PLEASE CLICK ON THE FOLLOWING LINK TO WATCH THE LECTURE ONLINE:-

https://www.youtube.com/watch?v=HtWD90kAv1c&list=PLuBRb5B7fa_dtajIUw2Eo1E-8Uv8vVNmR&index=7

Periprosthetic fractures

Dr Zaid al momani

THA Periprosthetic Fracture:

- Epidemiology:
  - Intraoperative→3.5% (uncemented), 0.4% cemented.
  - Postoperative→0.1%.
    - Most common at tip of stem.
- Prevention:
  - **Pre-operative templating.**
  - **Good surgical exposure.**
  - **Increased vigilance with cementless implants in poor bone.**

  - **P.S. DVT Prophylaxis post Hip Fracture Surgeries**

- Types:
  - **Intra-Operative:**
    - Femur.
    - Acetabulum.
  - **Post-Operative:**
    - Femur.
    - Acetabulum.

RF:

- **Technical errors.**
- **Cementless implants.**
  - Esp. **press-fit implants**
  - **Elltiptical/modular cups**
- **Impaction bone grafting.**
- **Revision setting.**
- **F>M.**
- **Poor bone:**
  - **Osteoporosis**
  - **Paget's**
  - **Irradiated**
  - Others→RA, pathologic, previous #
- **EtOH Abuse**
- **Movement Disorders**
- **Dementia**
- **Sickle Cell→**esp, middle zone intra-op femur fractures
- Minimally invasive techniques (controversial).

- **Intraoperative:**
  - Femur Fractures:
    - Incidence→0.1-5% primary, 3-21% revision.
    - Mechanism:
      - Proximal femur→**bone preparation** (i.e. rasping), **prosthesis insertion, poor selection of size.**
      - Mid femur→**bone preparation, surgical exposure.**
      - Distal femur→**impaction of prosthesis tip into bow.**

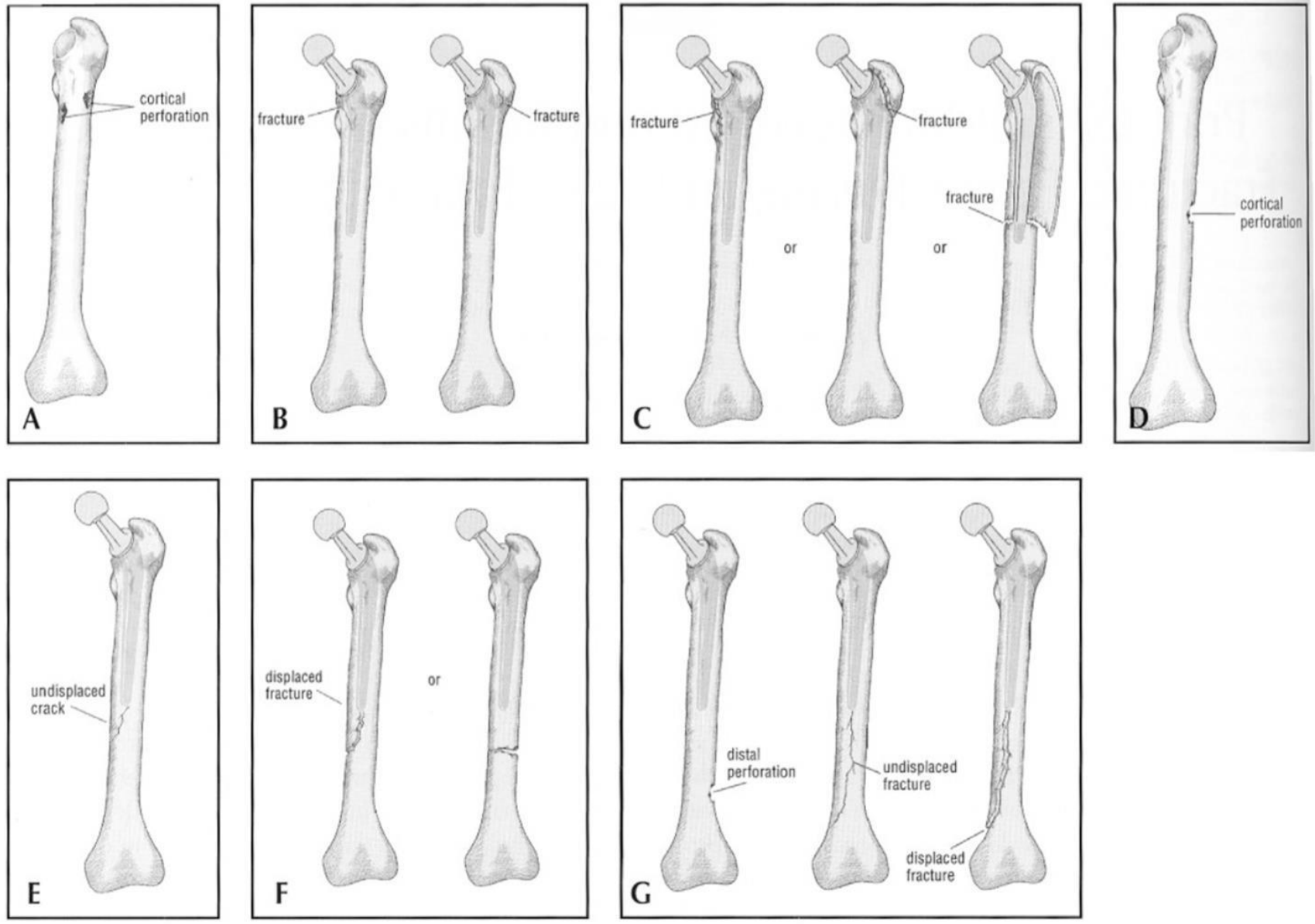


Fig. 1

Vancouver classification of intraoperative femoral periprosthetic fractures. A: type A1; B: type A2; C: type A3; D: type B1; E: type B2; F: type B3; and G: type C1 (left image), type C2 (center image), and type C3 (right image). (Reprinted, with permission, from: Greidanus NV, Mitchell PA, Masri BA, Garbuz DS, Duncan CP. Principles of management and results of treating the fractured femur during and after total hip arthroplasty. Instr Course Lect. 2003;52:309-22.)

- Classification→**Vancouver Classification for Intraoperative Fractures:**
  - **Type A-** proximal metaphysis:
    - **A1-** perforation.
      - **Morcelized bone graft.**
    - **A2-** undisplaced crack.
      - **Cerclage +/- bone graft.**
    - **A3-** displaced/unstable.

      -Diaphyseal stem + cerclage.

- **Type B-** proximal diaphysis:
  - **B1-** perforation.
    - Proximal to tip:
      - Yes→**morcelized bone graft.**
      - No:
        - Stem Stable:
          - Yes→**Allograft strut + cerclage.**
          - No→**long stem + allograft strut + cerclage.**

- **B2-** undisplaced crack.
  - Stable stem:
    - Yes→**cerclage.**
    - No:
      - Adequate bone stock:
        - Yes→**long stem + cerclage.**
        - No→**long stem + allograft strut + cerclage.**

- **B3-** displaced/unstable.
  - Stem stable:
    - Yes→**allograft strut + cerclage.**
    - No→**longer stem + allograft strut + cerclage.**

- **Type C-** distal diaphysis/distal metaphysis:
  - **C1-** perforation.
    - **Morcelized bone graft.**
  - **C2-** undisplaced crack.
    - **Cerclage +/- strut**
  - **C3-** displaced/unstable.
    - **ORIF.**

*Diagnosis→**intra-operative imaging (REQUIRED).**

Vancouver Classification & Treatment - **Intraoperative** Periprosthetic Fracture			
Type	*Description*	*Treatment*	
A1	Proximal metaphysis, cortical perforation	Bone graft alone (e.g. from acetabular reaming)	
A2	Proximal metaphysis, nondisplaced crack	Cerclage wire before inserting stem (to prevent crack propagation) Ignore the fracture if fully porous coated stem is used (provided there is no distal propagation)	
A3	Proximal metaphysis, displaced unstable fracture	Fully porous coated stem, or tapered fluted stem Wires/cables/claw plate for isolated GT fractures	
B1	Diaphyseal, cortical perforation (usually during cement removal)	Fully porous coated stem (bypass by 2 cortical diameters) ± strut allograft	
B2	Diaphyseal, nondisplaced crack (from increased hoop stress during broaching or implant placement)	Cerclage wire (if implant stable) Fully porous coated stem to bypass defect (if implant unstable) ± strut allograft PWB and observation (if detected postop)	
B3	Diaphyseal, displaced unstable fracture (usually during hip dislocation, cement removal, stem insertion)	Fully porous coated stem to bypass defect ± strut allograft	
C1	Distal to stem tip, cortical perforation (during cement removal)	Morcellized bone graft, fully porous coated stem to bypass defect, strut allograft	
C2	Distal to stem tip, nondisplaced fracture	Cerclage wire, strut allograft	
C3	Distal to stem tip, displaced unstable fracture	ORIF	

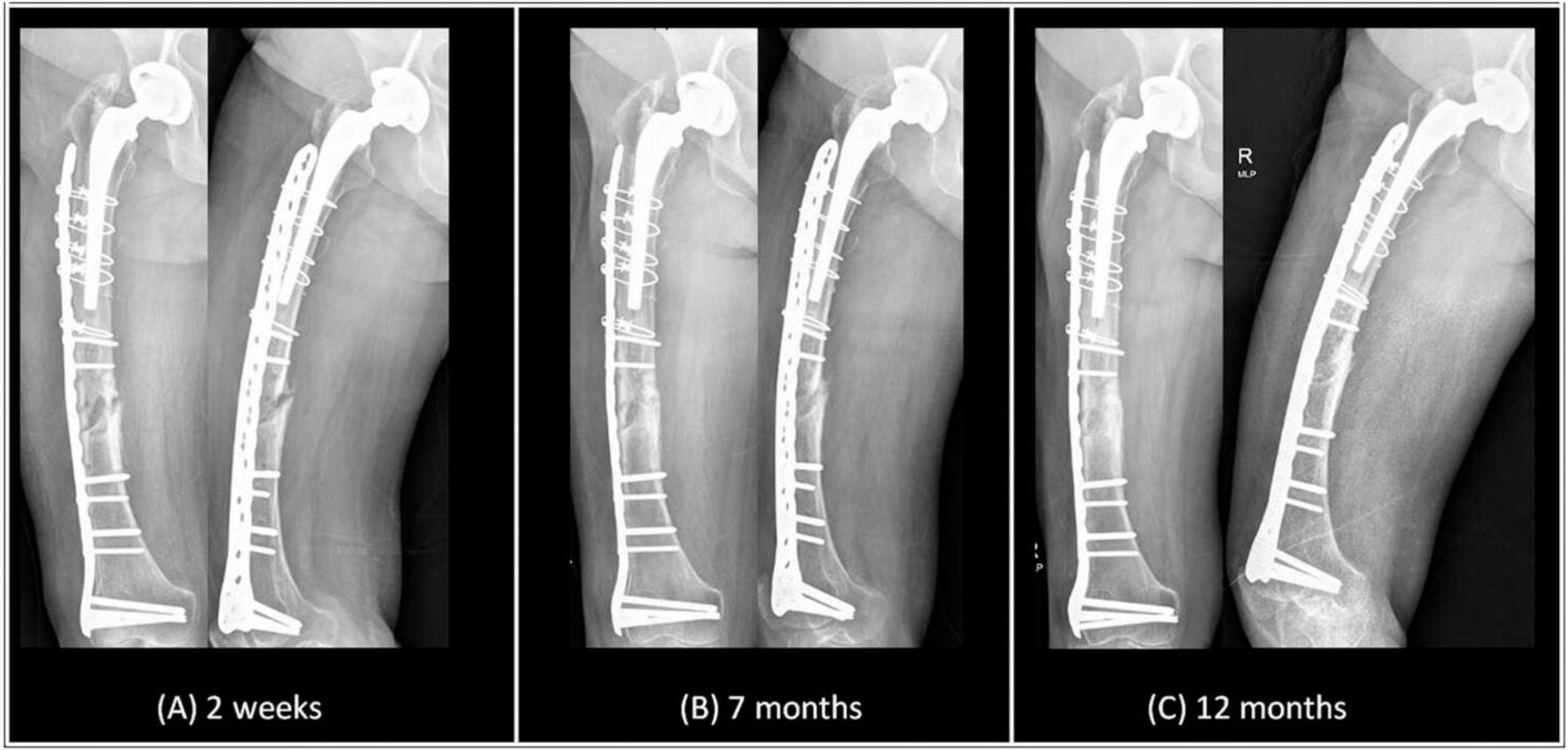


Fig. 3

- Management:
  - GENERAL:
    - **Expose all fractures to distal most extent.**
    - **Place cerclage around femur.**
      - **Insert 1 size smaller broach to prevent overtightening.**
  - Proximal #→**trochanteric fixation** (wires, cable, claw-plate).

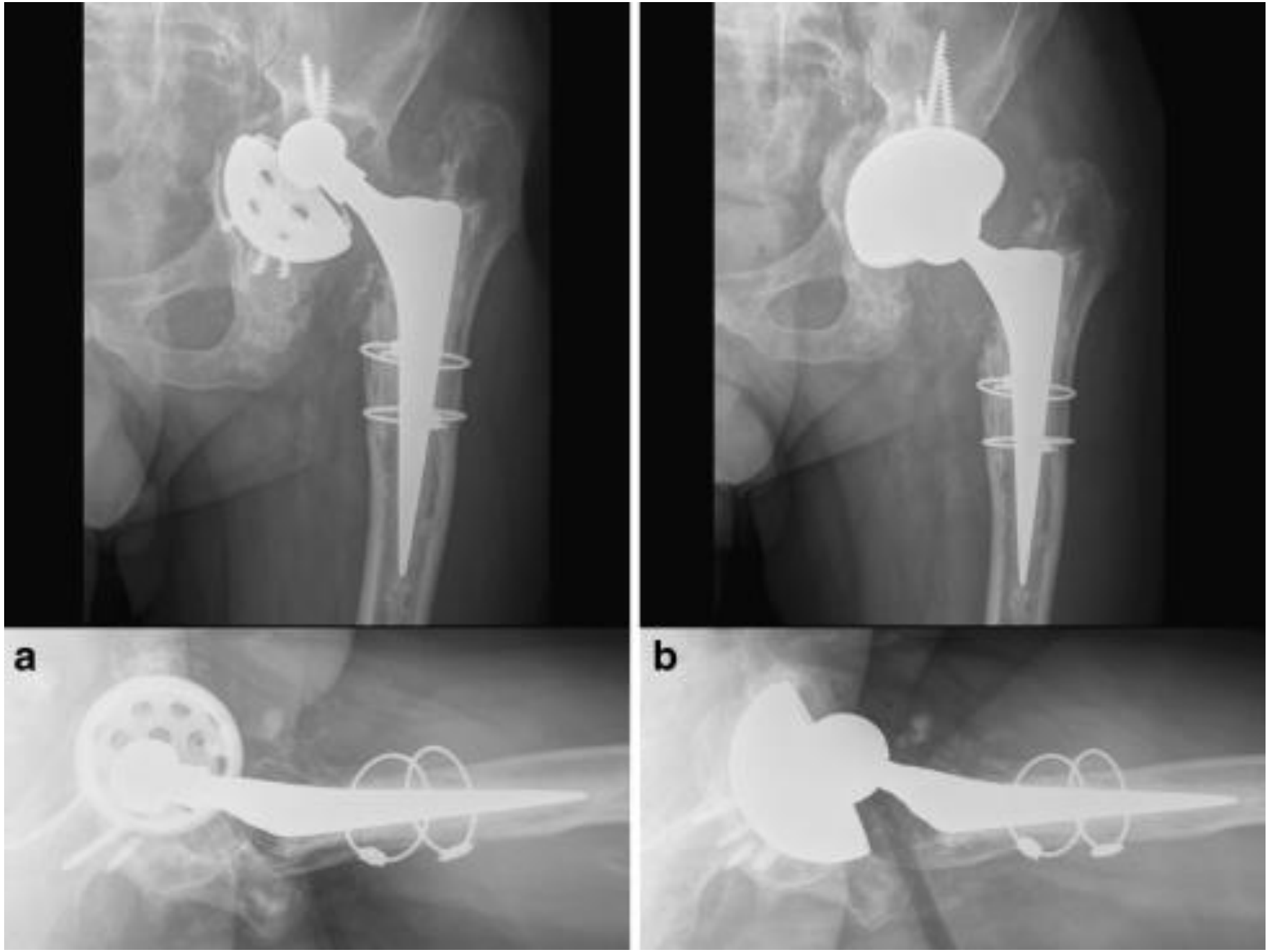
- Mid/Distal #→**removal of implant, cerclage/ORIF, reinsertion of stem.**
  - Length of stem depends on fracture:
    - Longitudinal calcar split→may be able to use same length.
    - Fracture beyond tip→**longer stem.**
  - Stem must bypass fracture by **2 cortical diameters.**
  - +/- **cortical strut allografts.**

- Acetabulum Fractures:
  - General:
    - Probably underrecognized.
  - Classification→**Paprosky Classification of Acetabulum Fractures:**
    - **Type 1→Intra-Op- Due to Component Insertion:**
      - **1A→**recognized, non-displaced/stable cup:
        - Rx:
          - **Leave cup + augment with multiple screws**
          - **PWB x 8-12 weeks**

Type	Description	Subtypes
I	Intraoperative fracture secondary to acetabular component insertion	A: Recognized intraoperatively, undisplaced, component stable B: Recognized intraoperatively, displaced, acetabular column or component unstable C: Not recognized intraoperatively
II	Intraoperative fracture secondary to acetabular component removal	A: Loss of <50% bone stock B: Loss of >50% bone stock
III	Traumatic fracture	A: Component stable B: Component unstable
IV	Spontaneous fracture	A: Loss of <50% bone stock B: Loss of >50% bone stock
V	Pelvic discontinuity	A: Loss of <50% bone stock B: Loss of >50% bone stock C: Prior pelvic radiation

- **1B→**recognized, displaced/cup unstable:
  - Rx:
    - **Remove cup**
    - **Fix Fragment→screws/buttress plate**
    - **Re-ream (minimize underreaming)**
    - **Insert cup + augment with multiple screws**
    - **PWB x 8-12 weeks**
- **1C→**unrecognized intra-op:
  - Rx→refer to Type 3-5

- **Type 2→Intra-Op- Due to Component Removal:**
  - **2A→**loss of <50% acetabular bone stock:
    - Rx options:
      - **Large revision cup + multiple screws**
      - **TM Cup**
  - **2B→**loss of >50% acetabular bone stock:
    - Rx:
      - **Augments/structural bone graft**
      - **TM Cup**


a
b

- **Type 3→Traumatic Fracture:**
  - **3A→**Cup stable:
    - Rx:
      - **PWB x 8-12 weeks**
  - **3B→**Cup unstable:
    - Rx:
      - **Remove component**
      - **Porous Revision or TM Cup with multiple screws**
        - Ream line to line
      - +/- **Posterior Column ORIF**

•If posterior column #

- **Type 4→Spontaneous Fracture:**
  - **4A→**loss of <50% acetabular bone stock:
    - Rx options:
      - **Large revision cup + multiple screws**
  - **4B→**loss of >50% acetabular bone stock:
    - Rx options:
      - **Bulk allograft/metal augment**
      - **+/- Cup Cage**
      - +/- **Posterior Column ORIF**
        - If posterior column #

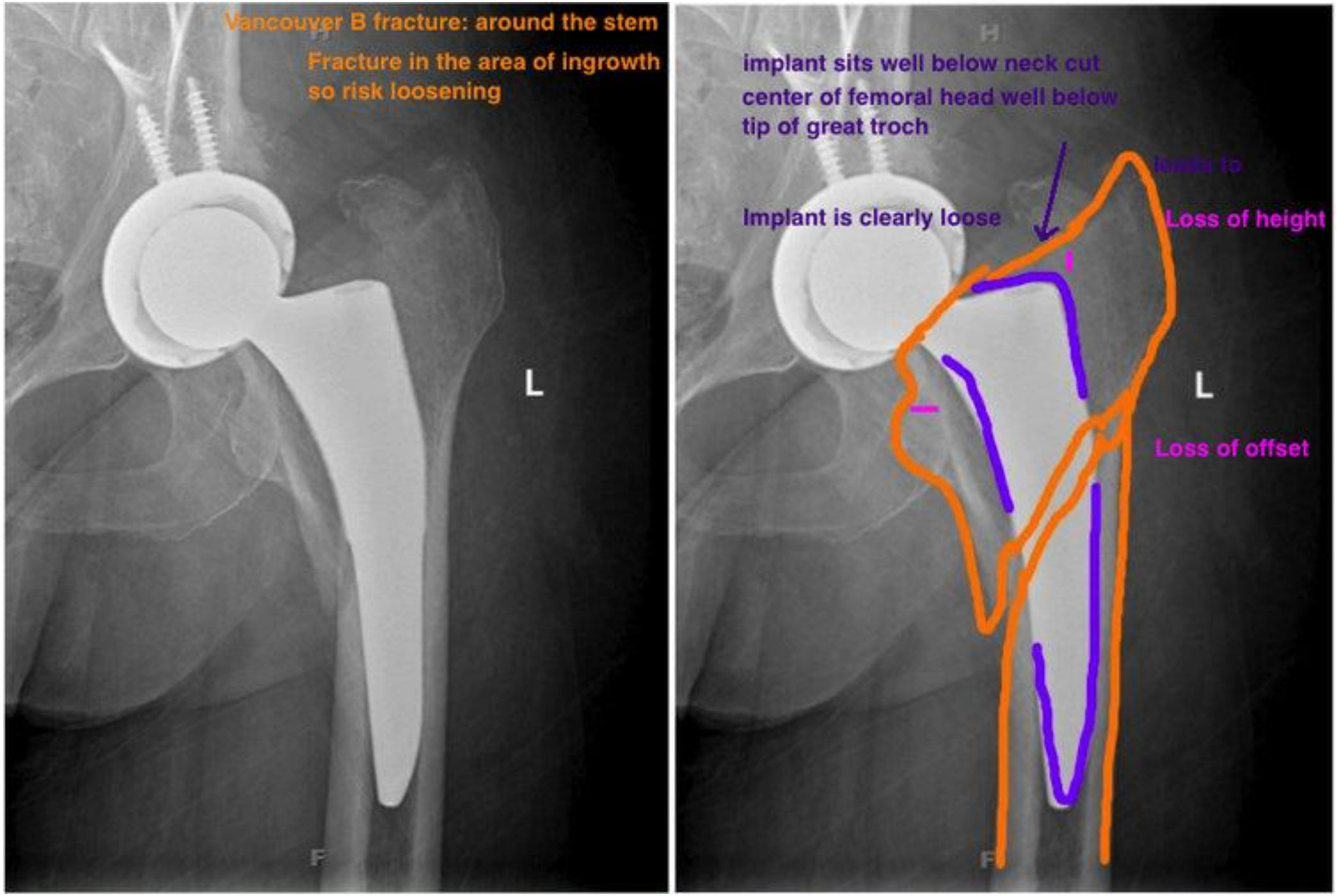
- **Type 5→Pelvic Discontinuity:**
  - **5A→**loss of <50% acetabular bone stock:
    - Rx:
      - **Posterior Column ORIF**
      - **Revise to Porous Revision Acetabular Component + Multiple Screws**
  - **5B→**loss of >50% acetabular bone stock:
    - Rx:
      - **Posterior Column ORIF**
      - **Bulk Allograft/Augments**
      - **Cup-Cage Construct**

- Management:
  - Dependent on stability of implant:
    - Stable→**observation, protected WB x2-3 months**
    - Unstable:
      - **Acetabular revision with screws**
      - **Jumbo Cup + bone graft**
      - **ORIF of Acetabulum #**
      - Post-op→protected WB x 2-3 months

- Post-Operative:
  - Femur Fracture:
    - Incidence → 0.1-3% primary cementless.
    - Mechanism:
      - Early Post-Op #:
        - Cementless prostheses tend to fracture in **first 6 months.**
          - Stress risers during remaing/broaching.
          - Esp. wedge fit tapered designs (proximal #).
          - Esp. cyclindrical fully porous-coated (distal split in shaft).

- Late Post-Op #:
  - Cemented prostheses tend to fracture later (i.e. **5 years out).**
  - Tend to fracture at **tip/distal.**
- Realize:
  - **Cementles**→usually EARLY (stress risers during preparation)
    - Wedge-fit tapered→proximal
    - Cylindrical fully porous→distal
  - **Cemented**→usually LATE
    -Usually at or distal to tip

- Classification→**Vancouver Classification:**
  - **Type A** (**AG**- GT, **AL**-LT)**-** fracture in trochanteric region:
    - **Non-Operative→protected WB** (MOST COMMON):
      -Limited abduction +/- abduction brace for GT #.


Vancouver B fracture: around the stem
Fracture in the area of ingrowth
so risk loosening
L
implant sits well below neck cut
center of femoral head well below
tip of great troch
Implant is clearly loose
Loss of height
L
Loss of offset

- **Operative→ORIF.**
  - Indication:
    - **Displaced (>2.5cm) AG # in higher functioning adult**
    - **Continue pain/abductor weakness**
  - Technique:
    - **GT hook plate.**
    - Realize: Wires alone are INADEQUATE

- Note: these fractures may be associated with osteolysis.
  - May need to address cause of osteolysis.

Vancouver Classification & Treatment - Postoperative Periprosthetic Fracture		
Type	*Description*	*Treatment*
A	Fracture in trochanteric region. Commonly associated with osteolysis. AG (greater trochanter) fractures caused by retraction, broaching, actual implant insertion, previous hip screws.	Often requires treatment that addresses the osteolysis. AG fractures with <2cm displacement, treat nonoperatively with partial WB and allow fibrous union. AG fractures >2cm needs ORIF (loss of abductor function leads to instability) with trochanteric claw/cables.
B1	Fracture around stem or just below it, with a well fixed stem	**ORIF using cerclage cables and locking plates**
B2	Fracture around stem or just below it, with a loose stem but good proximal bone stock	**Revision of the femoral component to a long porous-coated cementless stems** and fixation of the fracture fragment. Revision of the acetabular component if indicated
B3	Fracture around stem or just below it, with proximal bone that is poor quality or severely comminuted	**Femoral component revision** with **proximal femoral allograft** or **proximal femoral replacement**
C	Fracture occurs well below the prosthesis	**ORIF with plate** - leave the hip and acetabular prosthesis alone

- **Type B-** fracture around stem/just distal to it:
  - **B1-** well fixed stem + good bone stock:
    - Assessing stability:
      - Pre-Op (XR→ALWAYS COMPARE TO PREVIOUS):
        - Definitive signs of loosening:
          - Change in stem position (subsidence).
          - Progressive periprosthetic/cement mantle radiolucency.
          - Stem/cement mantle #.

- **MUST BE READY FOR REVISION TO LONG STEM** (i.e. unexpected B2).
    - Rep available
    - Removal tools (Burr, osteotomes, implant specific)
    - Revision components available
    - ORIF (plates, cables) material available
    - +/- strut grafts
    - +/- APC/tumor prosthesis if bone stock unclear

- **B2-** loose stem + good bone stock:
    - **Revision Long porous coated diaphyseal fixation stem + ORIF.**
        - Note: can sometimes used **cement fixation** instead of porous coated stems.

- **B3-** loose stem + poor bone stock:
  - **Proximal Femoral Allograft (PFA)** or **Proximal Femoral Replacement (Tumor prosthesis).**

- **Type C-** fracture distal to stem:
  - **ORIF with plate:**

    -Screws distally, cerclage proximally

TKA Periprosthetic Fracture: Femur:

- Incidence:
  - 0.3-2.5% primary TKA
    - **Medial Femoral Condyle→MOST COMMON**
  - Increased with revision TKA
- Types:
- **Intraoperative-** femur or tibia.
    - **Medial Femoral Condyle→**MOST COMMON
    - **PS Knee→**more common

- **Post-operative-** femur or tibia.

- **Anterior Femoral Notching-** weakness femur although NO CLINICAL SUPPORT for increased rates of supracondylar femur #.
- **F>M.**
- **Inflammatory Arthritis/RA.**
- **Chronic Steroid therapy treatment.**
- **Osteoporosis**
- **Neurologic disorder.**

- Classification:
  - **Rorabeck, Angliss and Lewis:**
    - Type 1→undisplaced, prosthesis stable.
    - Ttype 2→displaced, prosthesis stable.
    - Type 3→unstable prosthesis +/- displacement.
  - **Su and Associates→BEST CLASSIFICATION:**
    - **Type 1**→proximal to femoral component.
    - **Type 2**→origin at proximal aspect of anterior flange of femoral component + extends proximally.
    - **Type 3**→any part of the fracture line is distal to proximal anterior flange of femoral component.

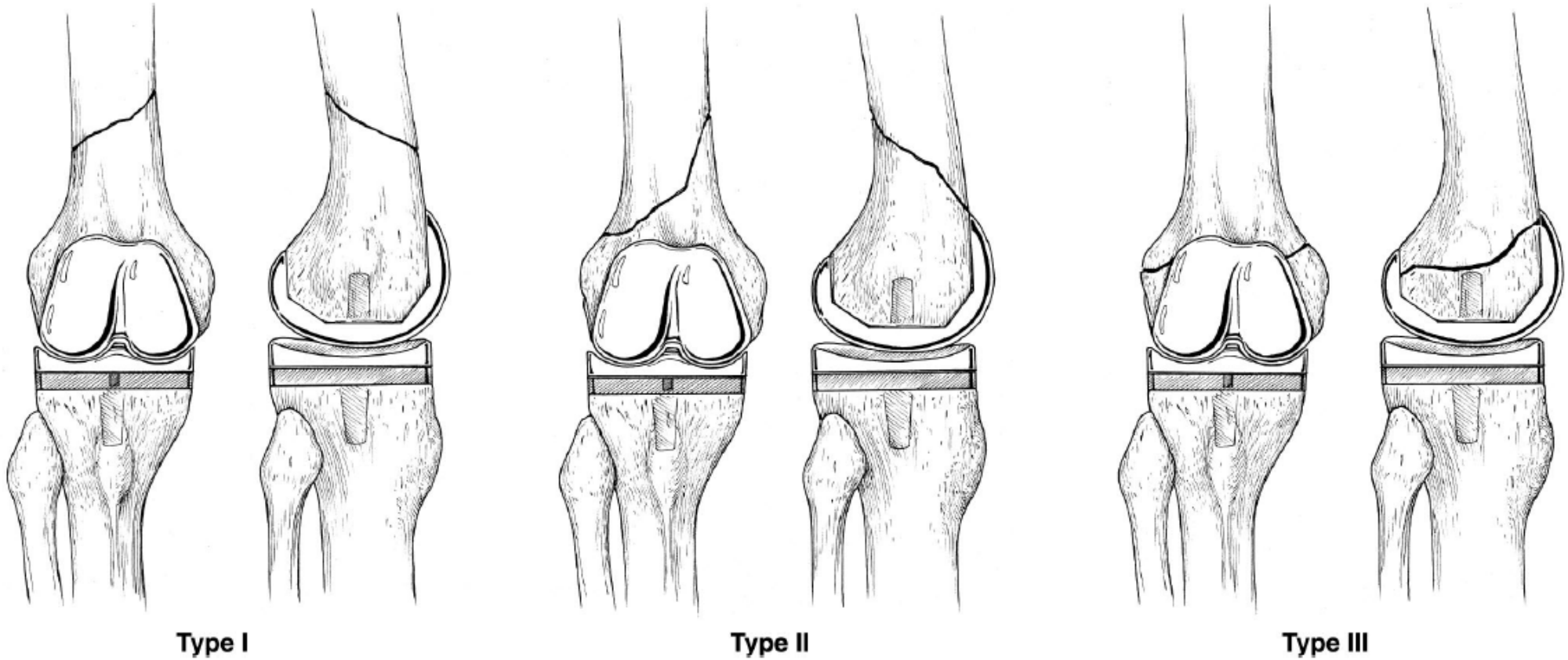
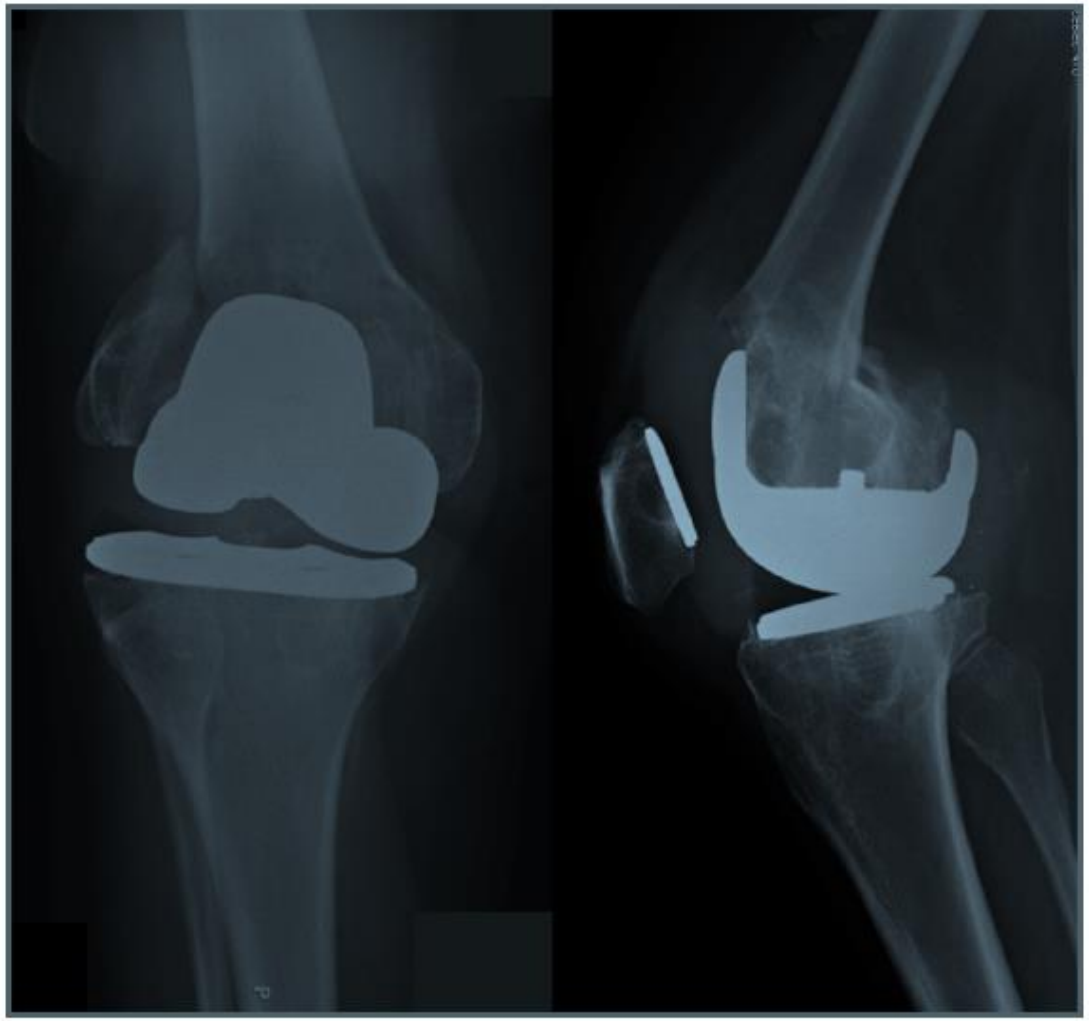
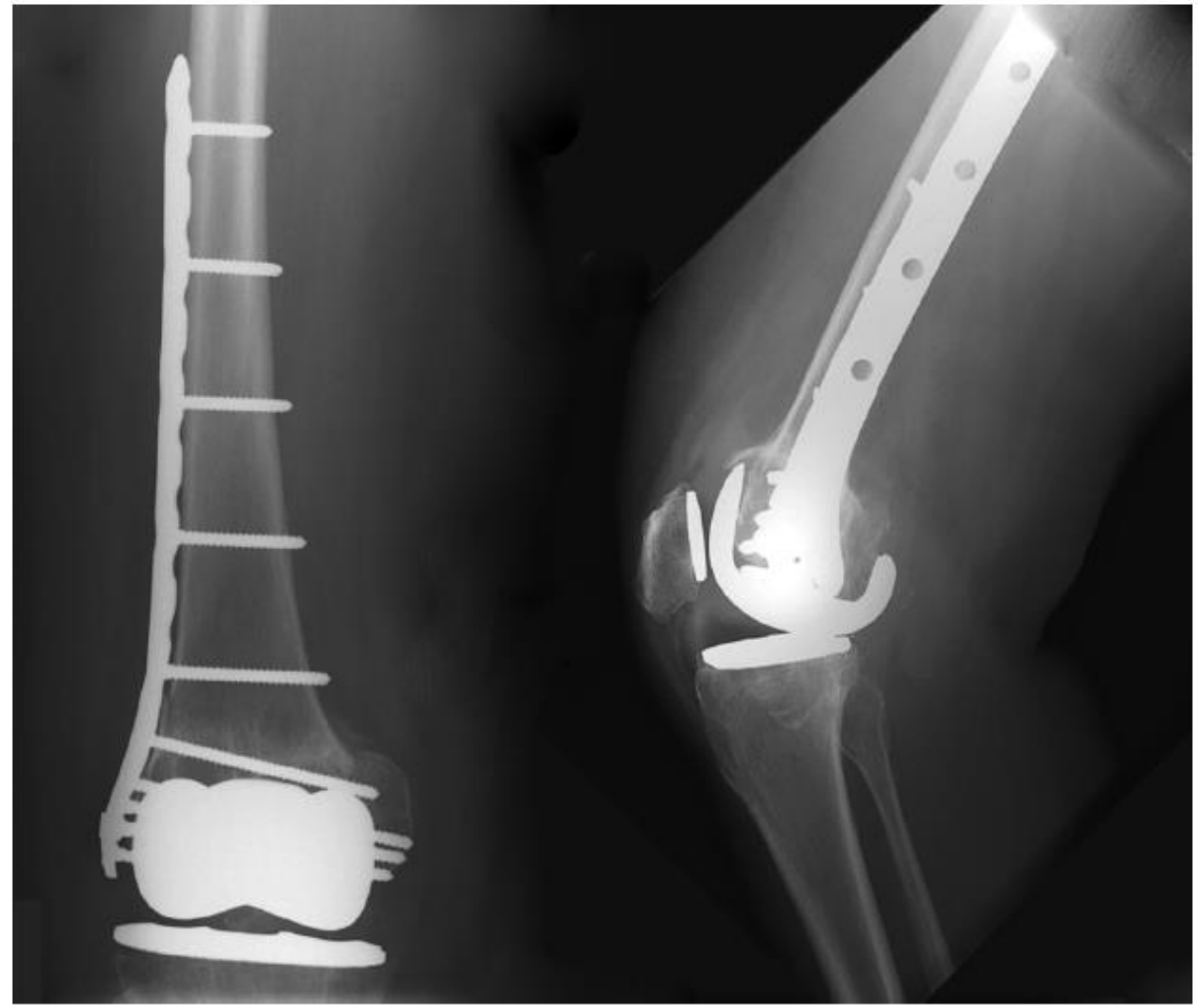
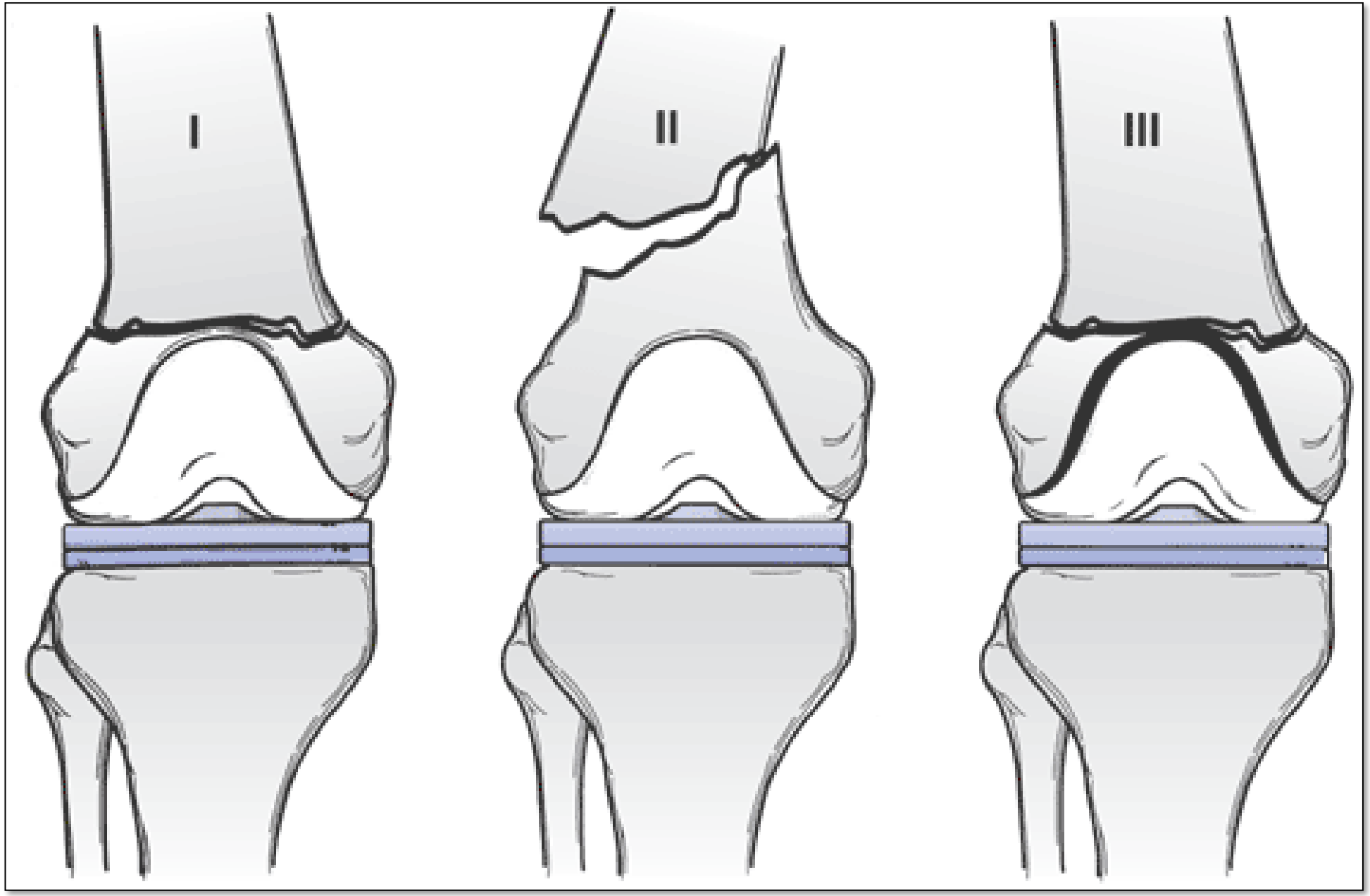


Figure 4 Anteroposterior and lateral views of supracondylar periprosthetic femoral fracture classification. Type I: Fracture proximal to femoral knee component. Type II: Fracture originating at the proximal aspect of the femoral knee component and extending proximally. Type III: Any part of the fracture line is distal to the upper edge of the anterior flange of the femoral knee component.





- Others:
  - **Neer and Associated:**
    - Type 1→non-displaced (<5mm displacement, $<5^0$ angulation).
    - Type 2→displaced >1cm.
      - 2A→lateral femoral shaft displacement.
      - 2B→medial femoral shaft displacement.
    - Type 3→displaced + comminuted.
  - **DiGioia and Rubash:**
    - Group 1→extra-articular, non-displaced (<5mm, $<5^0$ angulation).
    - Group 2→extra-articular, displaced (>5mm, $>5^0$ angulation).
    - Group 3→loss of cortical contact or angulated ($>10^0$).
      - May have intercondylar or T-shaped component.


I
II
III

- Management:
  - **Non-Operative→NWB + Cast/brace:**
    - Indication→non-displaced, stable prosthesis.
  - **Operative:**
    - **ORIF:**
      - Indications- both:
        - **Displaced fractures.**
        - **Stable prosthesis.**

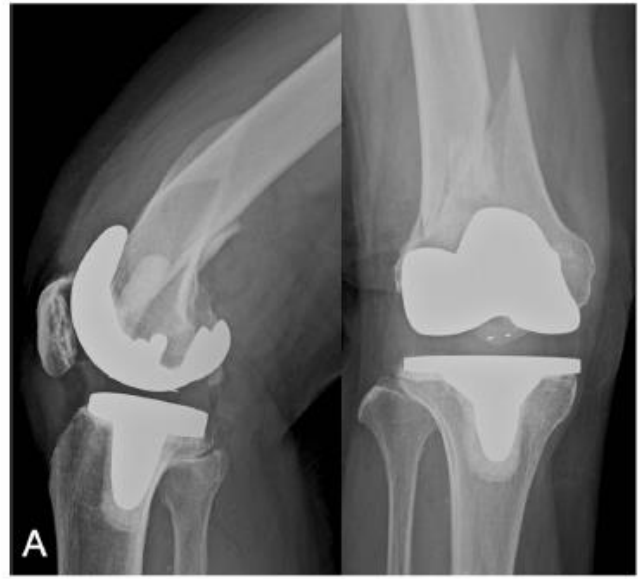


Fig. 1 Pre-operative anteroposterior (AP) and lateral plain radiographs of a 73-year old female patient who sustained a Su type II fracture (**a**). This patient was treated with a lateral locking plate using the minimally invasive plate osteosynthesis (MIPO) technique (**b**). AP and lateral plain radiographs at the final follow-up examination at 19 months showed solid bony union

Fig. 2 Pre-operative anteroposterior (AP) and lateral simple radiographs showing a Su type III fracture in a 75-year-old female patient, which extended distally to the upper edge of the femoral component (**a**). We treated this patient with lateral and medial plating using the minimally invasive plate osteosynthesis (MIPO) technique (**b**). Plain radiographs at the final follow-up examination at nine months showed firm bony union without collapse or malunion

- **Long stem revision:**
  - Indications:
    - **Displaced fractures.**
    - **Loose component.**
  - Realize: may require augmentation:
    - **Metaphyseal/diaphyseal cones.**
    - **Wedges.**
    - **Augments.**
  - Very rarely require ORIF (very distal fracture).
- **Tibial Tubercle ORIF:**
  - Indications:
- **Type 4 ===> Ext Mechanism rupture (**out of scope**)**

Are outcomes improved with ORIF compared to revision TKA?

Primary DFR may be associated with lower rates of complications and revision surgery compared with ORIF for periprosthetic distal femur fractures. However high level evidence confirming this is lacking.

DFR allows immediate weight bearing, but does not have a clear benefit regarding long-term functional outcomes.

- The current standard of care for most intra-articular distal femur fractures (above the knee joint) in geriatric patients is a surgical fixation using plates and screws until the fracture as healed.

- However, surgical fixation of these complex fractures in geriatric patients, is associated with significant complications, such as non-union, infection and the need for revision surgery.
- Additionally, surgical fixation requires prolonged immobilization of the affected limb (typically around 6-12 weeks post-operatively), which can lead to disability and other complications.
- Geriatric patients, especially those frail and with cognition impairment, are unable to adhere to the immobilization restrictions, which leads to an increased risk of fixation failure.

- Another treatment option for those patients is an acute distal femoral replacement (DFR).
- This procedure allows patients to ambulate immediately after the surgery and faster return to previous level of function, therefore avoiding the complications for immobilization.

- There is a lack of guidelines and evidences to suggest which surgical technique is best to provide superior function outcomes, lower complications and reduced costs.
- The proposed study seeks to answer this question by performing a large clinical trial comparing knee replacement versus surgical fixation in geriatric patients with distal femur fracture.

Table 1
Indications for Performing Distal Femoral Arthroplasties (DFAs) Versus Open Reduction and Internal Fixation (ORIF).

	DFA	ORIF
Fracture location	Too distal for meaningful fixation	Able to place screws in distal femoral bone
Implant	Loose	Well fixed
Bone loss	Significant	Minimal
Bone quality	Osteopenic or osteoporotic	Osteopenic, poor in osteoporotic bone
Weight-bearing	Unable to perform partial weight-bearing	Able to perform partial weight-bearing
Patient medical status	Sick and unable to handle more than one operative procedure	Medically stable and able to handle multiple operations if necessary

Fig. 2. Periprosthetic fracture treated with open reduction and internal fixation (ORIF). A) Original periprosthetic fracture – AP view, B) original periprosthetic fracture – lateral view C) Initial ORIF – AP view, D) Initial ORIF – lateral view, E) failure of ORIF due to nonunion – AP view, F) failure of ORIF due to nonunion – lateral view, G) revision to a distal femoral replacement (DFR) – AP view, and H) and I) revision to a distal femoral replacement – lateral views.

Thank you