Tibial Plateau Fractures

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Disclosure

- Clinical images provided by the author.
- Figures used with permission from Tornetta P, Ricci WM, eds. Rockwood and Green's Fractures in Adults, 9e. Philadelphia, PA. Wolters Kluwer Health, Inc; 2019.

Objectives

- Describe initial evaluation and management of tibial plateau fractures
- Identify common fracture patterns
- Apply treatment principles and strategies
  - Partial articular fractures
  - Complete articular fractures
- Discuss rehabilitation, complications, and outcomes

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Plateau Fractures: Initial Presentation

- 1-2% of all fractures
- Similar bimodal distribution to many peri-articular injuries
- 70% in young adult men, average age 43

These two figures represent the spectrum of injuries seen in tibial plateau fractures.

A: A low-energy lateral plateau fracture in a 37-year-old male who missed a step and fell which was treated nonoperatively. **B:** High-energy bicondylar tibial plateau fracture in a 42-year-old man who sustained a motor vehicle crash that was treated initially with an external fixator followed by definitive fixation with bicondylar plating.

Rockwood and Green, 9th edition

Age and mechanism dictate injury pattern

-Middle age and elderly with simple falls

-commonly split depressed patterns, or less common isolated medial side injuries

-Higher energy or sports related

-pure split injuries, or rim injuries with associated ligamentous injuries to the knee and potential for instability

-High energy MVA, fall from height, pedestrians struck

-Often younger patients

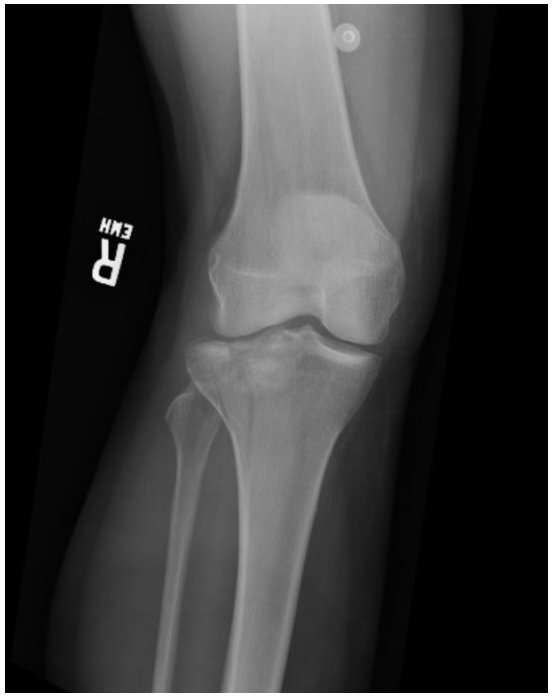
-bicondylar patterns

-higher risk for neurovascular injury

-compartment syndrome and open fractures common

Initial presentation – mechanism matters!

- **Lower energy**
- **Simple falls, struck from side**
- **Remain length stable**



- **Higher energy**
- **Axial load, associated shearing**
- **Compartment syndrome risk**

Initial Management

- Physical exam
  - Swelling – compartment syndrome
  - Distal pulses – vascular injury
  - ?ABIs
  - Valgus Instability?
- Splinting
  - Knee immobilizer
  - Compartment checks
  - DVT Prophylaxsis
- Imaging
  - CT scan routinely obtained
  - Plain films
  - MRI for occult or suspected fractures, particularly in the elderly
  - Fracture-dislocation patterns: high risk for ligamentous damage, MRI indicated
  - Think about need for MRI prior to placing ex fix! Save yourself some phone calls!

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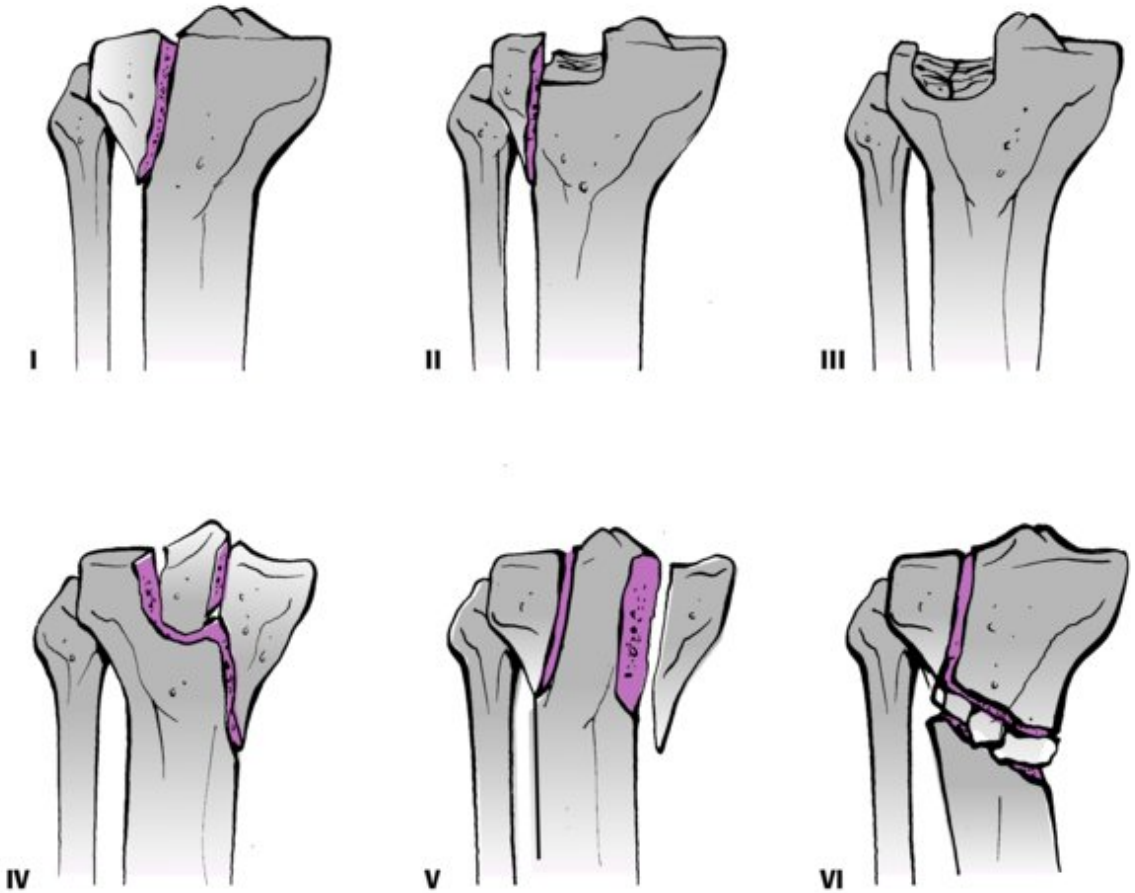
Schatzker Classification



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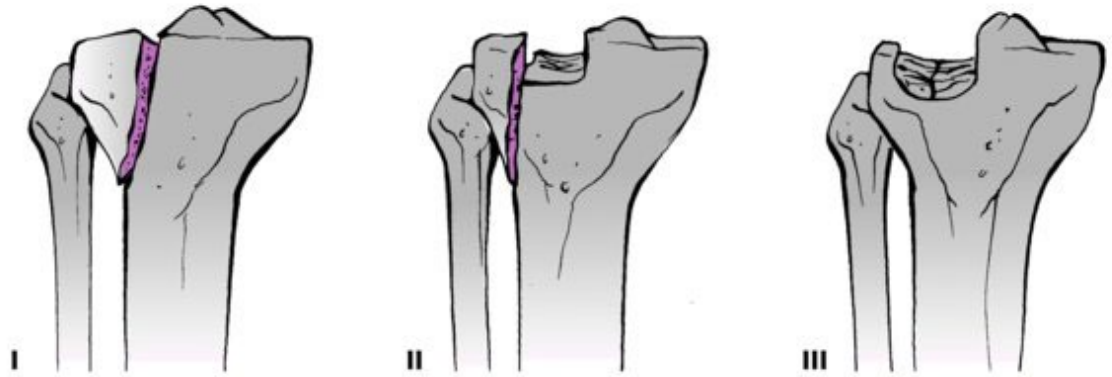
Schatzker Classification: Injuries isolated to the lateral plateau

- **I: Younger patients, better bone quality**
- **II: Higher energy, with associated depression of the lateral chondral surface**
- **III: Poor quality bone in elderly patients**
- **Most common patterns**



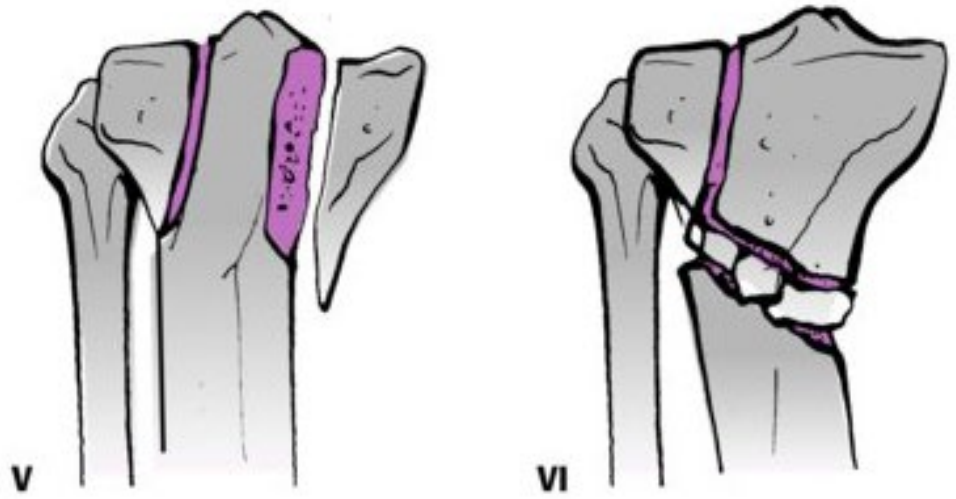
Schatzker Classification: Isolated medial fractures come in two flavors

- Lower energy, elderly
- Simple depression
- Varus loading
- Fracture lines exit medial to spines

- Higher energy, young patients
- Medial shearing
- Higher risk for vascular injuries
- Fracture lines exit lateral to spines
- Called “fracture dislocation” variants

Schztzker Classification: Bicondylar injuries

- Typically higher energy
- Compartment syndrome risk
- Vascular exam a must
  - Consider ABIs
- Commonly open
- Soft tissues at risk
- Exam will progress over hours and often worsen with time
- Includes varus hyperextension Bicondylar variant*



Firoozabadi R, Schneidkraut J, Beingessner D, Dunbar R, Barei D. Hyperextension Varus Bicondylar Tibial Plateau Fracture Pattern: Diagnosis and Treatment Strategies. J Orthop Trauma. 2016 May;30(5):e152-7.

OTA Classification

- **Uniform classification**
- **Captures all variants**
- **A: Extra articular**
- **B: Partial Articular**
- **C: Complete Articular**

OTA/AO Classification of Tibial Plateau Fractures

Classification	Description
• Type A	• Technically, these are not classified as plateau fractures as the articular surface is not involved; they can be labeled as proximal tibia fractures
• Type B	• Includes both medial and lateral plateau fractures
B1	• Simple articular split
B2	• Split and depression of the articular fragment
B3	• Comminuted split and depression
• Type C	• Complex articular fractures and frequently called bicondylar tibial plateau fractures
C1	• Noncomminuted total articular fractures
C2	• Noncomminuted articular fractures with metaphyseal comminution
C3	• Comminuted articular fractures with metaphyseal comminution

Rockwood and Green, 9th edition

Important Variants – Open injuries

Open injuries

-antibiotics: ASAP

-tetanus

-vascular exam

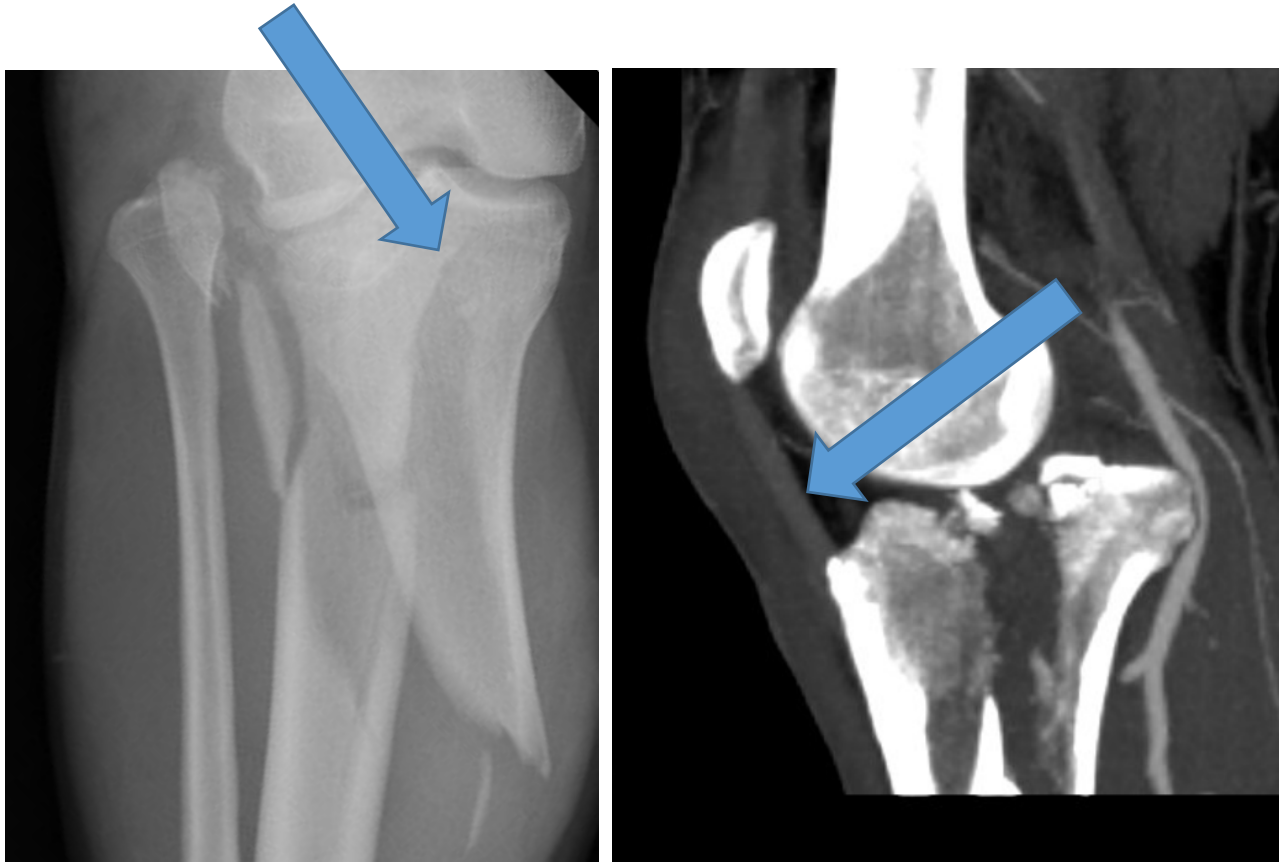
Present challenges for coverage

Shaft extension

Early coverage within 72 hrs decreases late infection rate

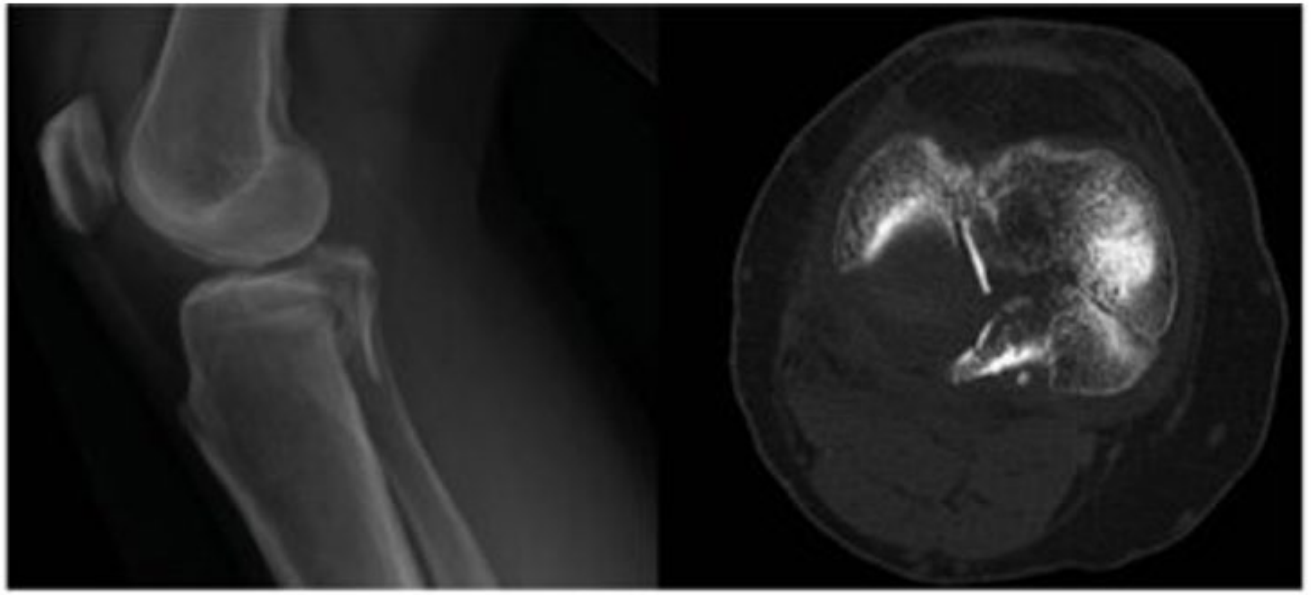
Fracture Dislocation patterns

- **High energy**
- **Frequently with medial displacement and shortening**
- **High association with vascular injury**
- **Subluxation or dislocation thru the fracture causes traction injury to the vessels**
- **Don’t always “fit” Schatzker**
- **Hohl and Moore Classification may be more descriptive**



Posterior Shear Patterns

- **Commonly posteromedial patterns**
- **“B-type” partial articular injury to the medial plateau**
- **Often associated with**
  - **bicondylar patterns and less commonly isolated fracture; lateral side seen as well**



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Three Column Concept of Plateau Fractures

- Evolution of the Schatzker Classification
- Better incorporates fractures involving posterior plateau
- Help with determining appropriate fixation strategy

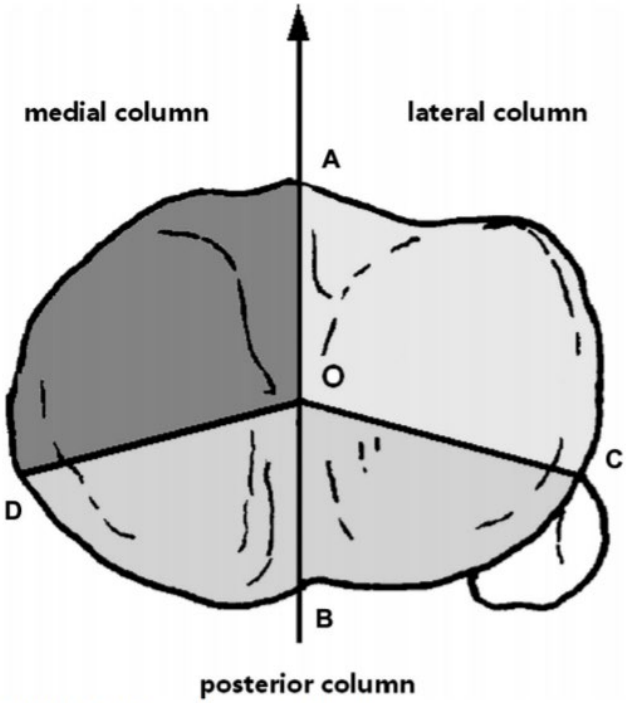

FIGURE 1. Three-column classification.

Luo CF, Sun H, Zhang B, Zeng BF. Three-column fixation for complex tibial plateau fractures. J Orthop Trauma. 2010 Nov;24(11):683-92. doi: 10.1097/BOT.0b013e3181d436f3. PMID: 20881634

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General Principles for Plateau Treatment

- Fracture location and classification generally dictate approach
- Anterolateral, posteromedial, direct medial most common
- Visualization of the fracture – key for articular reduction
  - Direct visualization; ie anterolateral with submeniscal approach
  - Fluroscopic; ie minimally invasive reduction and plating
  - Arthroscopic; in conjunction with fluoroscopic
- Use of temporary external fixation may be considered
- Fractures which are length stable can be safely delayed with bracing alone

Nonoperative treatment: Indications and contraindications

Indications	Relative Contraindications
• Undisplaced or minimally displaced fractures • Small depressions of the lateral plateau without deformity or instability on clinical exam • Significant medical comorbidities that preclude surgical treatment • Elderly patients with low functional demands in whom subtle deformities are tolerated	• Knee instability • Greater displacement where deformity is easily predictable • Displaced medial-side injuries

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Nonoperative management

- **Valgus instability – 5-10 degrees**
- **Articular step-off threshold is controversial**
- **Isolated medial injuries: late varus collapse**
- **In general, small isolated lateral injuries without valgus instability**
- **Early ROM, limited wb x 8-12 weeks, +/- bracing**
- **Angular malalignment poorly tolerated**

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Goals of Surgical Fixation – plateau fractures

- Restore alignment
  - Coronal
  - Sagittal
  - Slope
- Normal Condylar width
- Fully stable knee
- Congruent Articular Surfacte

Lateral Plateau Fixation

- **Most common fracture pattern**
- **Anterolateral approach**
- **Key steps:**
  - Anterolateral approach
  - Submeniscal arthrotomy
  - +/- distractor if needed
  - “book open” the split portion
  - Reduce the depressed articular segment and provisionally stabilize with K-wires
  - Fill voids as necessary
  - Reduce the split portion
  - Apply rafting screws and/or lateral plate

Click below for video link

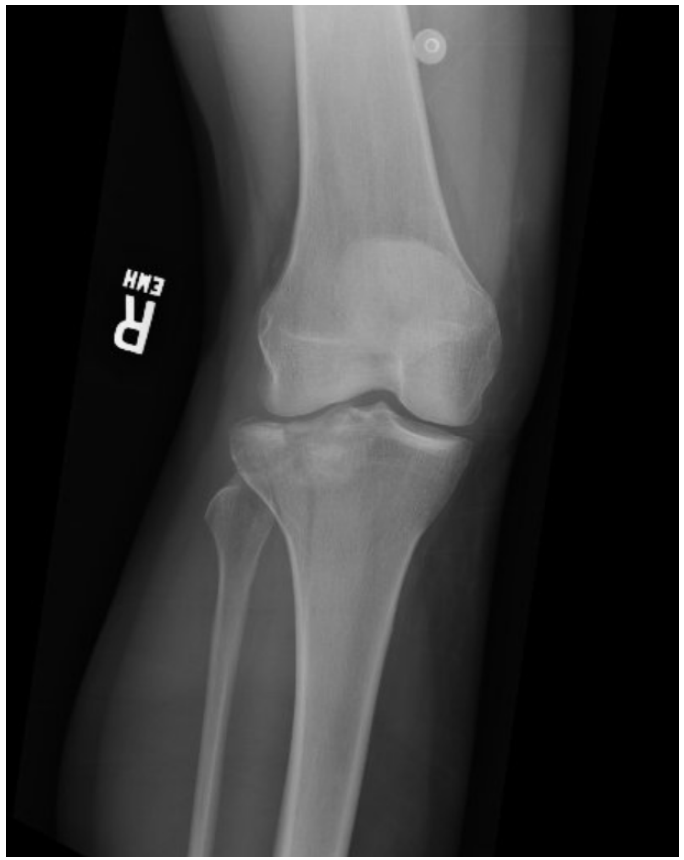
OTA ORTHOPAEDIC TRAUMA ASSOCIATION — Online Trauma Access

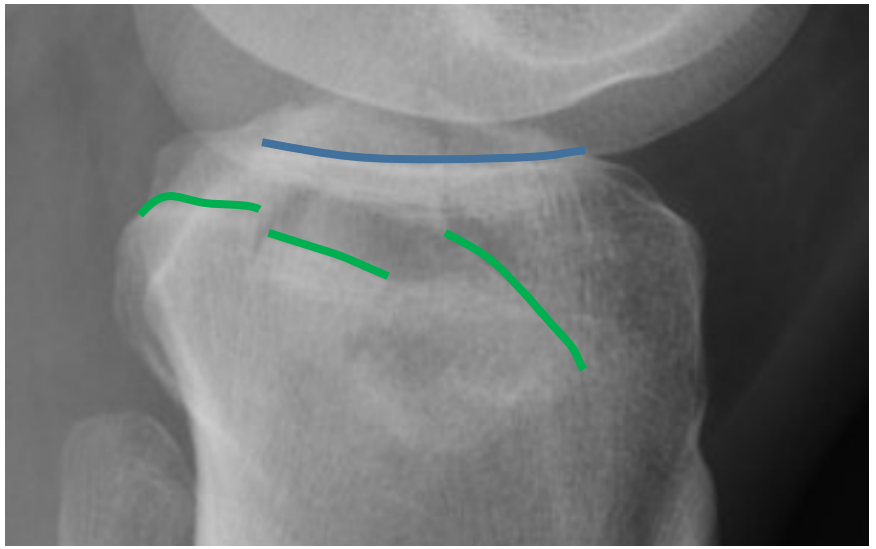
Anterolateral Approach for the Treatment of Tibial Plateau Fractures

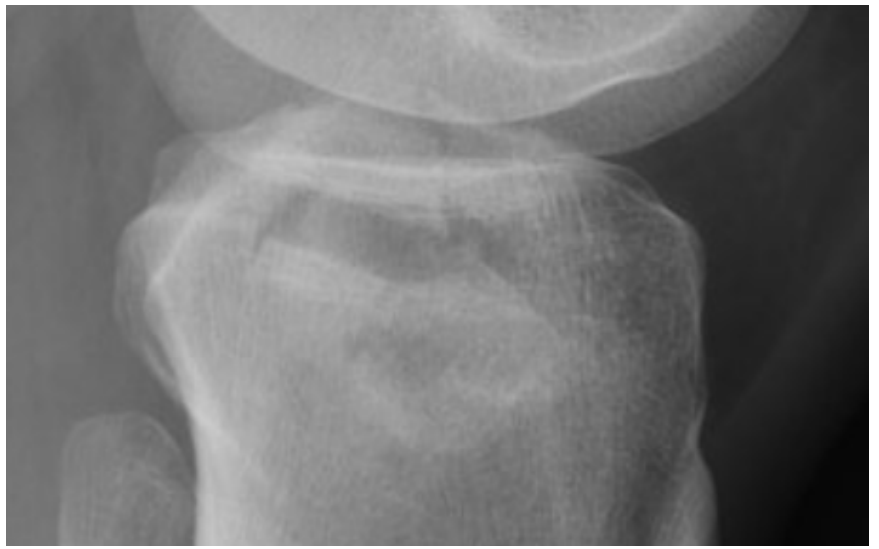
Mark Hake, Rajbir Hundal, Jacob Kirsch, Michael Yee

Lateral Plateau Fixation

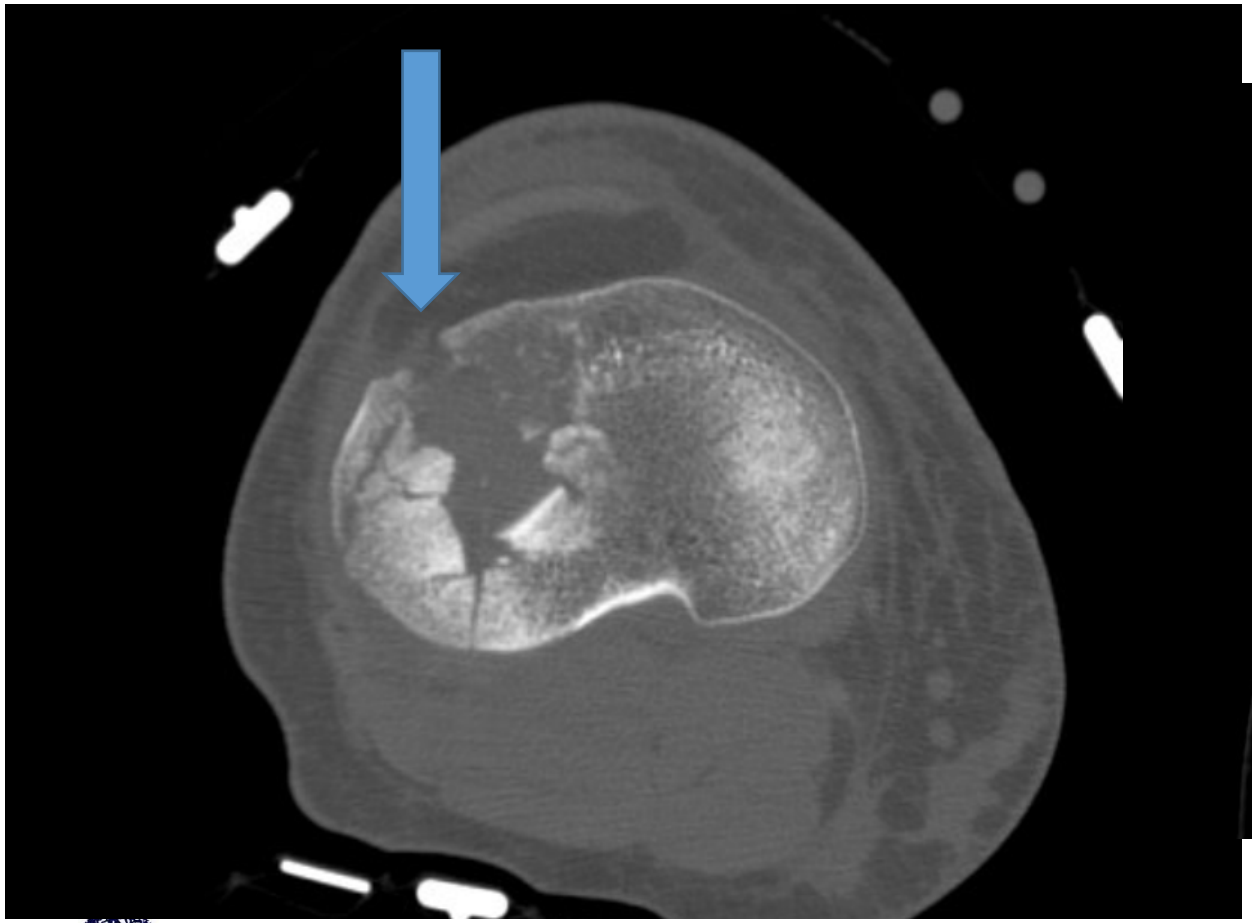
- Healthy, active 48 year old woman fell off scooter

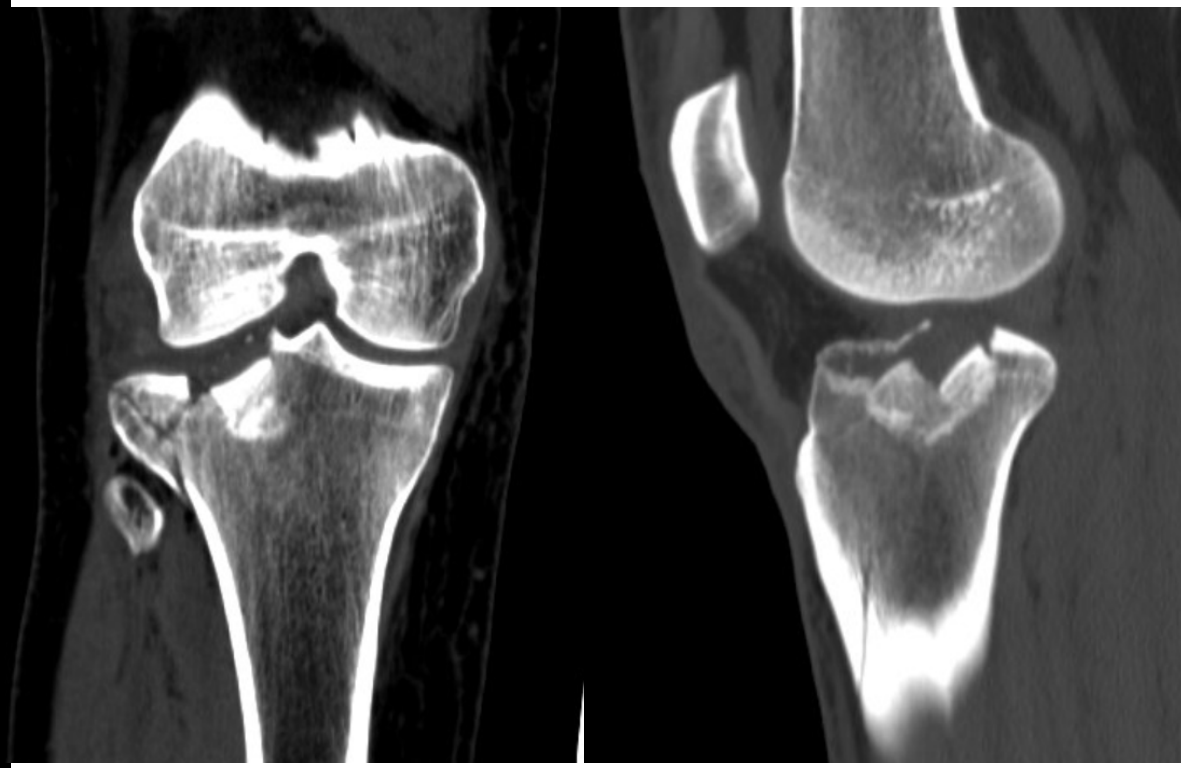






CT Imaging – axial cuts demonstrate approach



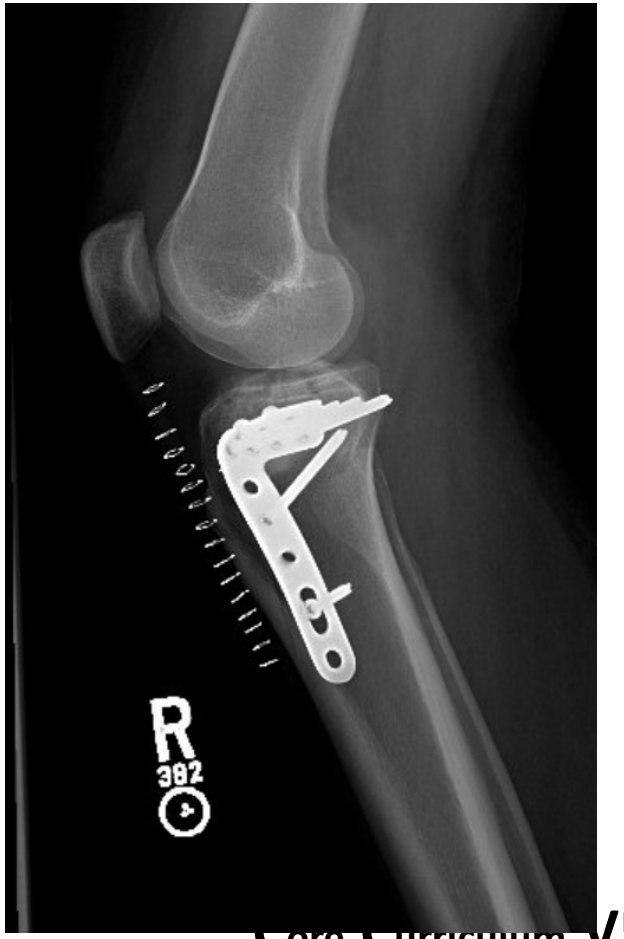


Anterolateral approach – visualize + reduce




Postoperative Care

- Early ROM – trust your fixation
- Protected WB
  - 8 weeks tdwb, then adv to wbat over weeks 8-12
- Bracing?
- DVT prophylaxis

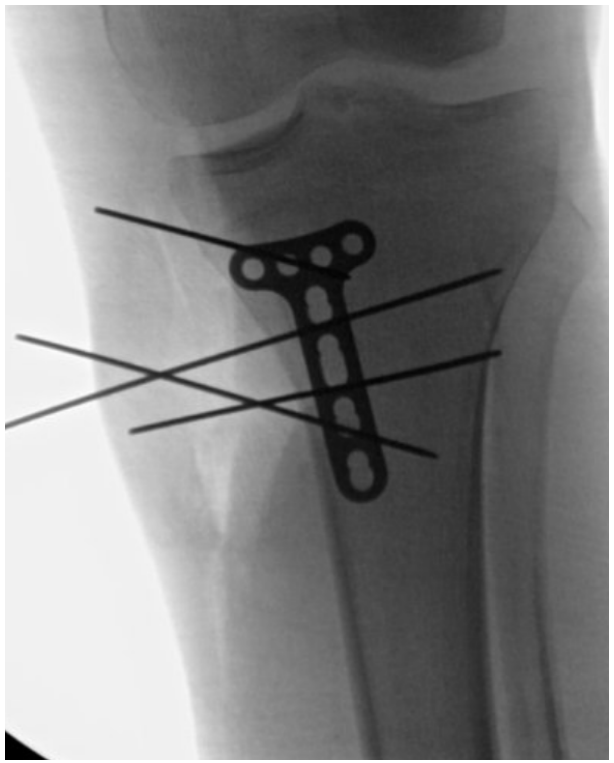


Isolated medial injuries

- **Much less common**
- **Posteromedial approach**
- **Key steps:**
  - **Generally buttress at the apex**
  - Prone vs supine?
  - Supine – simple, allows for anterolateral approach, also adds significant rotation and varus often thru the fracture in bicondylar injuries
  - Posterior – inconvenient, but fewer deforming forces, simplifies fixation
  - Direct approach to apex
  - Indirect reduction at joint line
  - Fluroscopic reduction key
  - With Medial surface impaction – can perform submeniscal arthrotomy to visualize the surface

Isolated medial injuries – prevent late varus

Lobenhoffer approach – interval between hamstring and medial head of the gastroc

More complex injuries…bicondylar plateau

-Neurovacular checks are crucial

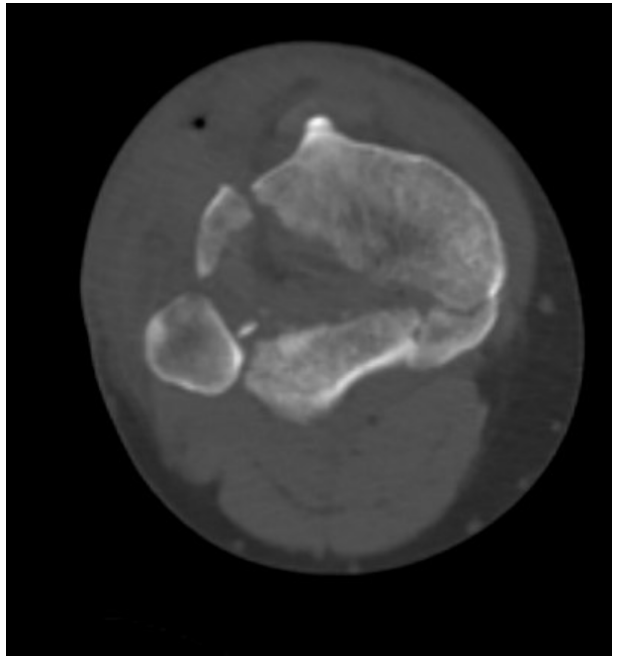
-Exam can evolve

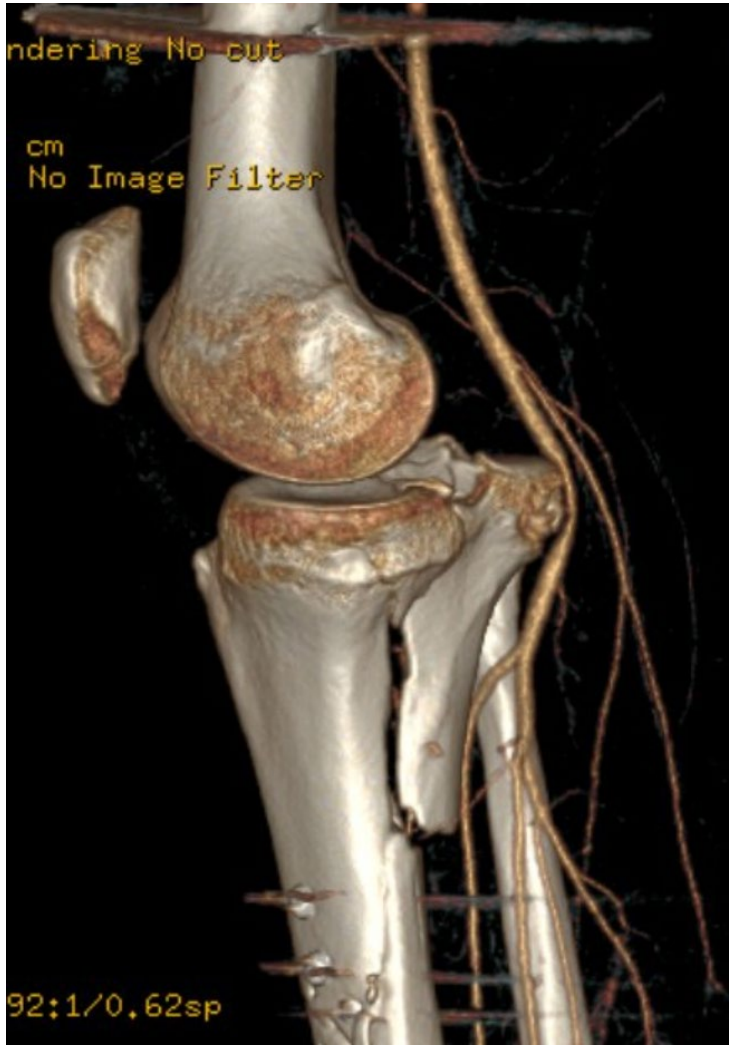
-applying external fixation can change the vascular exam

-restoring length can increase compartment pressure as well

Extensile posteromedial approach

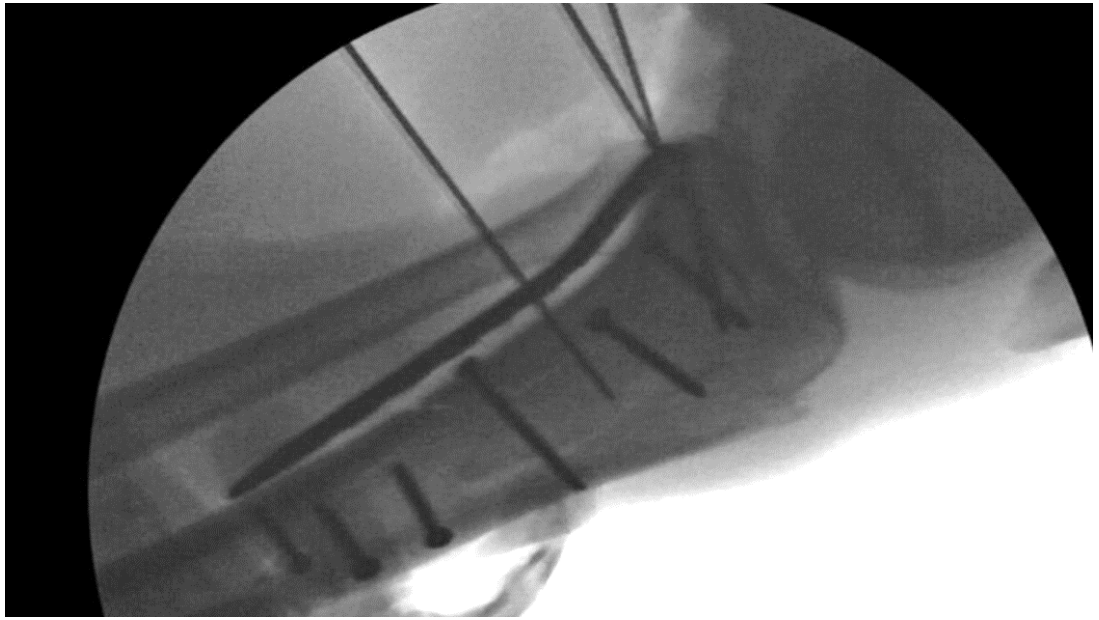
- Standard Lobenhoffer approach with an extended proximal limb
- Isolate the medial head of the gastroc at its femoral insertion
- Release the medial head
- Provides access to a portion of the posterolateral plateau as well

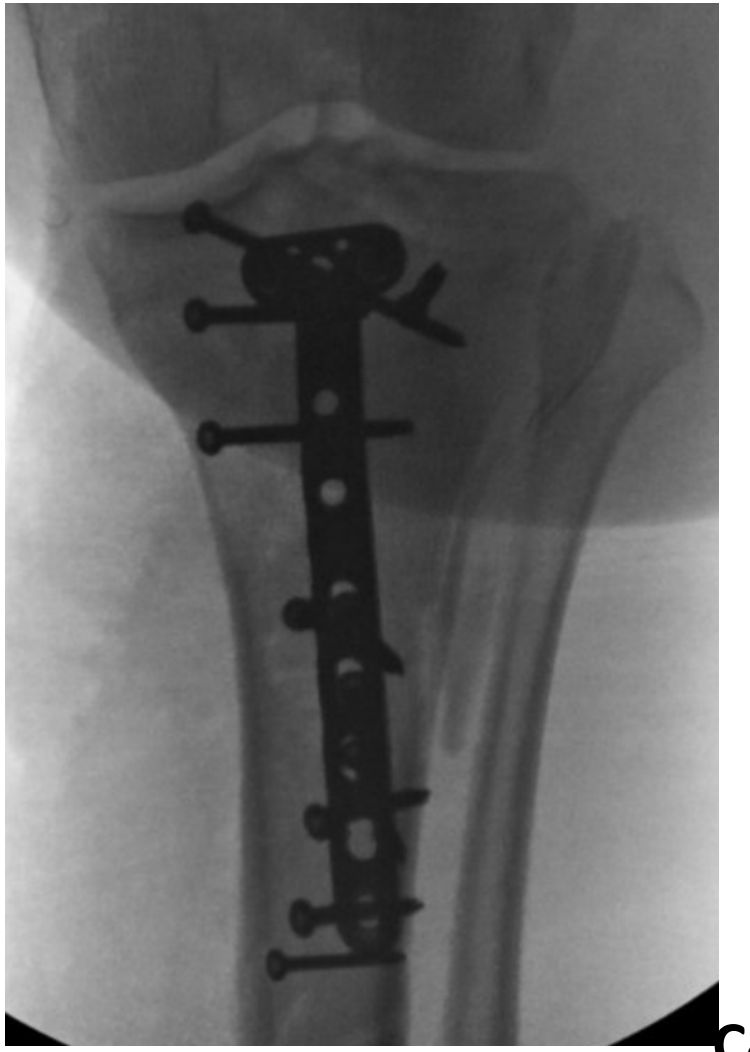




Orapiriyakul W, Apivatthakakul T, Phornphutkul C. Posterolateral tibial plateau fractures, how to buttress? Reversed L posteromedial or the posterolateral approach: a comparative cadaveric study. Arch Orthop Trauma Surg. 2018 Apr;138(4):505-513. doi: 10.1007/s00402-018-2875-3. Epub 2018 Jan 19

Extensile posteromedial approach - prone





Second approach – anterolateral supine

Bicondylar plateau – medial decision making

- Medial side
  - ? Posterior shear = posterior buttress
  - ? Unstable medial column = direct medial plating
  - Axial CT scans helpful
  - Fixing from medial or lateral alone may entirely miss posteromedial fragments! Think three columms!
  - Buttress posterior fractures – at the apex!

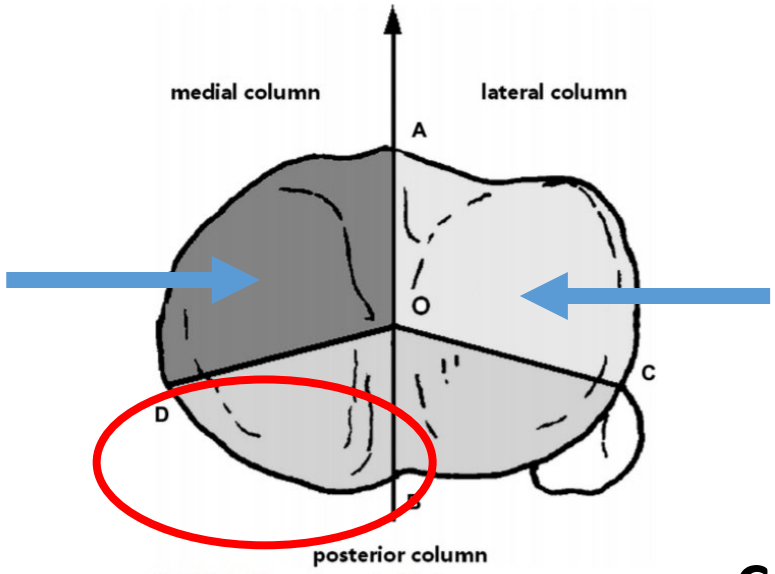
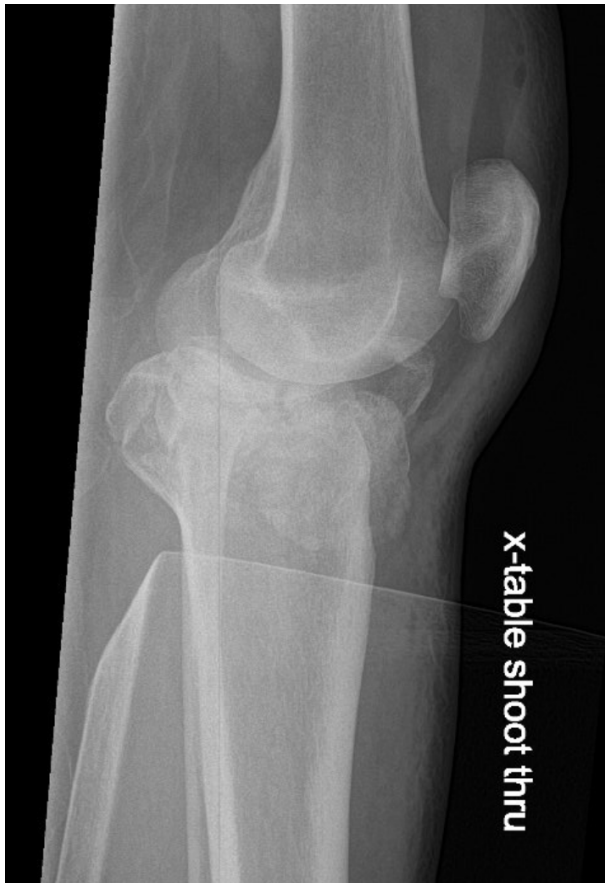
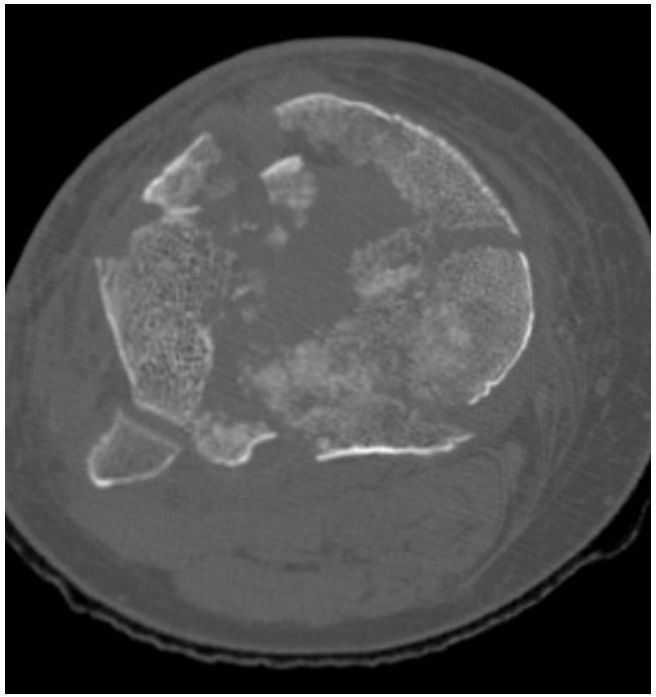


FIGURE 1. Three-column classification.

External fixation and 4 compartment fasciotomies required



Bicondylar plateau – medial decision making: CT scan after external fixation applied



Requires bicondylar plating – with direct medial plating, not posteromedial!

Medial side – limited proximal exposure and bridging distally

- Medial first
- Established length
- Anterolateral
- Clamp the two plates together

-Axial alignment

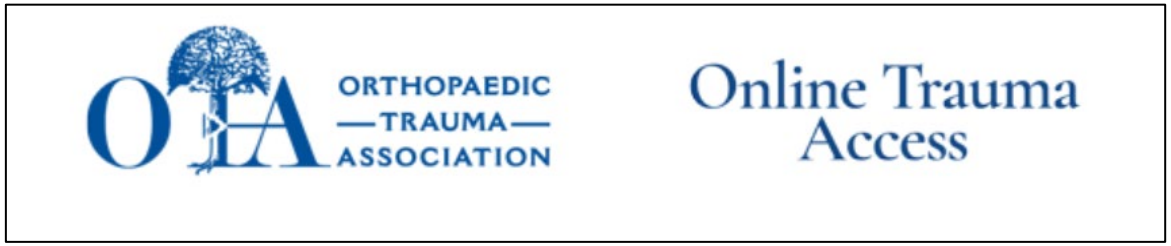
-condylar width

-joint congruity

Bridge plating techniques

- It the fracture a plateau, that extends into the shaft – or is it a shaft that happens to extend into the plateau?
- Simple fracture lines call for anatomic reduction
- Percutaneous bridge plating used for more comminuted diaphyseal fractures with proximal extension
- Can the joint be reduced without a direct approach?
- Is an IM nail in conjunction with plating beneficial?

Click below for video link

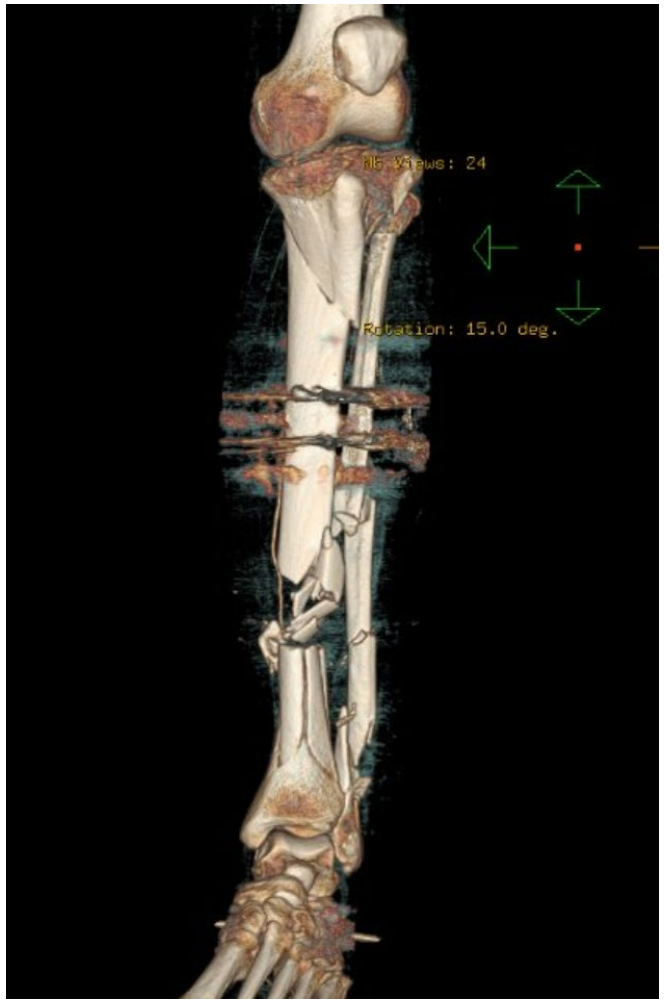


Bridge Plating of Proximal Tibia Metaphyseal Fracture by Limited Open Technique

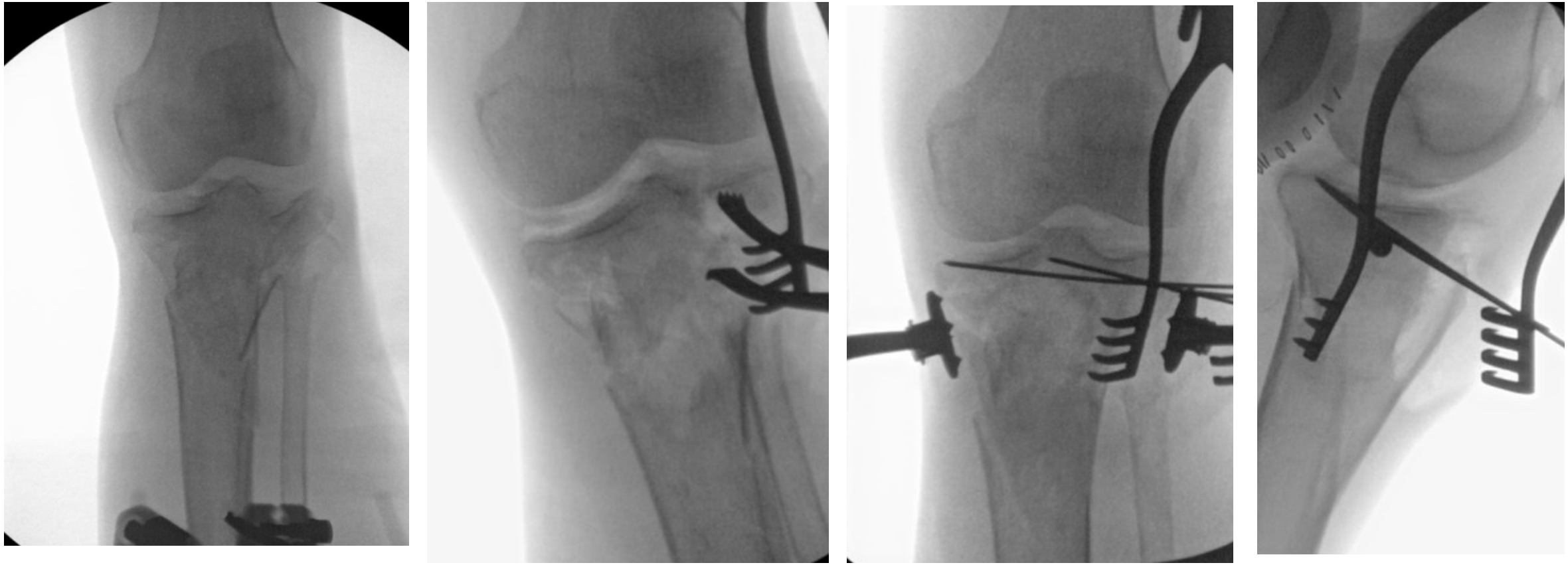
Michael Gardner, Benjamin Pulley

Associated shaft and plateau – combining techniques

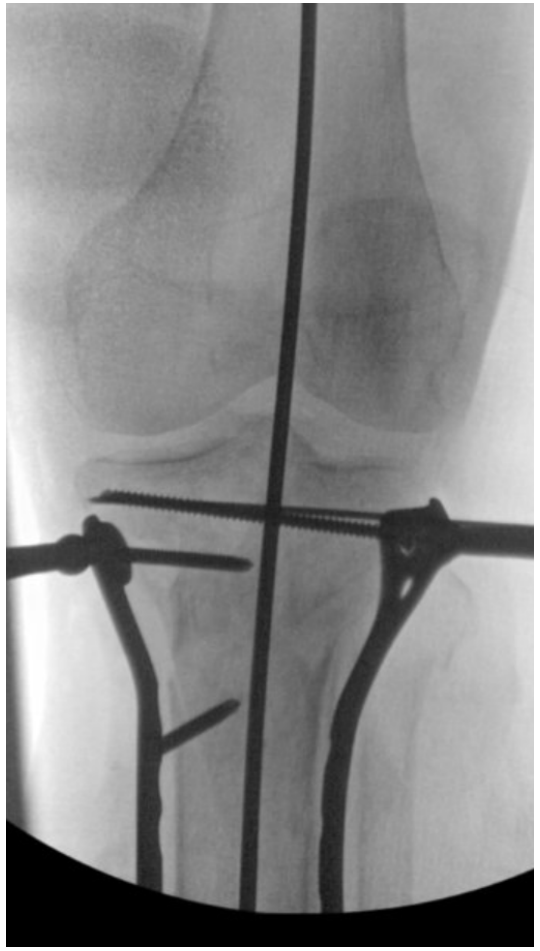
- Presents in extremis
- Bilateral open tibias
- Associated bicondylar plateau on the left
- Emergent ex fix and VAC
- Returns for fixation HD 2 in anticipation of free flap HD 3

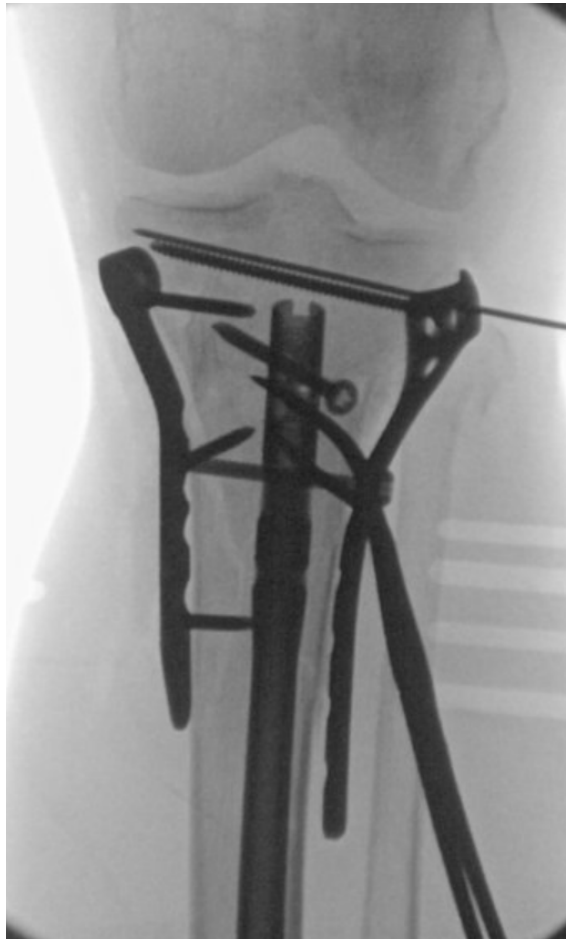


Limited anterolateral approach, percutaneous medial fixation, suprpatellar nailing



Limited plating, nail inserted, screws added



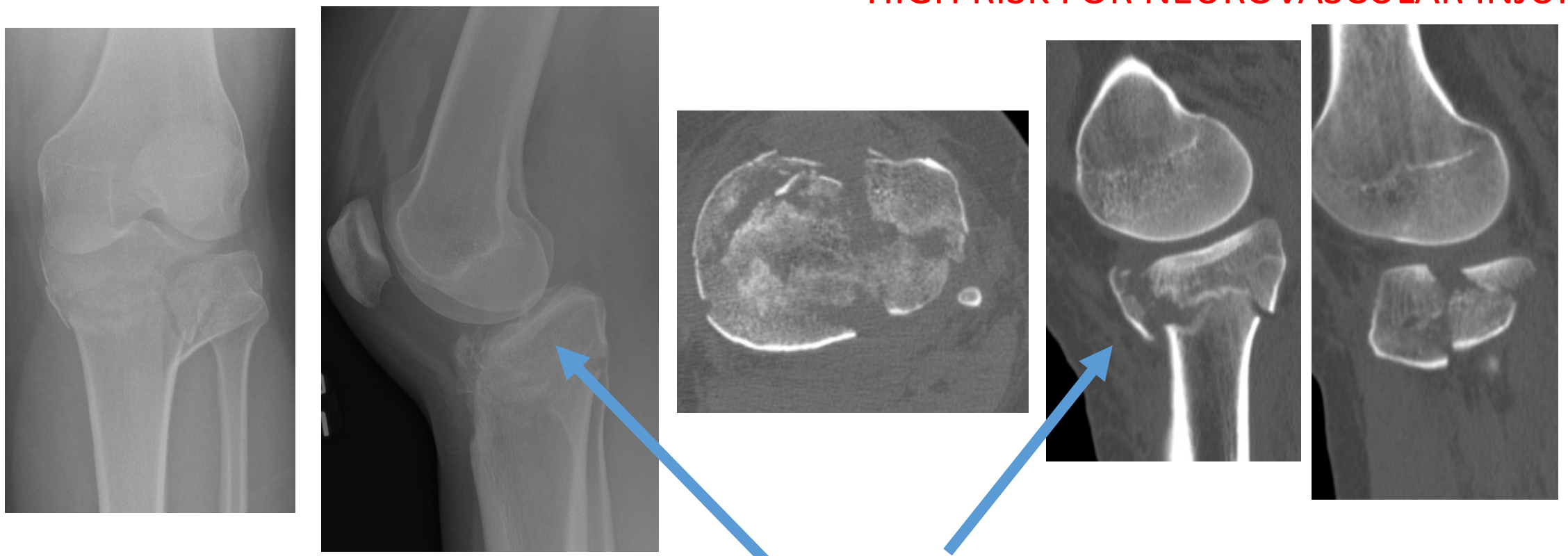


3 year f/u

*cement retained in diaphyseal fracture, shaft treated with posterolateral bone grafting

Bicondylar plateau – hyperextension mechanism from trampoline

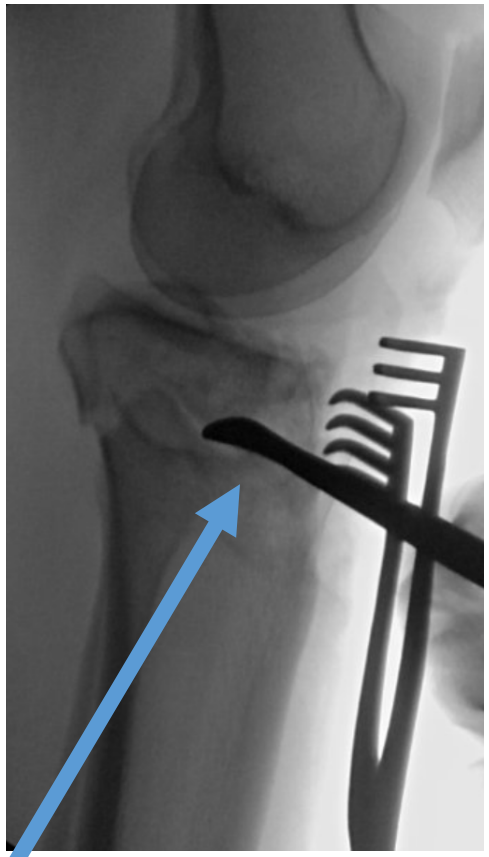
HIGH RISK FOR NEUROVASCULAR INJURY!



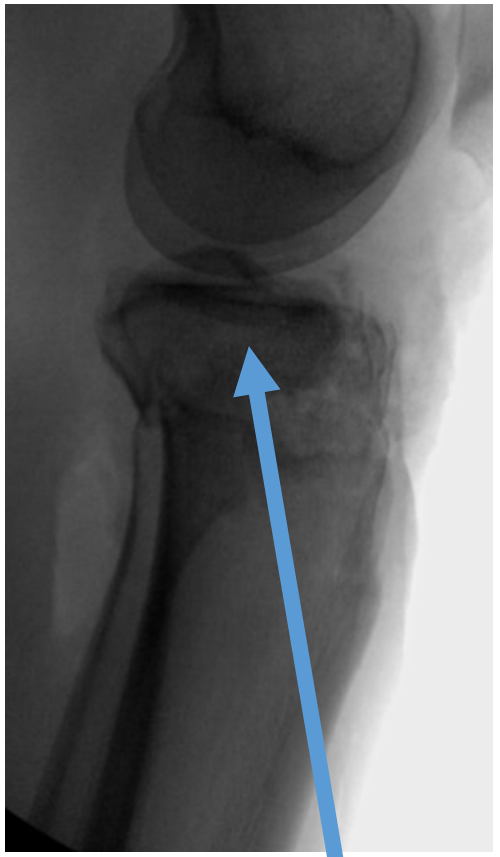
Hyperextension causes anterior slope

Plan for bicondylar plating, direct medial

- External fixator applied
- “Travelling traction”
- Anterolateral approach
  - Medial extension deformity corrected with elevator from the anterolateral side
  - Second posteromedial approach allows for correction of the posterior translation of the plateau
  - Dual plating lateral and medial



Elevate slope!



Final correction

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- Discuss rehabilitation, complications, and outcomes

Rehabilitation

- Post op protocols:
  - Can vary by fracture severity
  - Goal of surgery – allow for complete ROM immediately postop
  - Unlocked hinged knee brace commonly used
  - Consider appropriate DVT prophylaxis
  - Touch down WB 8 weeks
  - Advance after 8 weeks depending on severity
  - Quad sets, isometrics important

Complications

- Pre or postop compartment syndrome (increases with complexity of injury)
- Can release anterior compartment easily from anterolateral approach
- Infections more common after compartment release
- Medial plating prevents late varus collapse
- Residual valgus common with isolated lateral injuries

Tibial Plateau Fractures: Common Adverse Outcomes and Complications

- Loss of reduction
- Wound breakdown and infection
- Septic arthritis after external fixation
- Knee stiffness
- Prominent or painful hardware
- Nonunion or delayed union
- Posttraumatic arthritis

Rockwood and Green, 9th edition

Conclusions

- Systematic approach to initial presentation
  - Evaluate neurovascular exam
  - Consider compartment syndrome
  - Evaluate in light of age and mechanism
- Operative goals
  - Axial alignment, condylar width, joint congruity
- Key Steps
  - Plan the approach, reduce the articular block, fill voids as necessary, re-establish length and alignment
  - Medial fixation: Direct medial or posteromedial buttress?
  - Bicondylar fixation: Bridge plating helpful for comminuted metaphyseal or diaphyseal extension injuries