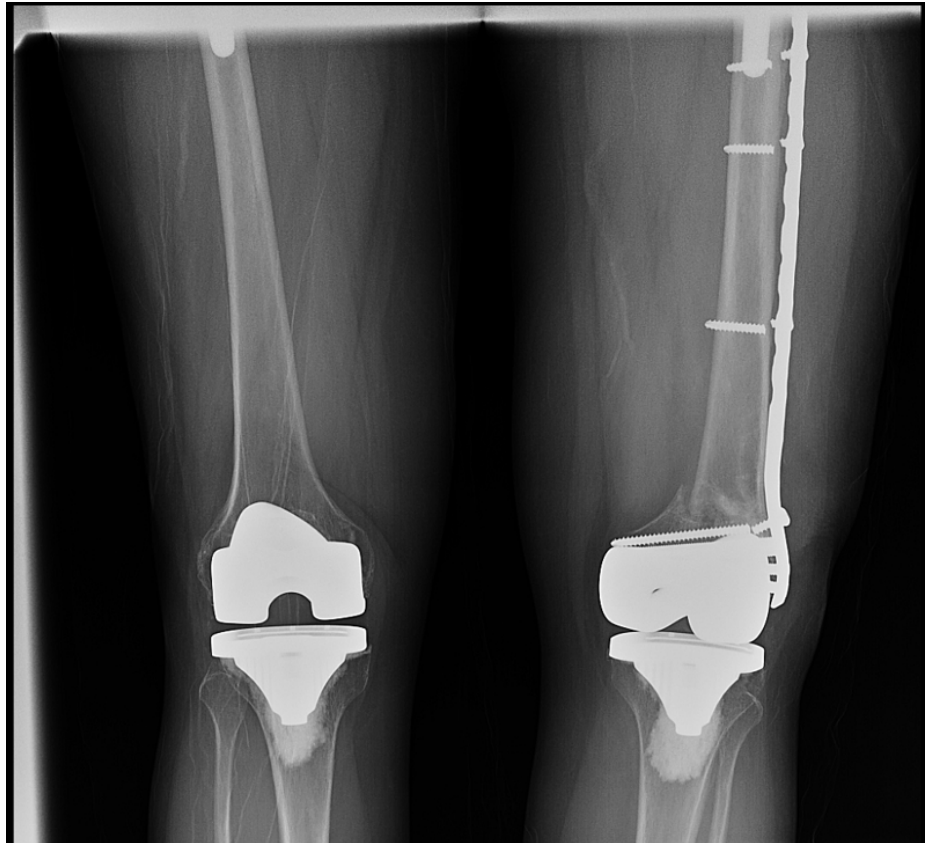
- **Nail Plate Combination Technique for Native and Periprosthetic Distal Femur Fractures.** Liporace FA, Yoon RS. *J Orthop Trauma*. 2019
 - Review of 15 patients (9 periprosthetic and 6 native), mean age 74.8
 - All patients made WBAT immediately after surgery
 - Mean follow up time 19.2 weeks, 1 deceased patient due to unrelated comorbidity
 - No reports of nonunion, hardware failure, deep infections, or subsequent OR returns; 1 superficial SSI
 - 14 patients remain ambulatory with assistive device
 - Limited study for periprosthetic fractures, but NPC allows for reproducible technique with immediate weight-bearing opportunities in the elderly patient population

Case 4 (courtesy of Derek Donegan MD MBA, University of Pennsylvania)

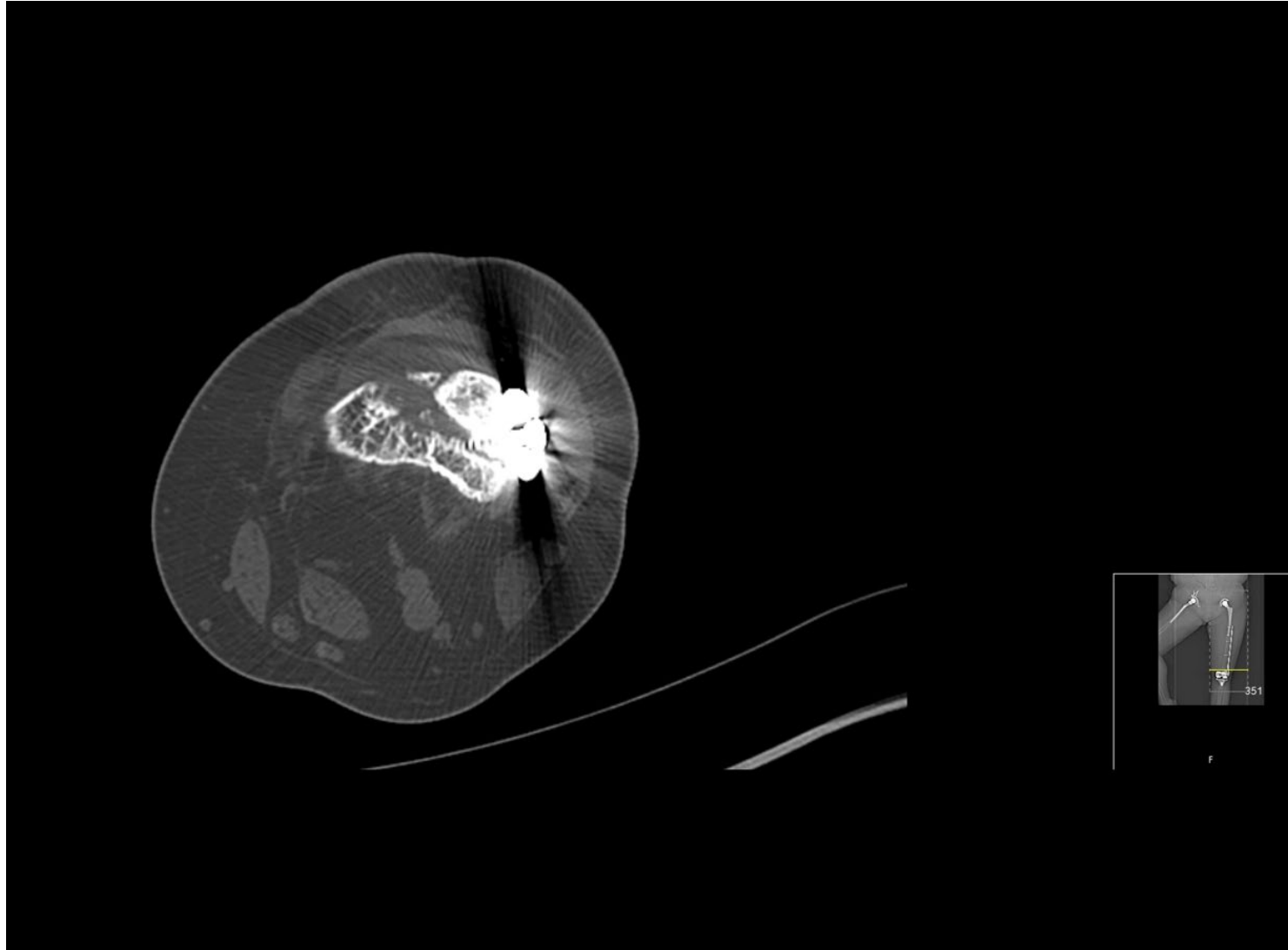
68 yo female with left leg injury



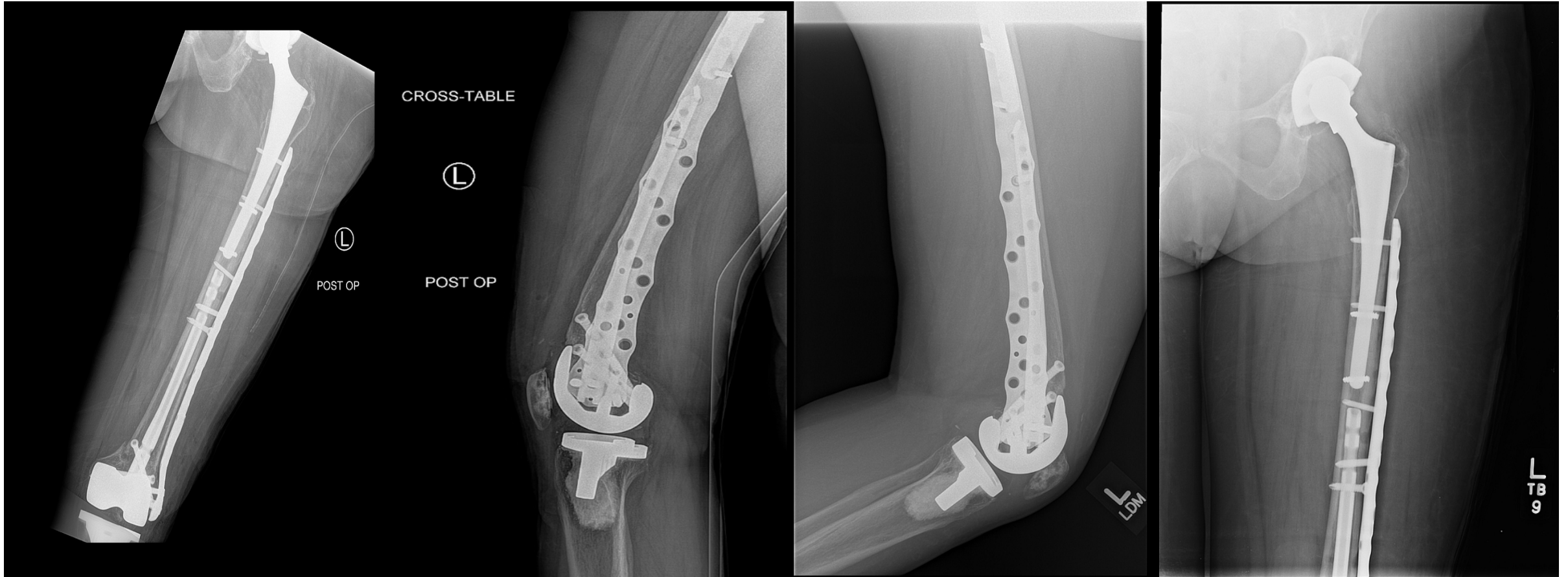
Case 4



Case 4



Case 4



Postoperative Management

- Goal: Immediate/Rapid Mobilization and progression to full weight bearing
 - Advantage of DFR, TKA revision, and IMN
 - WB with plate fixation: Generally restricted for 6-12 weeks postoperatively
- DVT Prophylaxis is essential during early post-operative day course
 - Duration and type of VTE treatment dependent on patient and injury factors
- Standard 1st gen IV Abx for 24 hours

Summary

- TKA Periprosthetic fracture incidence will continue to grow
- Preoperative history, physical exam and radiographic assessment is essential especially to...
- ...determine quality of bone, stability of implant that guide operative management
- Plate if lower segment fracture above TKA or 'closed box'
- IMN if metaphyseal fracture above TKA with 'open box'
- DFA allows for immediate weightbearing and should be considered if ORIF is not possible
- Plate-IMN combinations confer greater stability and strength (and confidence in WB) but with increased physiologic / surgical and implant burdens

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