Introduction

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

Biomechanics of Plate Fixation

Resident Comprehensive Fracture Course

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**
  
  ![Dynamic Compression Principle](image)
  
  Absolute Stability
  Can compress more than one hole
  Good for transverse and short oblique fx

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”
Bridge Plate

- Restore length
- Restore alignment
- Restore rotation
- Respect fragment biology

Tension Band

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

Tension Band

Tension Side
Compresson Side
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
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 fx- Forearm/fibula

Order of fixation?

Sequence of Lag Screw: Before or after plate?

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

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
How do you decide?

- Comminuted pattern
- Bridge

Case Example

50 yo female - fall off horse

Case Example

- Options
  - Location
  - Bone Quality
  - Goals

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

How Do You Decide

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

Case Example
Case Example

3 mos post op

Case Example
Case Example

42 yo M MCC
After Ex Fix applied/Fasciotomies
Case Example

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

Questions?