Basic Science Focus Forum: Optimal Locking Plate Configuration

DATE: Wednesday, October 17 **TIME: 9:43 - 9:51 am**

Title of Talk: Role of screw location, screw type and plate working length!

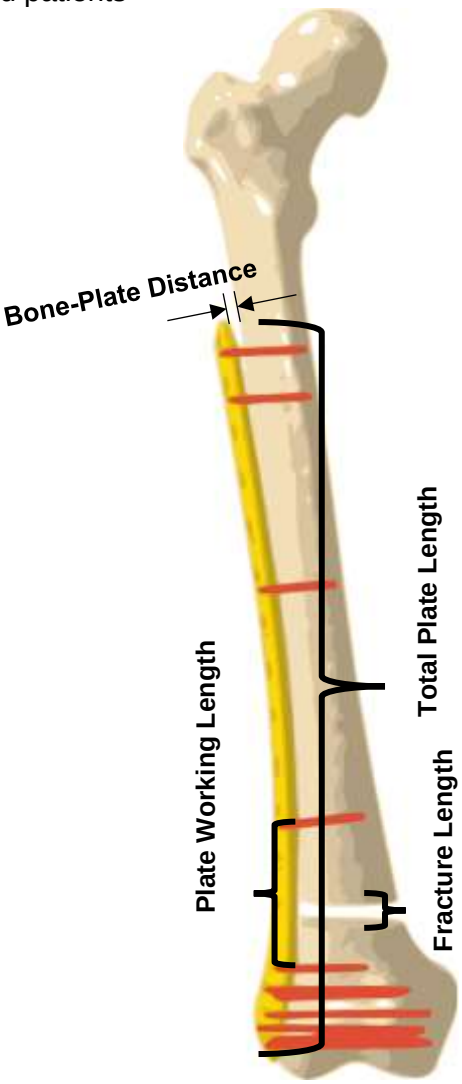
Background

- Traditional non-locking screws & plates remain gold standard for simple, diaphyseal fractures; however, in some patients, preserving biology is of utmost importance
- New findings unravelled the relevance of cell mechano-biological stimulation by controlling interfragmentary movements (IFM) in aged or otherwise compromised patients

Locking Plates

Conceptually, locking plates address compromised vascularity under a plate fixation by providing a Bone-Plate Distance > 0

- Beneficial in
  - Short Segment Fixations: Peri-Articular
  - Peri-Prosthetic Fractures
  - Osteoporotic Bone
  - Indirect Reduction
  - Minimally Invasive Plate Osteosynthesis (MIPO)
    - preserving soft tissue envelope
    - but still enabling fragment repositioning when necessary; or fracture gap bridging when anatomical reduction of all fragments is not possible in comminuted fractures
- Proper screw placements enable early adjusted **loading and load-sharing** = properly flexible, compliant fixation



TAKE HOME: Screw location in locking plate

- Sufficient plate length to allow empty screw holes in bone shaft (especially closer to fracture): reduces failure risk
- Plate Span Ratio: Total Plate Length / Fracture Length:
  - 2-3 times in large comminuted fractures, screws close to fracture!
  - > 8-10 times in short fractures, screws NOT too close to fracture! but 1-3 empty holes in bridging titanium plate are usually efficient
- Sufficient, but not excessive screw number
  - More than 3 or 4 bi-cortical screws in bone shaft segment do not add much to axial stiffness or torsional stiffness respectively
- Plate Screw Density: Number of Screws / Number of Holes
  - Value usually < 0.5 or 0.4 in bone shaft: less than half of diaphyseal holes filled tends to reduce failure risk

TAKE HOME: Screw types

- Careful with mono-cortical screws, failure in rotation possible
- Stiffness reduction effect of near-cortical over-drilling or slots, far cortical locking or dynamic locking screws strongly reduced in *physiological set-up* versus *lab experiments*
- Hybrid Constructs:
  - Avoiding mal-reduction of fracture: **Lag Before Locking**
  - Locked screws may protect adjacent non-locking screws from loosening
  - Plate Independent Lag Screws (PILS) can help in fracture reduction and can be used with locking plate as a neutralization plate

TAKE HOME: Plate working length (PWL)

- With comminution or a gap: **PWL is the MAIN regulator of stiffness!**
  - axial and shear stiffness are coupled with locking plate, high PWL may lead to high shear!
  - Interfragmentary movements have different qualities (in-fracture-plane, out-of-fracture-plane: depending on fracture geometry): too flexible fixation causing shearing-off may also induce higher non-union rates
- Without a gap (graft, scaffold, closing gap under load, tissue-bridged gap during healing): importance of fixation stiffness diminishes