Tibial Plateau Fractures

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Disclosure

• Clinical images provided by the author.
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.
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 Prophylaxis

• 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

Rockwood and Green, 9th edition
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
Schitzker 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*

OTA Classification

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

### OTA/AO Classification of Tibial Plateau Fractures

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

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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
  • Fluoroscopic; 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

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

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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
Goals of Surgical Fixation – plateau fractures

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

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
  - Fluoroscopic 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

- Neurovascular 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

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 columns!
  • Buttress posterior fractures – at the apex!
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

• If 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, suprapatellar 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

Hyperextension causes anterior slope

HIGH RISK FOR NEUROVASCULAR INJURY!
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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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