Biomechanics of Plate Fixation

Resident Comprehensive Fracture Course

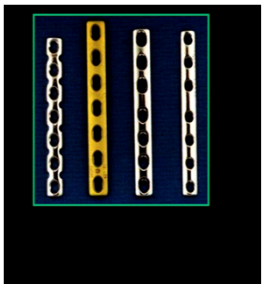
Introduction

- Thanks to Bob Probe, MD for contributing slides/case examples

Introduction

- Biomechanics of plates
- Plate Types
  - Compression
  - Buttress/Antiglide
  - Bridge
  - Tension Band
  - Locking
  - Internal Fixator
  - Neutralization

  Lag screws
- Case Examples



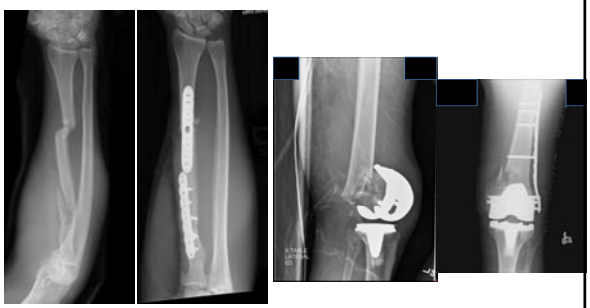
Biomechanics

- Plate is on outside of bone
- Materials
  - Ti
    - Closer Modulus of Elasticity to bone
    - Weaker in Shear(screw heads)
    - Cold Welding
  - Stainless
    - Stiffer
- Load Bearing(usually)
- Stability
  - Absolute vs relative

Stress Concentration

- Perren's strain theory
  - Stress concentration at fracture site can be minimized by compressing fracture

    • OR
- For comminuted segments, spreading force out over long plate



Stress Concentration

- DO NOT
  - Use bridge plating techniques for simple fracture patterns
    - Stress will be concentrated over small area and plate may fail
    - Example- bending tongue blade

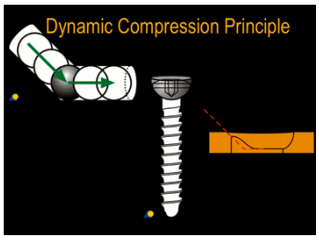
Types of Plates

- Dynamic Compression Plate

Absolute Stability

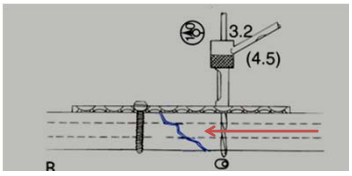
Can compress more then one hole

Good for transverse and short oblique fxs



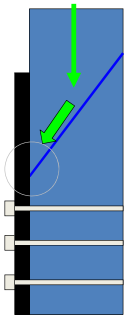
Compression plate

Offset drill guide

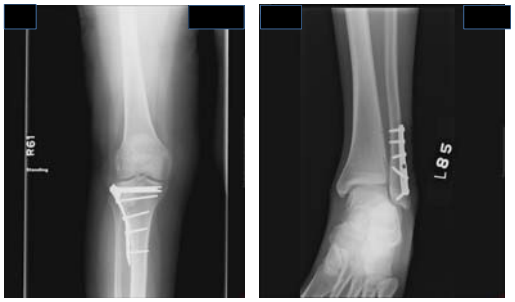


Buttress/Antiglide

- Plate is secured by three screws distal to the blue fracture line
- Axial loading causes proximal fragment to move distal and to the left along fracture line
- Plate buttresses the proximal fragment
  - Prevents it from "sliding"
- Buttress Plate
  - When applied to an intra-articular fractures
- Antiglide Plate
  - When applied to diaphyseal fractures

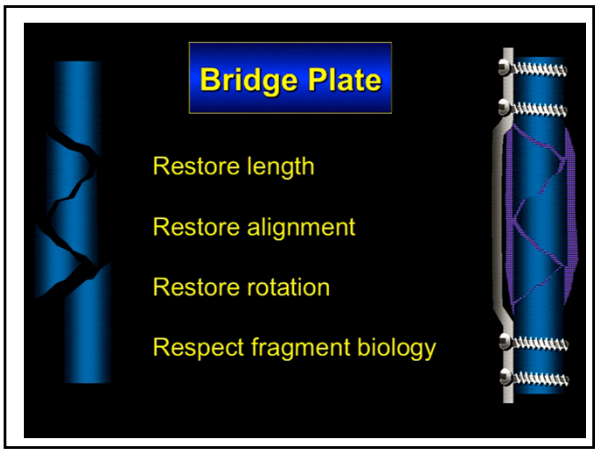


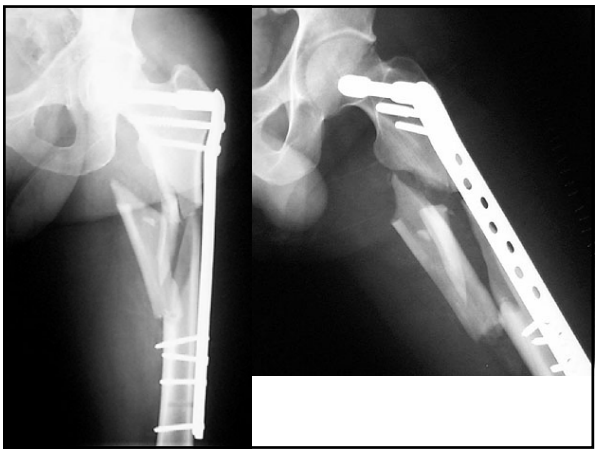
Buttress/Antiglide

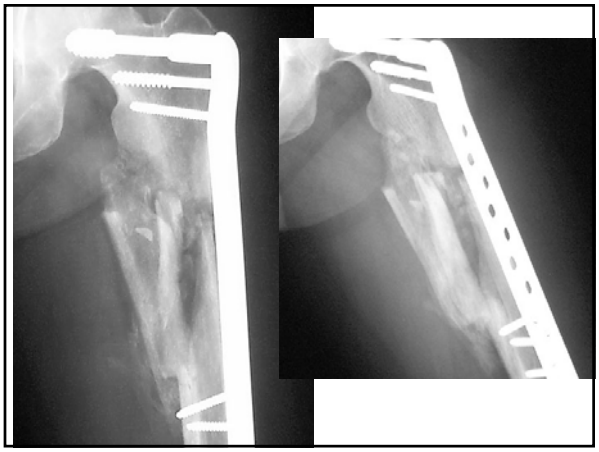


Bridge Plate

- Biologically friendly
- Avoids dissection in comminution
- "Relative Stability"



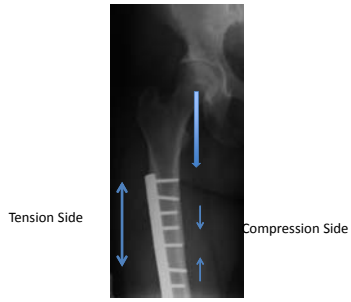




Tension Band

- Plate placement allows conversion of tension forces to compression
- Femur
- Patella

Tension Band



Tension Band

Straight Plate and Straight Bone
Compression will cause gapping on Far Side

Solution is to bend Plate (slightly)
Insert Screws from near to far

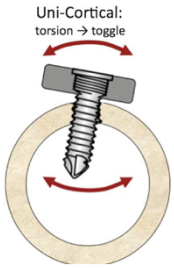
Ex- Femur/Humerus
Radius/Ulna

Locking Plates

- Does not rely on friction b/w plate and bone
- By threading screw head into plate-create multiple, mini fixed angle constructs.
- Very Stiff
- No significant advantage in non-osteopenic diaphyseal bone.
- Screws are expensive

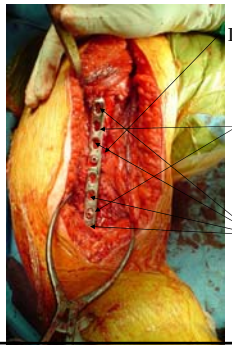
Locking Plates

- 1st generation were considered internal fixators
- Used unicortical screws
- Plate/bone mismatch



Diaphyseal Indications

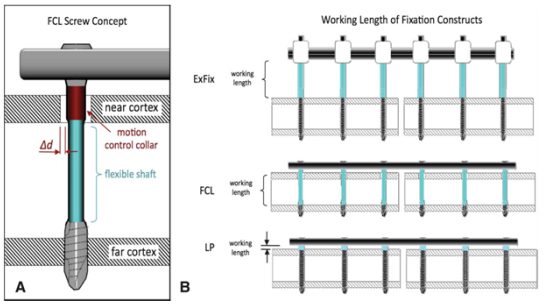
- Osteopenia
- Periosteal Preservation
- Percutaneous Application



Far Cortical Locking

- May overcome some of the inherent stiffness problems of bicortical locked screws.
- Allows some motion via interfragmentary strain at plate bone interface
- Respects concepts of relative stability

Far Cortical Locking



Bottlang, J Ortho Trauma 2011

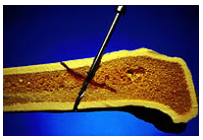
Neutralization plate

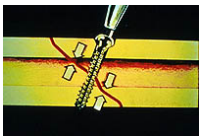
- Placed to support lag screw
- Helps resist torsion/shear/bending
- Serves as "splint" for lag screw
- Lag screw can be placed through plate to avoid additional stripping
- Ex- oblique fxs- Forearm/fibula

- Order of fixation?

Lag Screw Fixation

- Screw compresses both sides of fx together
- Proximal (gliding)hole is diameter of threads
- Distal hole is diameter of shank
  - Best form of compression
  - Poor shear, bending, and rotational force resistance
  - Lag by technique or design





Sequence of Lag Screw: Before or after plate?

- Does not matter
- As long as fundamentals are followed
- Lag through plate when possible

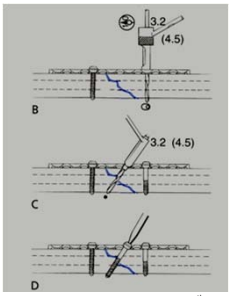


Figure from: Rockwood and Green's, 5th ed.

Summary

- Reviewed plate biomechanics
- Reviewed materials
- Reviewed plate types
- Lag screws

Case Examples

54 yo male- pedestrian struck by auto
Also has left femur shaft fx

Case Examples

- Options?
  - Op vs Non Op?
  - Goals?
  - Other circumstances?

Case Examples

10 mos post injury

How do you decide?

- Simple pattern
  - Transverse
  - Short Oblique
  - Absolute stability
  - Lag screw if possible

Case Example
50 yo Male- MCC

Case Example

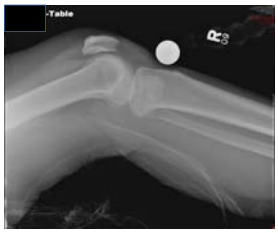
- Options?
  - Location
  - Bone Quality
  - Limitations
  - Goals
  - Special Circumstances

Case Example

How do you decide?

- Comminuted pattern
- Bridge

Case Example
50 yo female- fall off horse

Case Example

- Options
  - Location
  - Bone Quality
  - Goals

Case Example


How do you decide?

- Peri-articular depressed fragment
- Articular shear/split
- Buttress

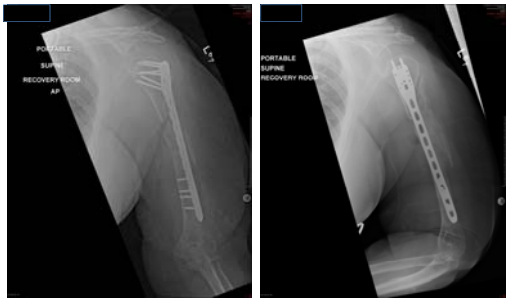
Case Example
76 yo F 9 mos s/p fall


Case Example

- Options

  Location
  Bone Quality
  Defect
  Special Circumstances

Case Example

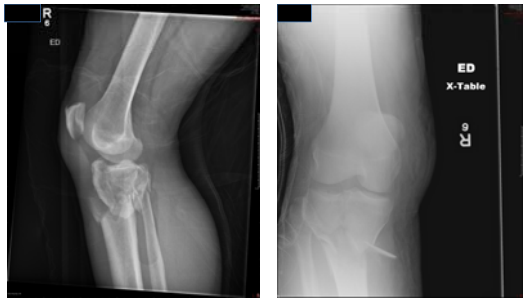


How Do You Decide

- Osteopenia
- Non-Union
  - Type?
  - Weaker bone
  - ?longer healing time
  - ?Locking plate/screws

Case example
3 mos post op

Case Example
42 yo M MCC

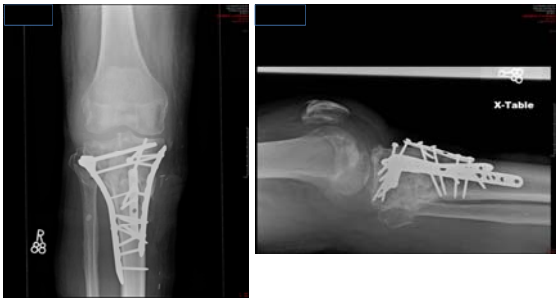


Case Example
After Ex Fix applied/Fasciotomies

Case Example

- Options
  - Periarticular- Yes
  - Diaphyseal- Yes
  - Comminuted- Yes
  - Tibial Tubercle as separate Fragment- Yes
  - Osteopenic- No

Case Example
Combined Techniques



Questions?