Locked plate fixation —
Principle and applications

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Stability

Stability of fixation is crucial for both anatomical and biological fixation

Stability affords early motion to maintain articular surfaces and soft tissues
Absolute Stability

- Strain at fracture site must be less than 2% for lamellar bone, 10% for woven bone

- Example compression plating

- Lead to primary bone healing
Relative Stability

- Based on controlled motion
- More physiological; leads to callus formation
- Example buttress plating, IM nailing
Anatomic vs. Biologic Fixation

- **Anatomic fixation**-
  - Plate maintains the reduction with no motion
  - Primary healing (endosteal healing)
  - Cutting cones, creeping substitution
  - No callus

- **Biologic fixation**-
  - Plate bridges the fracture site and allows controlled motion
  - Secondary healing
  - Hematoma, inflammation, fibrous tissue, remodelling and differentiation of mesenchymal stem cells to form new bone
  - Callus
Achieving Stability: Overcoming the Forces at the Plate Bone Interface

1. Axial Load
2. Bending Load
3. Torsion

Axial stress (tension and compression)
Shear stress at plate bone interface
Conventional Plate Biomechanics

Stability by plate $\leftrightarrow$ bone friction
Stability by plate $\Leftrightarrow$ bone friction
Periosteal Necrosis

- Plate/bone interface creates “compartment” under the plate
- Periosteal necrosis
- LC-DCP plates only reduce contact by 50%
  - Remember that plate/bone interface crucial for stability
Conventional Plate

1. Screw bending
2. Movement of plate during axial loading
3. Leading to high stress and bone resorption
4. Causes screw to rotate about axis in distal cortex

Axial Load
Conventional Plate

Force applied: screw orients to force. As this occurs strength of fixation equals thread pullout strength of single screw at the distal or proximal end of the plate.
Conventional Plate

Note: screw plate angle change
Limits failure load to that to the strength of thread purchase
Limitations of Conventional Plates

- Failure in osteopenic bone
  - Geriatrics
- Periosteal avascularity
  - Tissue necrosis under plate
- Percutaneous plating
  - Plate elevated off of the bone. No friction between plate and bone
Locking plate - Internal Fixator

Locking head screw

Threaded plate hole
Internal Fixator
Theoretical Advantages

- No focal necrosis of bone and soft tissue deep to plate… improved local resistance to infection

- Avoids early temporary bone losses under plate induced by vascular damage

- Strength of fixation equals the sum of all the bolts (screws) ability to resist shear at the bolt-bone interface. Not that of a single screw’s thread purchase
Locking Plate

As Single Beam Construct
Screws Must Shear Through Bone Simultaneously

Plate does not have to contact bone

Axial Load
Locking Plate
Locking Plate

Bolt plate interface allows no motion

Fixation fails when bolts overcome bone’s resistance to shear forces. All bolts must fail as a single construct.
Screws with angular stability in different directions
Locking plate = internal, external

Fixator

Long Tube

Long Plate
Biomechanical principles similar to those of external fixators

Stress distribution
Biomechanical principles similar to those of external fixators

Stress concentration
Advantages of int. Fixators

1. Angular Stability of Screws
2. No accurate Plate Contouring required
3. Less Damage to Periosteum
4. Less Screw Loosening
1. Angular Stability of Screws
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LC-DCP

LIF
4. Less Screw Loosening

LC-DCP

LIF
Application
LCP
Locking Compression Plate
Compression Plate and Fixator
LCP
Locking Compression Plate
LCP
Locking Compression Plate

= DCP + Limited Contact + Locking Holes + Titanium

Some designed for specific sites.
LCP
Locking Compression Plate

- Both a “plate” and an “internal fixator”
- Incorporating features of LC-DCP (Limited Contact DCP)
- Used in MIPO, semi-open or open fixations
- Uses non-locking and/or locking head screws (LHS)
- No external “targetting” device
Locking Screws

Self Taping & Self Drilling

Self Taping
Metaphyseal plate
Pre-op planning

- XR
CT
Reduction

- Traction
- External fixation
Pre-contour of plate
Insertion of plate
Place another plate on the surface of skin can guide your percutaneous skin incision for the locking screws.
Pre-contoured Locking plate
LISS
Less Invasive Stabilisation System
LISS
Less Invasive Stabilisation System

- A special kind of LCP
- Out-rigger for insertion and targeting
- So far, only distal femur and proximal tibia
Aiming device with guide sleeve for self-drilling self-tapping screws (only in LISS)
Cooling required!
LISS - Reservations

- “Less Invasive” is surgeon / experience dependent
- Difficult to train / supervise
- Doubtful anatomical conformity –
  - E.g. “ante-curvature” and size of the femoral condyle
- Not forgiving
- Not adjustable / revisable once implanted
Precaution:
Important!

- If the first screw to be inserted is a Locking Head Screw, it is important to ensure that the plate shows good temporary fixation.
- Otherwise, the plate rotates simultaneously when locking the screw, and might cause soft-tissue injuries.
**Locking Head Screws**

- Must be placed in exact axial alignment with the hole on the plate
- Difficult to angle screws in plate to obtain osseous purchase
- Drill blocks for self-tapping screws (requiring pre-drill)
Should the plate lie too ventral or too dorsal, the screws will not be centred in the medullary canal. This position may compromise the screw purchase.
• Limited ability to compress fracture
• Can not use plate as a reduction aid
• Positioning and Compression Device (PCD)

LCP Distal Humerus Plates
Skin impingement
Removal of locking screw from the plate sometimes is difficult:
- need to prepare broken screw removal set
The End

Thank You