Fixation Philosophy in Tibial Plateau Fractures

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Disclosures

• I have no industry relationships or stock holdings that would bias my presentation related to the subject matter of this presentation.
• Any medical devices or implants shown are for illustrative purposes only and their depiction should not be construed as a product endorsement.

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Where does Bruce get the topics?

Gestalt of intuition to process...

Overview

• The basics
• The Literature
• By fracture pattern
• The “Gestalt” becomes “Process”
Biomechanics of Plating

Plate functions

- Compression
- Neutralization/Protection
- Buttress/Antiglide
- Bridge
- Tension band

Function is dependent on technique of application. Any plate can serve any function.

Compression Plating

- Hallmark of absolute stability
- Compression of fracture through application of the plate
  - Requires anatomic reduction
  - Results in primary bone healing
    - Little/no fracture callus
    - Haversian remodeling

Neutralization plating

- Resists torsion, bending and shear forces on interfragmentary lag screw(s)
  - “protects” the lag screws
  - Primary bone healing
Buttress plating
- Resists shear forces
- “lifts” or “pushes” the fragments

Special buttress plates
- Antiglide plate
  - Prevents axial and rotational displacement of the fracture fragment
  - Requires simple oblique or spiral fracture
- Raft construct
  - Array of subchondral screws
  - Prevent subsidence of depressed subchondral bone
  - Through or outside of plate

Bridge plating
- Restore length
- Restore angular alignment
- Restore rotational alignment
- Respect fragment biology
- Relative stability
Tension band plating

- Placed on the tension side of an eccentrically loaded bone
- Converts distraction forces into compressive force
- Opposite cortex must be intact

Evolution of plate design

Conventional plate fixation

Stability provided by friction of plate against bone
Locking plate function

Provides stability without plate-bone friction

Basic Summary

- Plate name ≠ plate function
- Any plate can be used in many ways
- Plate function is dependent upon:
  - design
  - method of application
  - Biomechanics at fracture site
- Conventional screws generate friction between plate and bone; locked screws provide stability without plate-bone friction

The Literature

“just the facts Ma’am…”
Literature: Depressed plateau

- Cross, W.W., et al
- Injury 44, #6, 2013
- Lab study: Cadaver tibia (mean age 74)
- 3 raft screw constructs
- Screws through plate improved stability vs screws outside the plate
- No advantage to locking vs non locking construct

Literature: S II Split depression

- Abghari, M., et al
- J. Knee Surg, 2015
- Non-rand. consecutive case series 77 fx
- Unilateral locking vs non locking
- Mean F/U 18.5 mos.
- “... no evidence to support routine use of locked plating for simple split depression fx lat tibial plateau...”

Literature: Medial Posteromedial

- Ehlinger, M., et al
- Orthop. & Traumatol. Surg. & Res. 98, 201
- Case series 20 fractures (13 follow up 30 mos.)
- Single lateral locking plate
- 1 early return to surgery
- 5 had step off > 2mm
Literature: Bicondylar

- Gosling, T., et al
- CORR 439, 2005
- Case series (Level IV) 69 bicondylar
- Lateral LISS plate alone
- 15 Malreduction
- 1 Non-union
- 9 substantial loss reduction
- “... a good alternative...” (36% failure rate)

Literature: Bicondylar

- Zhang, Y., et al
- Orthopaedics 35, 2012
- Retrospective case series 79 pts. / 24 mo. F/U
- Double buttress or locking and buttress
- Dual incision
- 7 secondary loss of reduction
- 3 secondary loss of alignment
- No significant difference between 2 groups

Literature: Bicondylar

- Neogi, D., et al
- Indian J. Orthop. 49(2), 2015
- Prospective case series 61 fx
- Single lateral locked vs dual plating
- Significantly increased malalignment in single plating group
- More soft tissue issues with double plating
Literature: Bicondylar

- Ozkaya, U., et al
- Injury, Intl. J. Care Injured 405, 2015
- Retrospective case series 22 consecutive fx
- MIPO dual plating
- Mean F/U 26 mo
- No secondary loss reduction
- No secondary loss alignment

Literature: Bicondylar

- Lee, M-H., et al
- J. Orthop Surg. & Res. 6, #62, 2014
- Retrospective case series 76 SV & SVI
- Unilateral locking vs dual plating
- 45 fx F/U
- No difference groups
- If medial bony buttress cannot be established closed; open reduction and plating is indicated

Literature: Bicondylar

- Higgins, T. F., et al
- JOT 21, #5, 2007
- Lab study: 10 matched pairs Cadaveric tibia
- Lateral only locking vs bilateral non locking
- Less subsidence with dual plate construct
Literature: Bicondylar

- Yoo, B.J., et al
- J. Trauma, Inj., Inf., & Crit. Care 69, #1, 2019
- Lab study: 30 composite tibias / 6 constructs
- Bicondylar fx with posteromedial fragment
- Dual plating yielded higher load to failure than lateral locking plate alone
- This occurred because of poor penetration posteromedial fragment by lateral screws

Literature: Does size matter?

- Hubbard et al.
- A J Ortho, 1999
  *No significant difference* between small vs large fragment fixation strengths
- Karunaker et al.
- J Ortho Trauma 2002
  *No significant difference* in stiffness between: large fragment; periarticular small fragment plate; 3.5 mm subchondral screws with separate 1/3 semitubular anti-glide plate
  *local depression stiffness > with 3.5 mm vs 6.5 mm screws*

Literature: Type void filler

- Russell, T.A., et al
- JBJS 90A, 2008
- Multicenter prospective randomized trial
- *Alloplastic graft materials shown SUPERIOR to Autograft / DBM*
Literature: Review Article

• Musahl, V., et al
• JBJS 91-B, #4, 2009
  – Non locking plates: simple fracture pattern / minimal comminution / non osteoporotic
  – 2-3 lag screws: Non comminuted single split lateral plateau
  – Buttress or antiglide: Comminuted base / osteoporotic
  – Split depressed lat. plateau: Buttress / periarticular raft
  – Medial or posteromedial: Buttress
  – Locking: High energy / metadiaphyseal extension / Osteoporotic

By fracture pattern

SCHATZKER I

• PERCUTANEOUS VS OPEN REDUCTION
• PARTIALLY THREADED SCREWS VS BUTTRESS PLATE
  – COMMINUTION AT BASE OF CONDYLAR FRAGMENT
SCHATZKER II

- Articular/Condylar Fragment Commination
- Metaphyseal Void Following Articular Elevation
- CT Determination of Impaction Location

SCHATZKER II

- Meniscal Entrapment - Repair ...MRI?
- Restore Width, Joint, Fill Void ...ABG vs BGS
- Pre-Contoured Plates - Raft Plates
SCHATZKER III

- ISOLATED ARTICULAR LESION
- METAPHYSEAL VOID
- CT LOCALIZATION IMPORTANT WHEN CONSIDERING "SCOPE" OR PERCUTANEOUS APPROACH
- MUST HAVE AN INTACT RIM TO AVOID "ARTHROSCOPIC FAILURE"
ASSESS MENISCUS AS WELL AS LATERAL CTX "RIM FX"

NEVER UNDERESTIMATE MAGNITUDE OF THIS INJURY
NEVER "JUST A MEDIAL CONDYLE FX"
Knee Dislocation??
NEVER JUST "LAG SCREW" FIXATION

SCHATZKER IV
SCHATZKER V

- Extent of Immediate Rx is Soft Tissue Dependant
- Dual Incision Approach with Medial Anti-Glide
- Restore joint
- Lateral Butress Plate
- Periarticular Locking Plate?
- Hybrid Ex Fix??

S VI: Diaphyseal Dissociation

- Can you stabilize a bicondylar plateau with one plate?
  - Cortical contact medially
  - Absence of comminution/osteoporosis
  - Sagittal, not coronal fracture line medial
  - Adequate screw penetration far fragment
Posterior Medial Fracture

Sagittal Fracture Line

Coronal Fracture Line
In General: A posterior medial fragment equals a posterior medial plate.

In Summary

First: Understand the injury

XRAY  CT (in external fixator)  MRI (in external fixator)
“Fragment” concept

It’s more than this....

Remember the soft tissue component

- Presence & severity of articular injury
- Presence & severity of metaphyseal injury

- Complex
  - Usually high-energy
  - Substantial soft tissue injury
  - Substantial metaphyseal injury
  - Metaphysis
  - Articular surfaces
  - Tubercle
  - Low-energy
  - Poor bone quality

- MRI study of 105 operative plateau’s
  - Only 1 patient had NO soft tissue injury
  - Cruciate or collateral lig injury – 77%
  - Lateral meniscus injury - 90%
  - Medial meniscus injury - 45%
  - Posterior-lateral corner injury – 70%
  - Medial meniscus in medial plateau – 86%
Surgical tactic: Fragment specific...

1. Obtain Articular Reduction
2. Reduce Condylar Width
3. Restore Axial Alignment
4. Fragment specific fixation
   - Buttress articular fragments
   - Neutralize meta-diaphyseal fragments
   - Secure tibial tubercle

Medial/Lateral Plates
Lateral Fixed Angle Plate

CRASH!

Buttress medial fragments

Central Fix - Medial Fragment
Separate Epiphysis Medial Plateau
Coronal Fx
Posteromedial Fragment
Buttress medial fragments
Neutralize meta-diaphyseal fragments
Lateral locking only?
Plate applied at a mechanically-disadvantaged location
Lateral locking only?

• Medial side critical for stability
• Anterolateral locking plates miss

Plate applied at a mechanically-disadvantaged location

Bicondylar - Lateral locking only? (The exception, not the rule)

• Minimal medial articular involvement
• Minimal metaphyseal comminution
• Risk of late varus

Take home points...

➢ Outcomes more dependent on axial alignment and stability than joint reduction.
➢ Fragment specific reduction
➢ Don’t miss the postero-medial fragment (stability)
➢ Lateral locking plate alone is the exception.
➢ Differentiate the “fracture/dislocation”.

• Minimal medial articular involvement
• Minimal metaphyseal comminution
• Risk of late varus