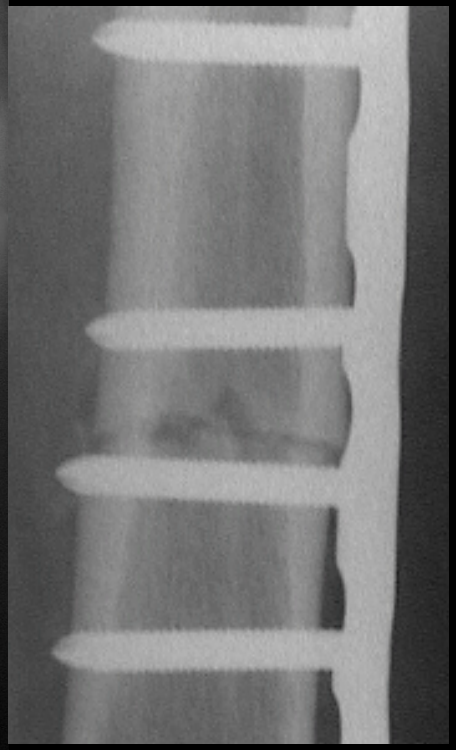
PLEASE CLICK ON THE FOLLOWING LINK TO WATCH THE LECTURE ONLINE:-

https://www.youtube.com/live/FDmYlzTyxY8?si=jCoMRDSULelsZf80

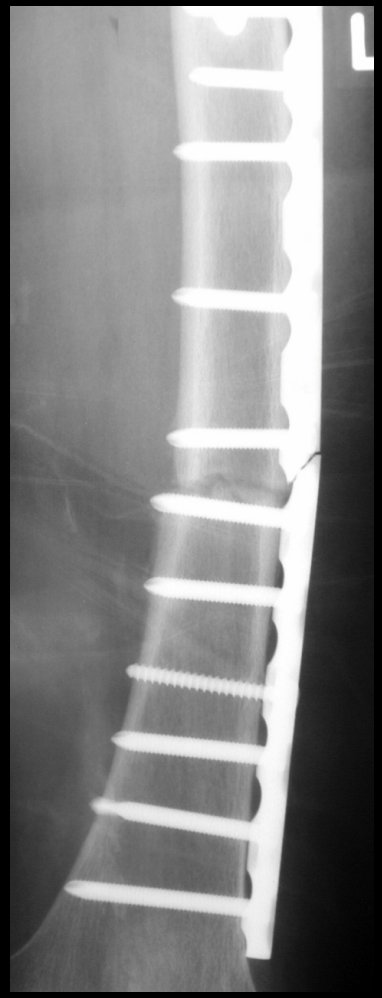
Principles of locking plate

Faleh Al-abbadi
Orthopedic and trauma specialist

Post-op.



7th w



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22y, polytrauma

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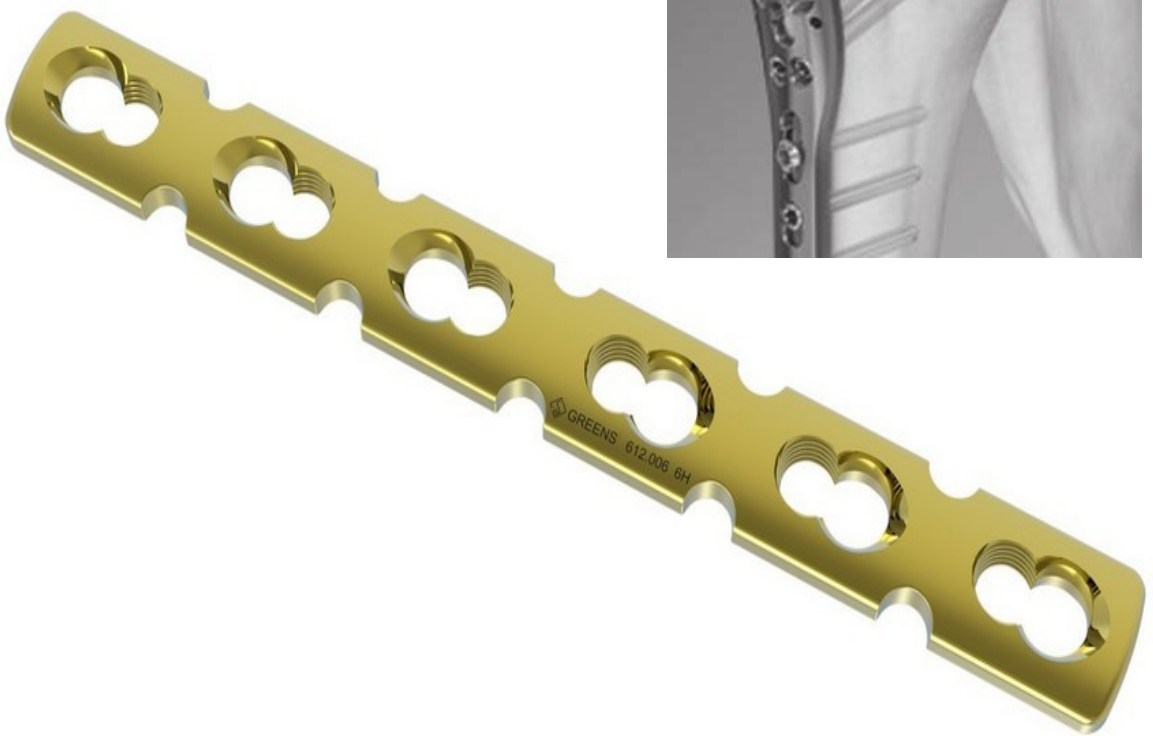
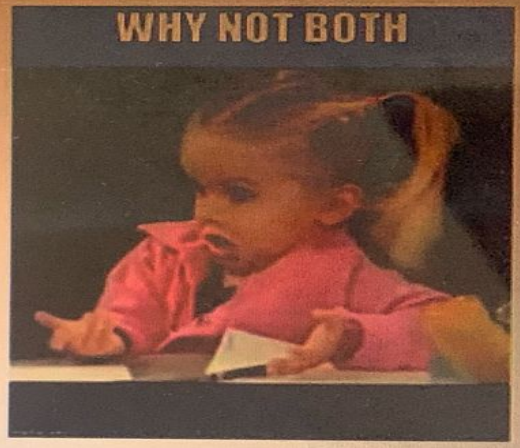
Learning objectives

- Describe the design difference between locking and conventional plates.
- List clinical indications
- Identify surgical tips
- Recognize how to optimize the stability /prevent failures
- Outline causes of failure



Combi Holes Plate



Maintains options intra-operative

Less plates required on shelf

Types of Locking Plates

- Fixed Angle - Monoaxial :

The screw can be locked to the plate only in one designed direction (guides threading into the hole is necessary for drilling)

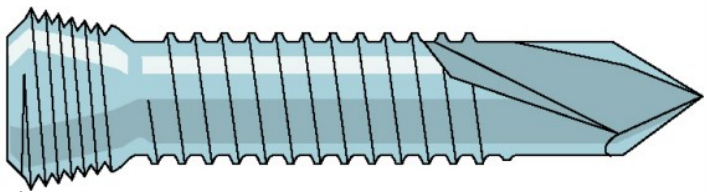
- Variable Angle - Polyaxial :

The screw can be locked within 10 ° -15° cone

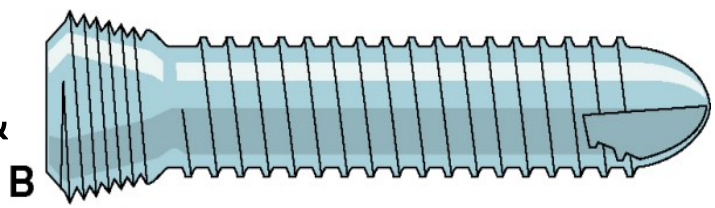
Types of LHS

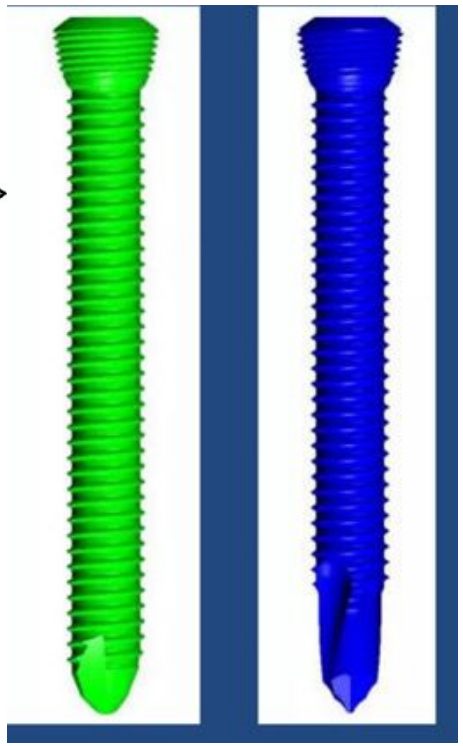
- 2 types of LHS are available:

A. Self-tapping self drilling screw (monocortical use only)



B. Self-tapping screw (mono- & bicortical use)
   Predrilling required



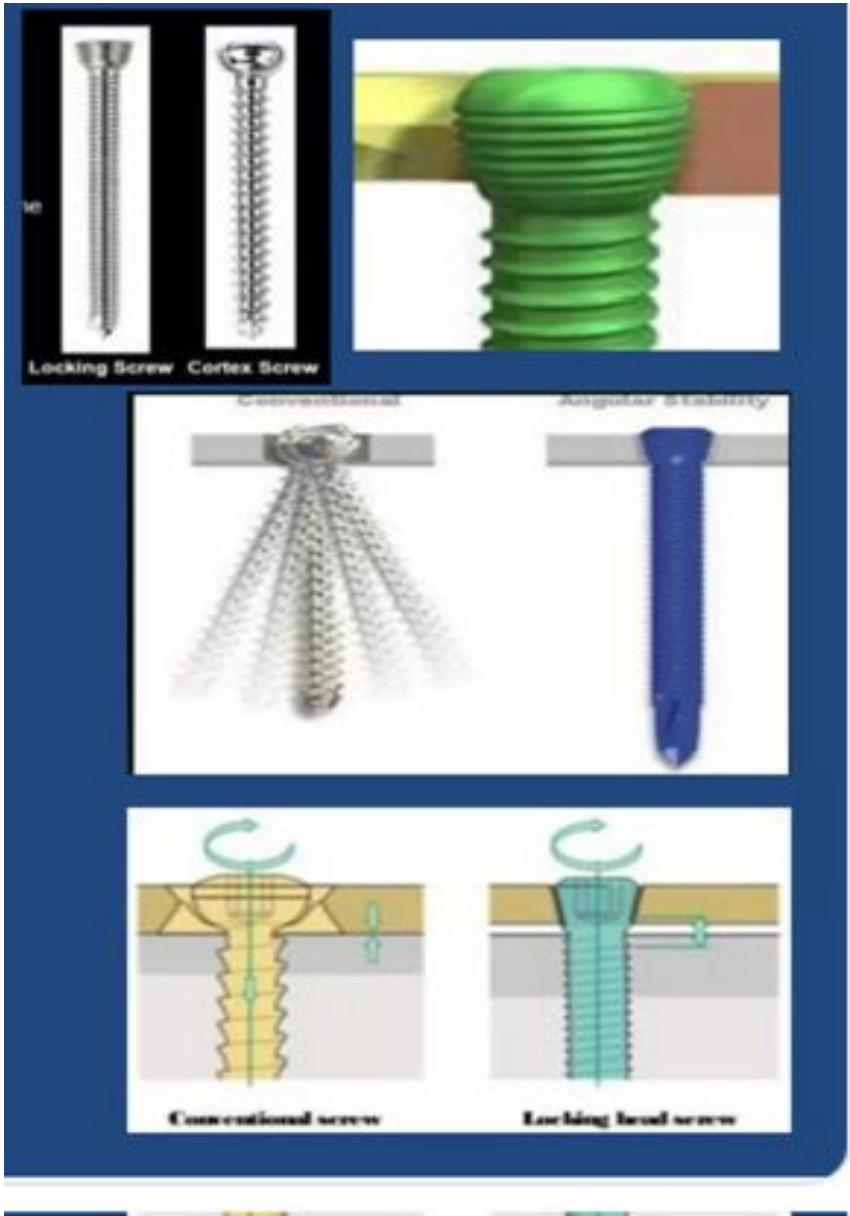


Locking screws

. Threded or locking head

- Thicker core diameter
- Smaller thread pitch
- Angularly stable construct
- Preserved periosteal blood supply
- Accurate plate contouring not required

Screws do not get loos so less risk of infection compare to conventional screw



Monocortical vs. bicortical

Monocortical screw

- In diaphyseal segments.
- Good quality bone
- Areas of low torque requirements
- Better to be self drilling than self tapping

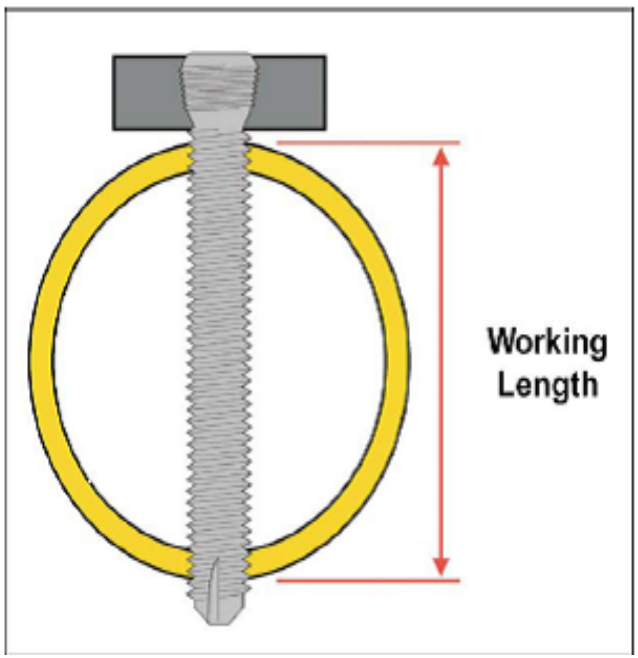
Bicortical screw

- All segments of bone
- Osteoporotic bone
- Areas of high torque requirements
- Can only be self tapping

Screw working length

- Defined as the distance from a point where screw enters a cortex to a point where it exits a cortex.

- **Helps to resist torsional loads**



Working length of bicortical screw

Applications

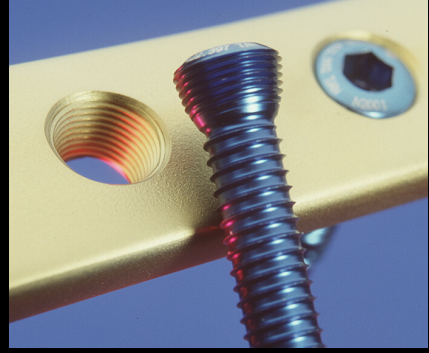
- Depending on the desired function the LCP can be applies in 3 different ways:

I. As conventional dynamic compression plate providing absolute stability.
II. As pure locking internal fixator i.e. bridging technique providing relative stability.
III. In combined fashion where both techniques are employed

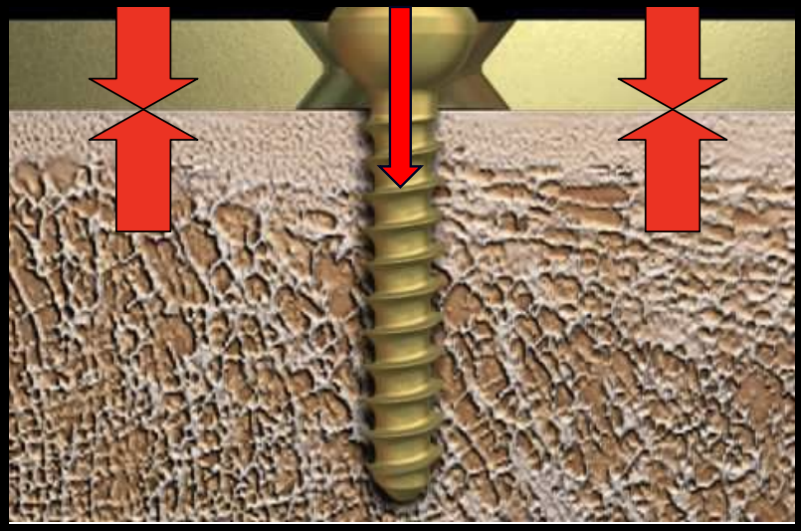
- **Articular fracture**: anatomically reduced and fixed by lag screws.

- **Metaphyseal fracture**: closed reduction and splinting by locking screws.

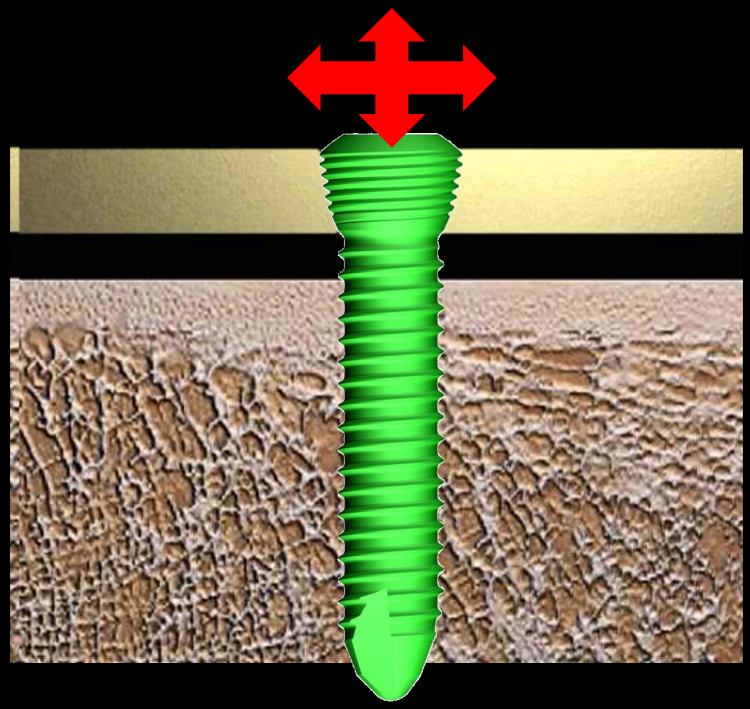
How locking plates differ?



Compression plate / screw



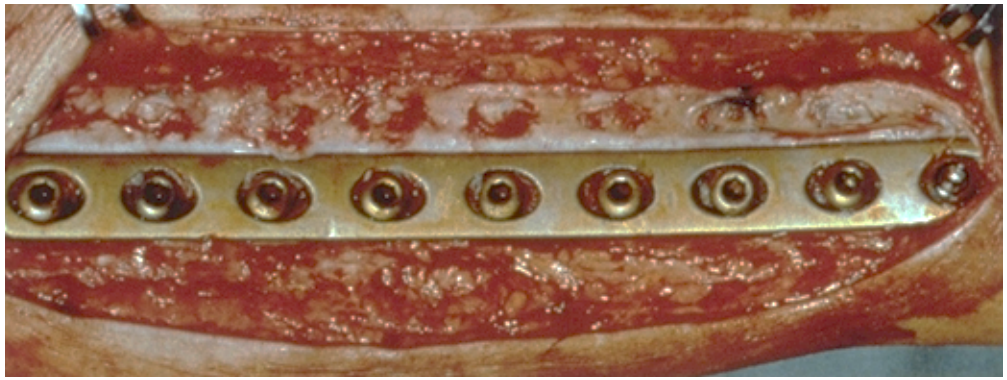
Locked plate / LHS

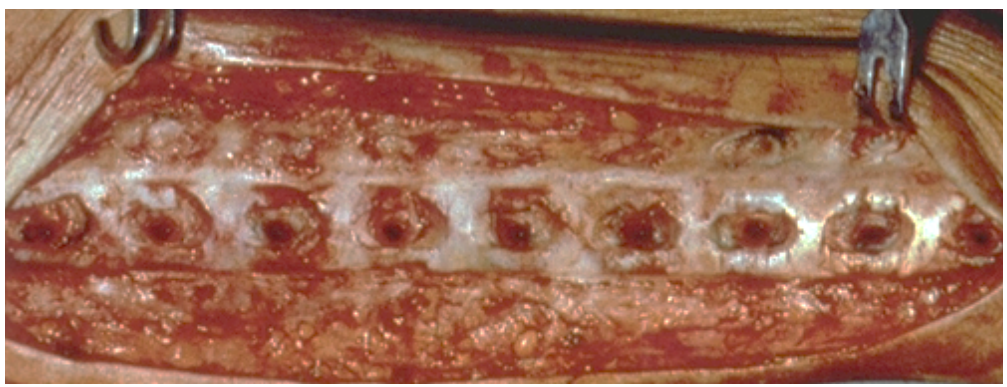


How locking plates differ?

Bone necrosis under plate

“Plate foot-print”



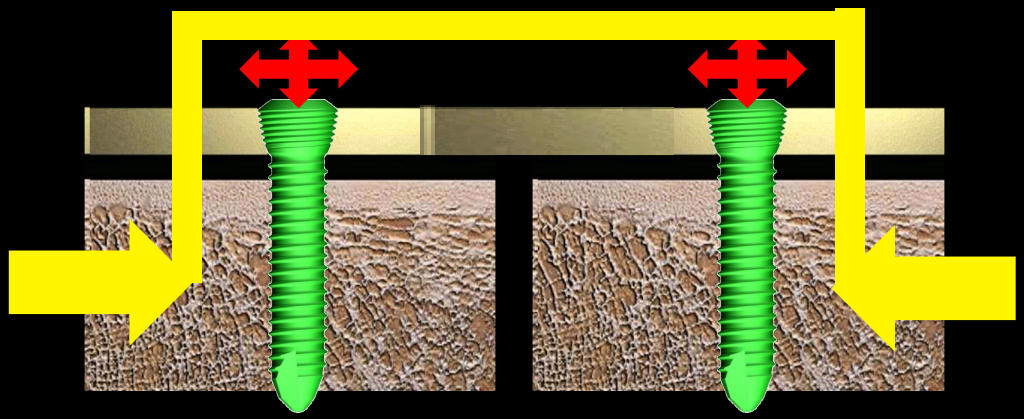


- Susceptibility for FRI /delayed union
- No callus under plate→ fracture after removal

How locking plates differ?

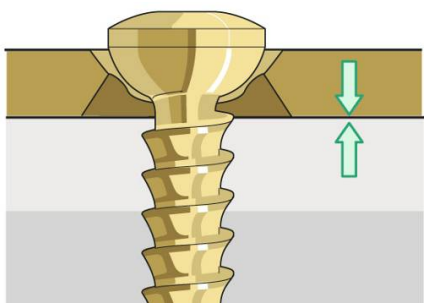
Compression plate / screw

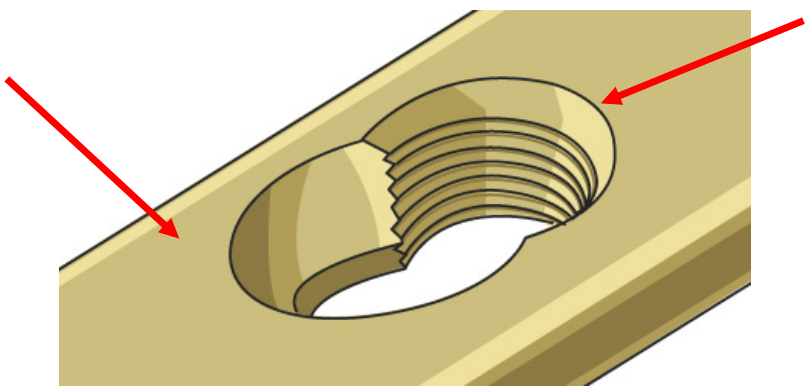
Locked plate / LHS



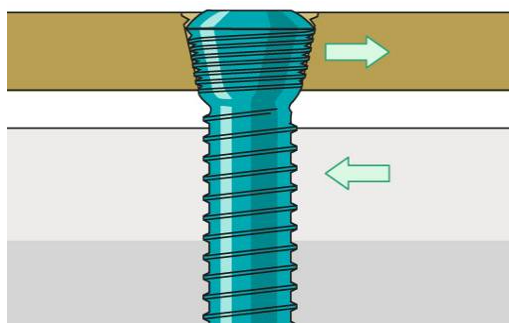
Locking compression plate (LCP) – dual function

Dynamic compression unit





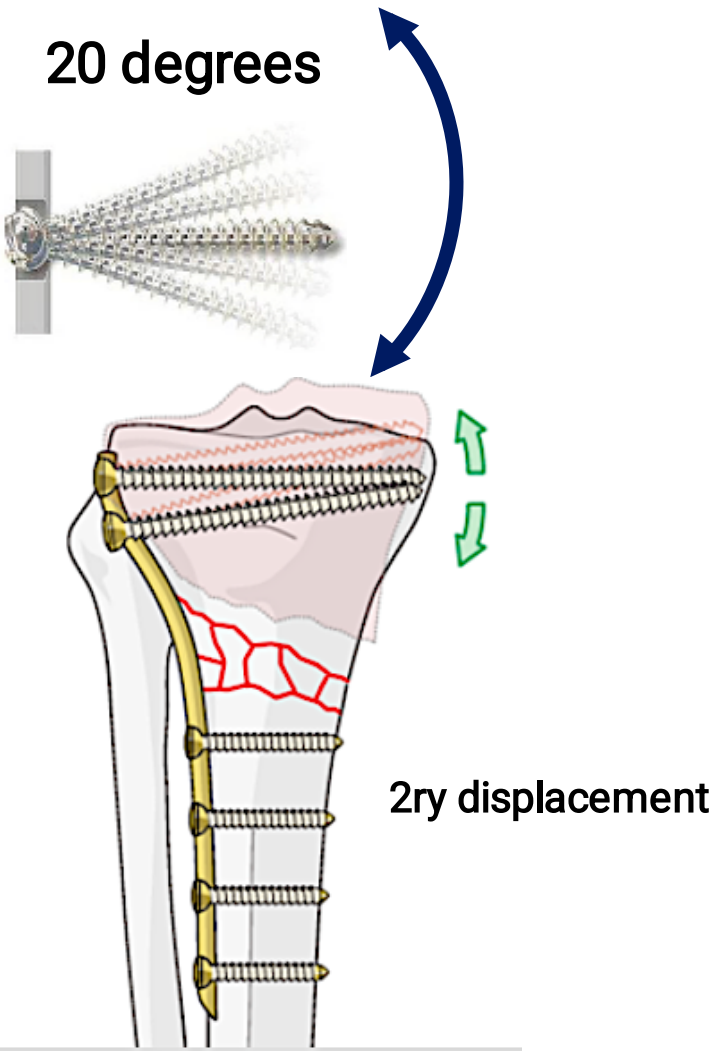
Conical and threaded unit



Internal fixator

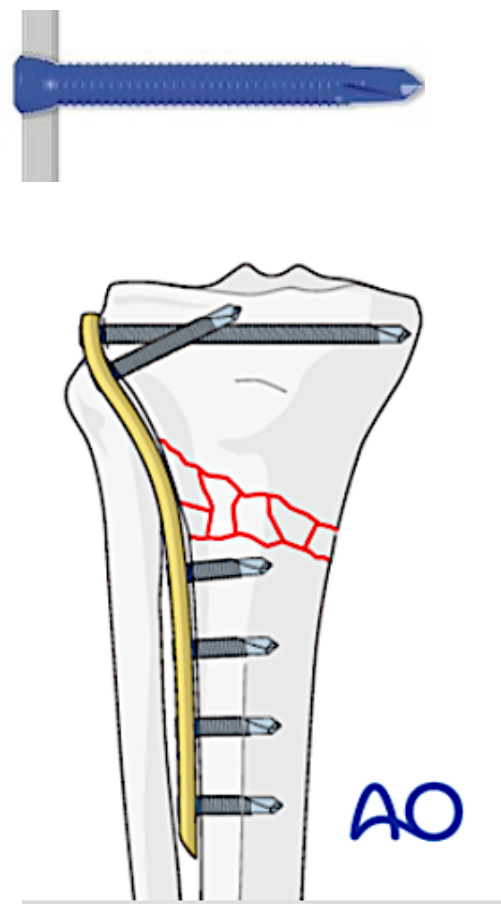
How locking plates differ?

20 degrees



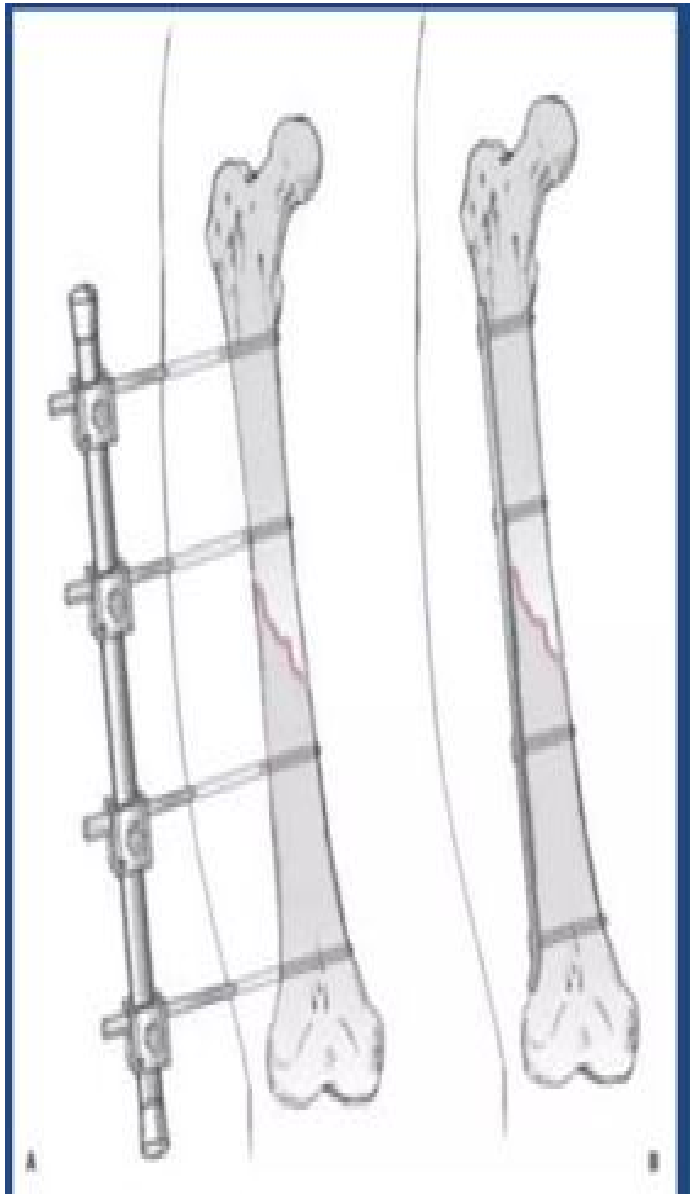
2ry displacement

Fixed angle construct



Biomechanics of locked plate

- “Internal external fixators”
- Single beam construct
  (strength of fixation rely on fixed angle construct)
- Less dependent on bone quality
  and anatomic anchoring region
-Purchase of screw to bone not critical
  (osteoporotic bone)

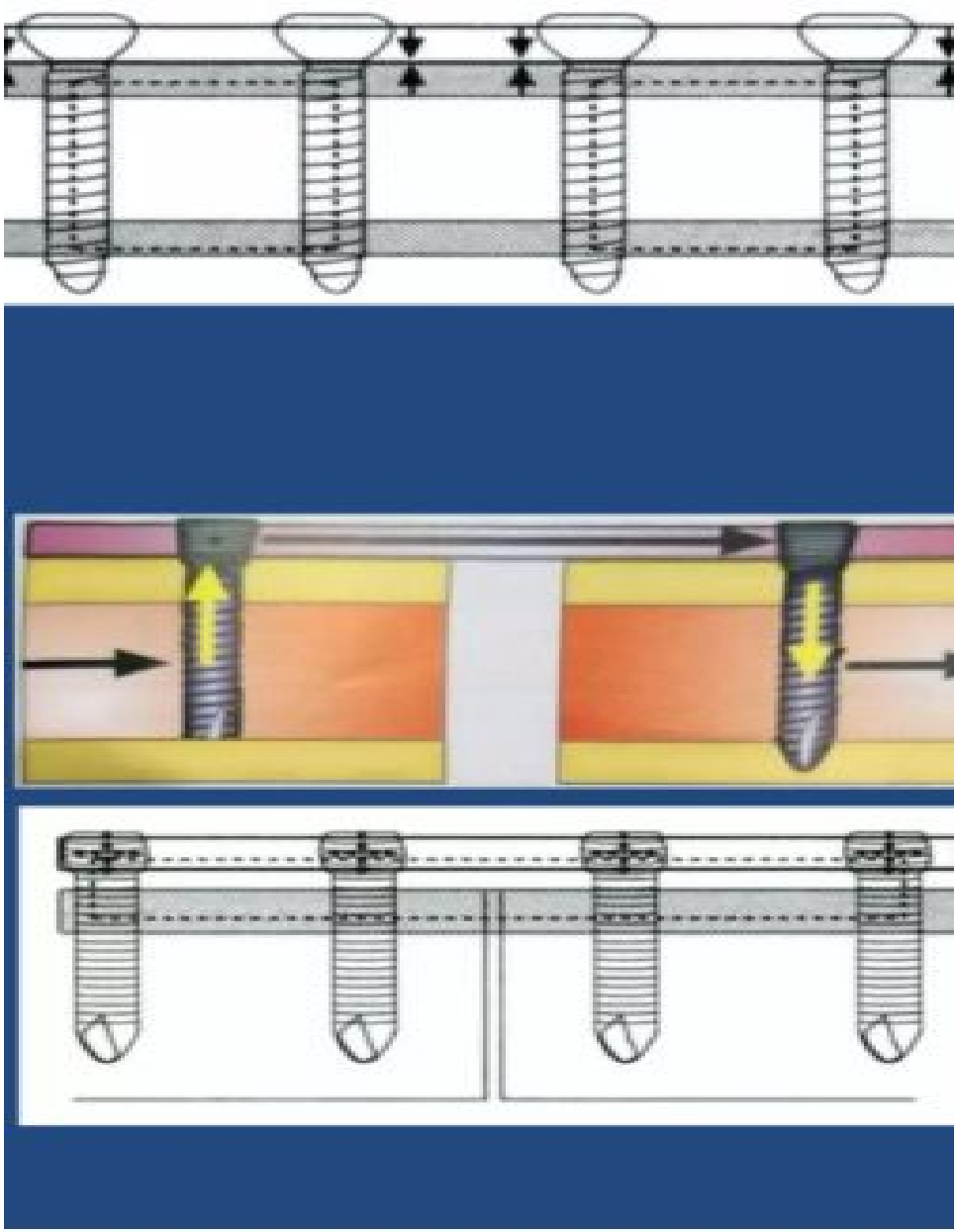


Conventional plate

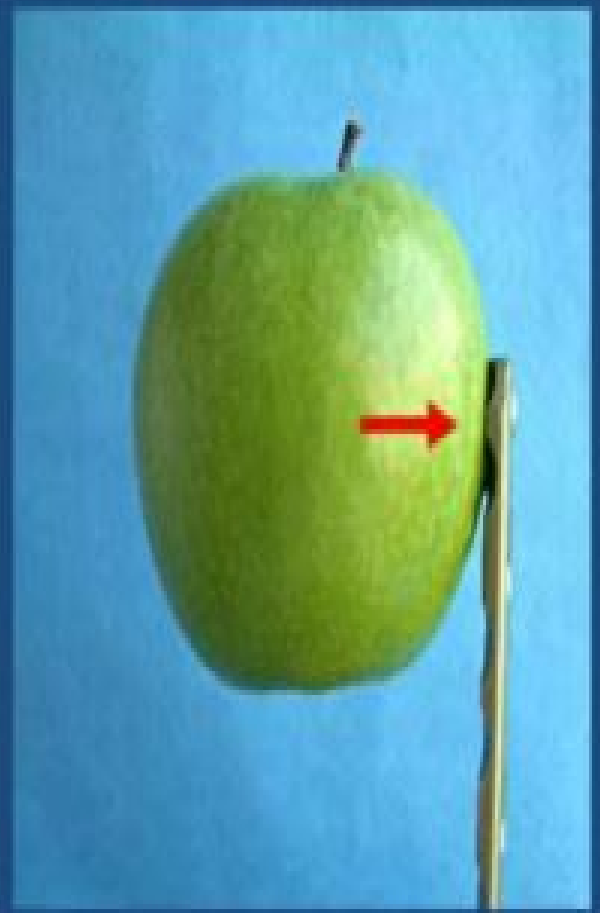
- **Stability** from plate bone contact
- Screw head free to tilt
- Requires bicortical hold for stability

Locking plate

- Load distributed to all screws
- No screw toggle
- Unicortical purchase ensures stability



Locking plate



Conventional plate

Bending force

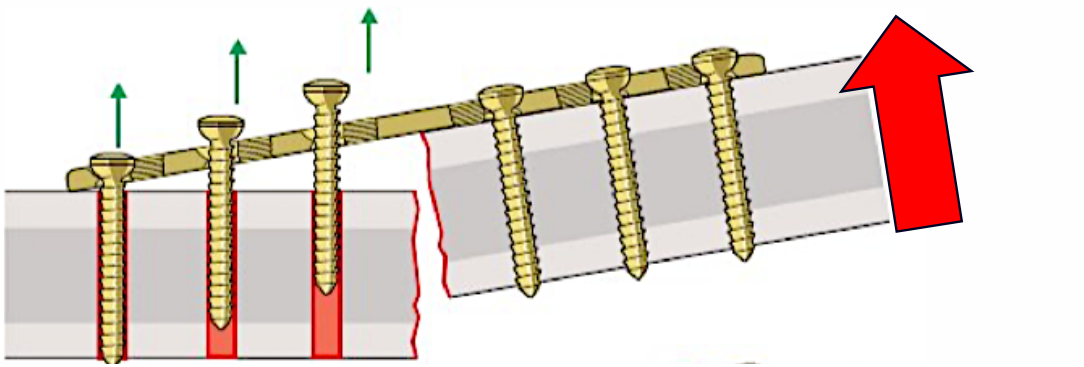
. **Conventional plate**

- Screws get oriented parallel to load applied
- Sequential pullout

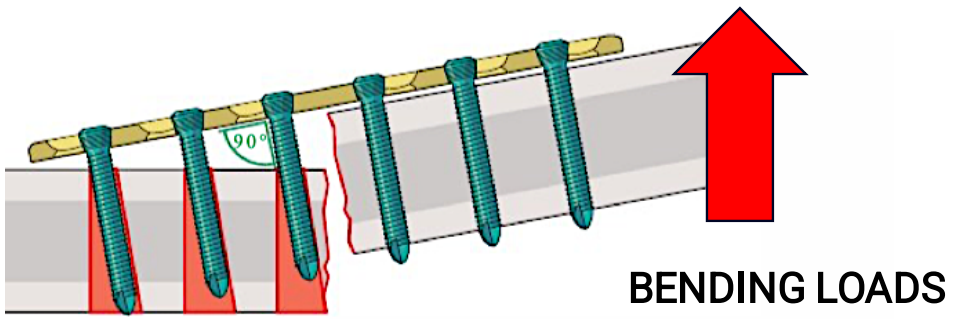
Locking plate

- screws overcome bone’s resistance to shear forces

How locking plates differ?-failure



- Individual/ Sequential failure
- Toggling→ pull out



- Failure on unison
- With cut through / pull out

Greater load to failure

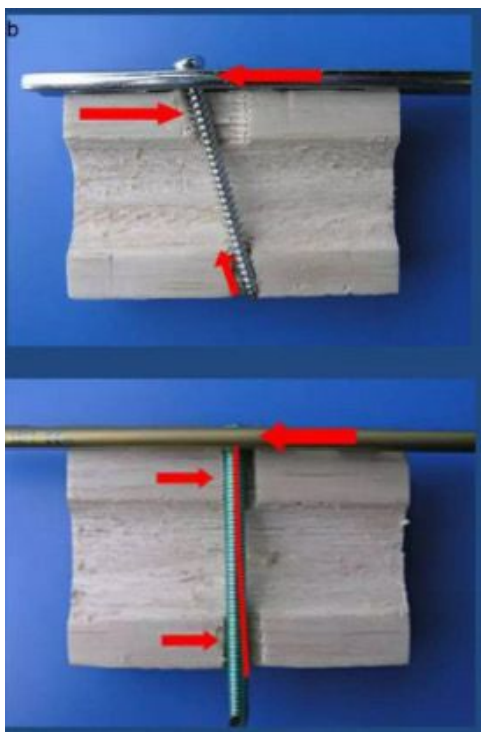
Axial load

Conventional plate

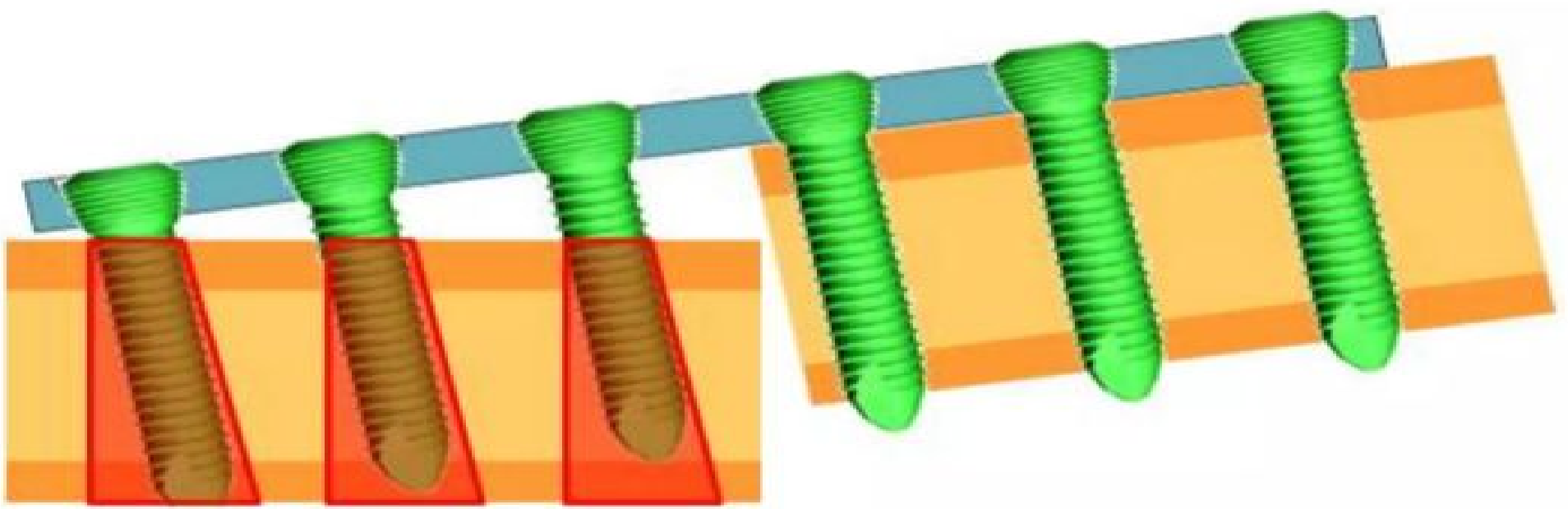
-shearing effect only on proximal side of screw

Locking plate

Resists shearing along its entire lenght



WORK AS A UNIT !!!!



Hybrid plating

- Application:
  - Using locking screws in metaphyseal fragment and nonlocking screws in diaphyseal fragment
  - Using nonlocking and locking screws in the same fracture fragment

- Nonlocking screws should be used BEFORE locking screws in the same fracture fragment: facilitate reduction and apposition of plate to bone

- When applied in diaphyseal fracture fragment, Locking screws PROTECTS nonlocking screws from failure

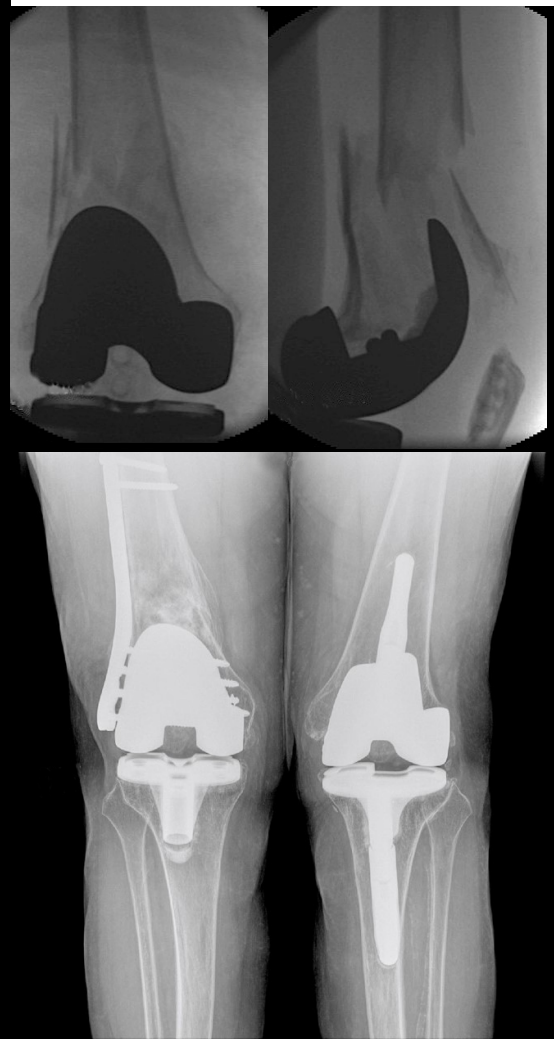
Indication

- Poor Bone quality/Low bone density / Thin cortical bone (Osteoporosis)
- Length/Area for fixation is limited (Periarticular fractures)
- Bridging Comminution & Bone defects (Long working length)
- Bicortical fixation not possible (e.g. proximal humerus, periprosthetic fractures)

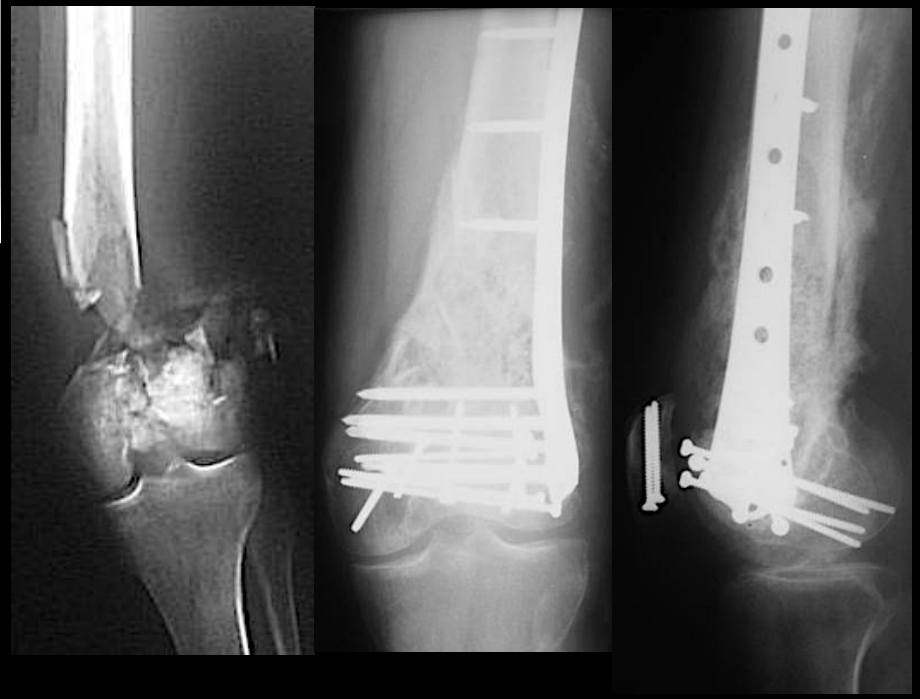
Locked plating—indications

- Osteoporosis /osteopenia

- Periprosthetic fractures

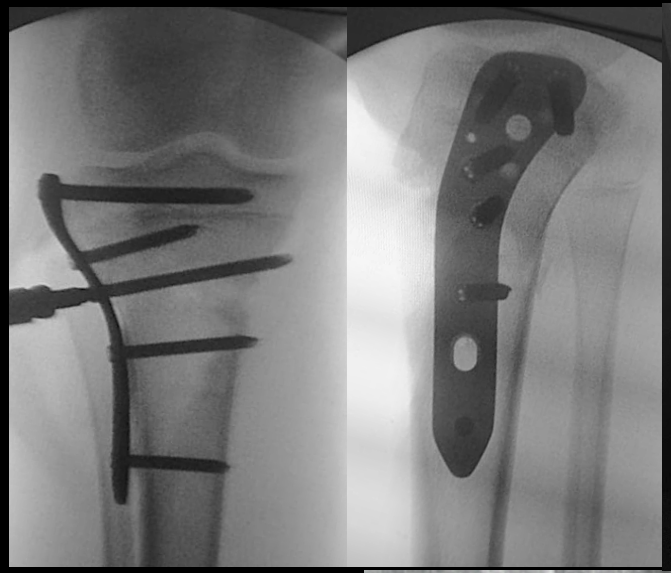


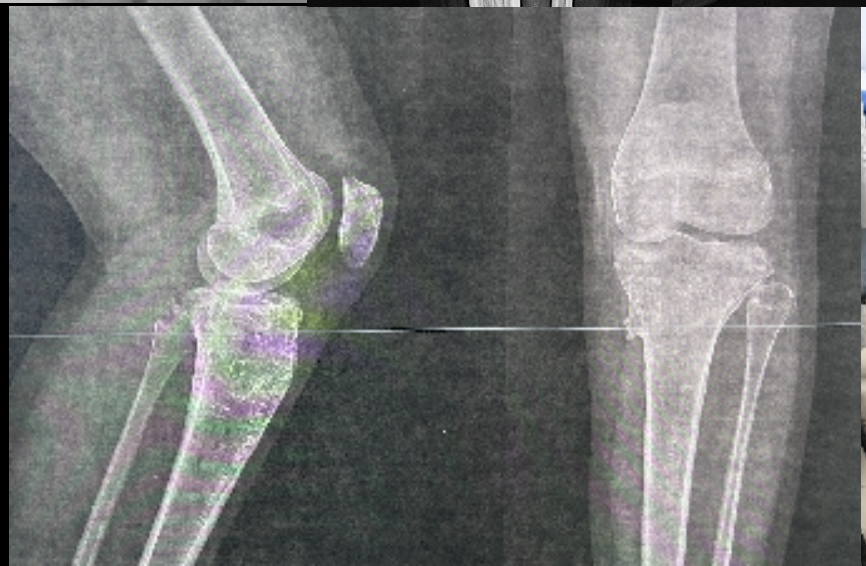
- Metaphyseal comminution/bone loss



Locked plating—indications

Less room for fixation

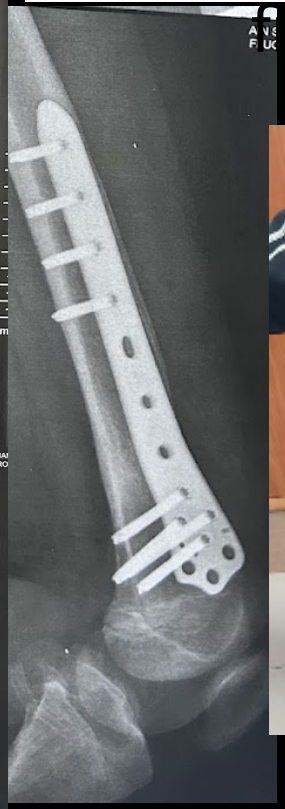


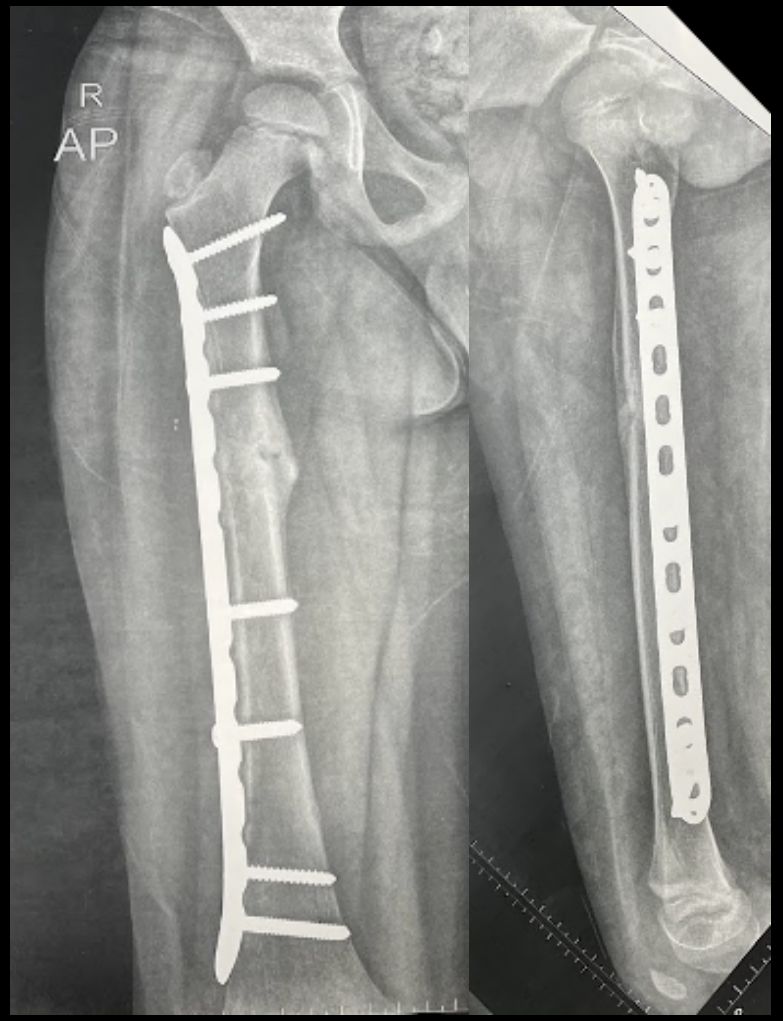


Locked plating—indications

Less room for

MIPO





Locked plating—indications

Less room for fixation

Features and advantages of LHS

- Axial and angular stability
- Higher resistance against bending loads
- Monocortical insertion is possible
- Lag first, lock second
- No primary/ secondary loss of reduction

. no or less screw loosening

Features and advantages of locked plates

- Screw-plate system with angular and axial stability
- Locked internal fixator/noncontact plate
- Anatomically contoured
- High pull out strength

Biological advantages

- Reduced compression of the periosteum
- Protects blood supply to the bone,less infection
- Callus formation/bone healing under the plate

Technical/mechanical advantages

- Angular and axial stability
- Good for osteoporotic bone—bicortical LHS
- Optimal predefined screw placement
- MIPO is easier

Splinting with locked plates—prerequisites

- Long plate
- Fixation with LHS only on main fragments
- No screws in fracture zone
- Prebending not necessary
- Elastic fixation

Drawback of fixation with LHS

- Screw insertion is only possible in a 90° angle
- Possible loss of the feel for the quality of the bone during screw insertion and tightening

Order of attack

1.reduce the fracture first

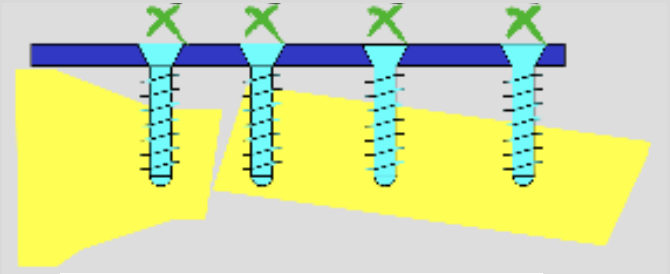
2. For reduction, if you need put to conventional screws - they should be put before the Locking Screws

3. Then fix it with Locking Screws.

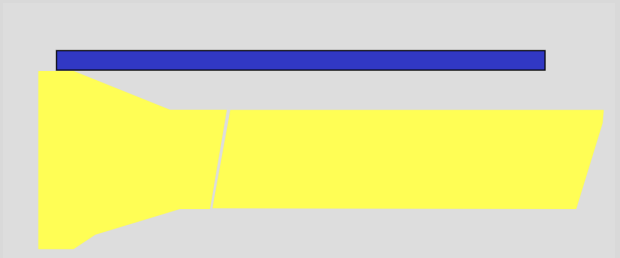
4. For Articular Fractures, the articular portion of the fracture is reduced first

5. Reduce the shaft to the articular block

How locking plates differ?-surgical technique

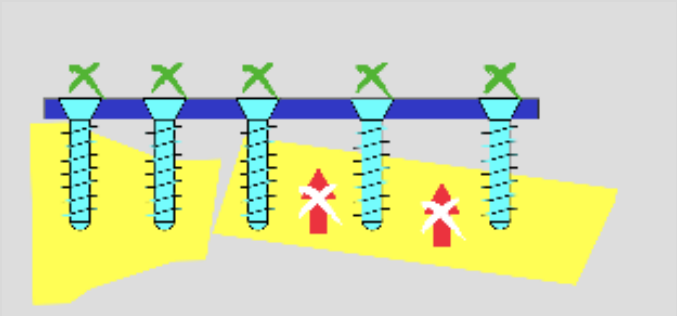


Unreduced fracture

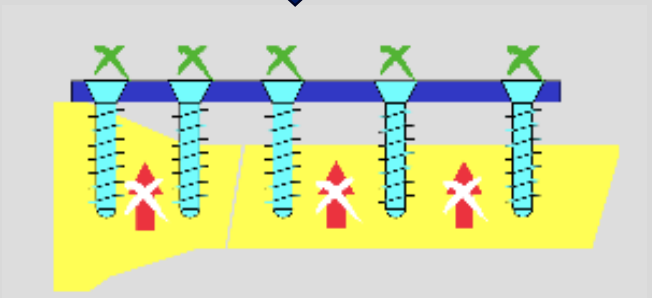


Reduced fracture

Reduce before you fix

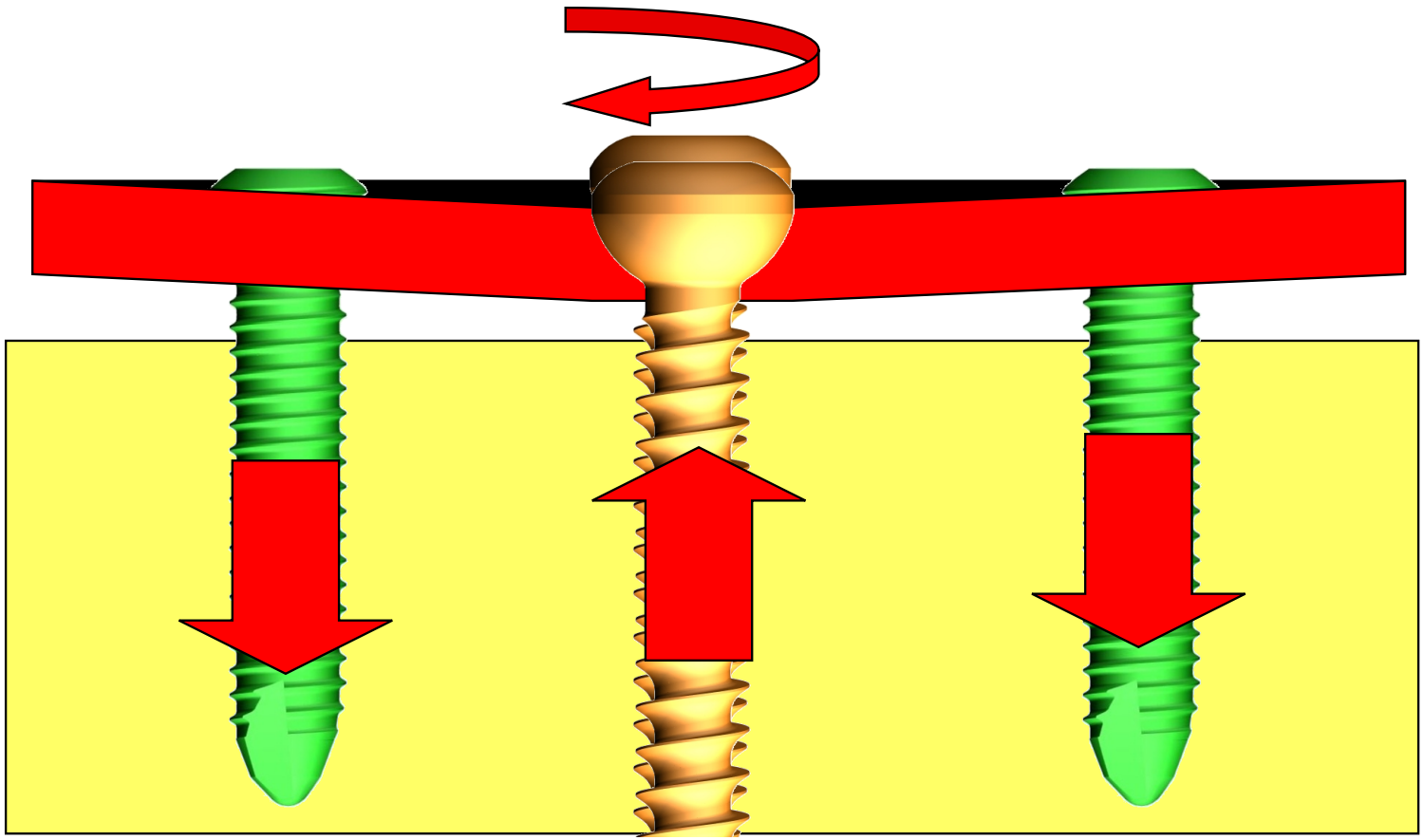


Unreduced fracture



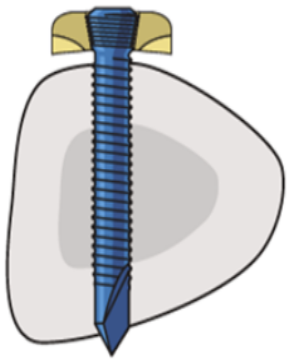
No malreduction

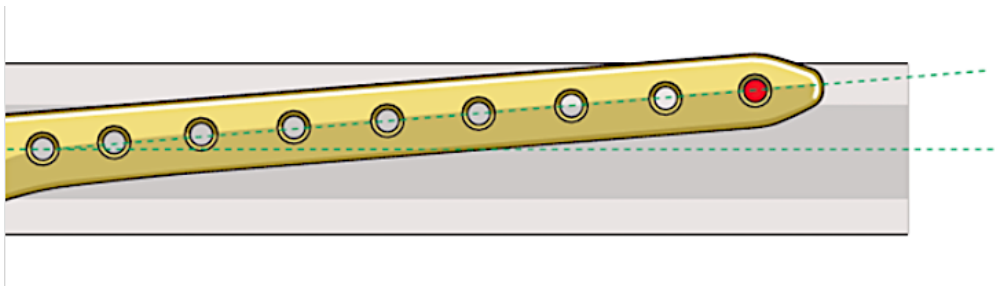
How locking plates differ?-surgical technique

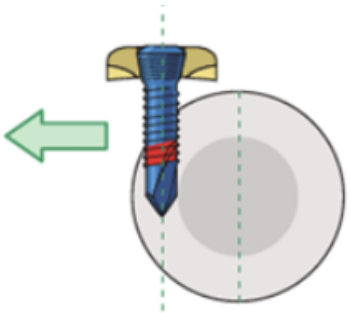


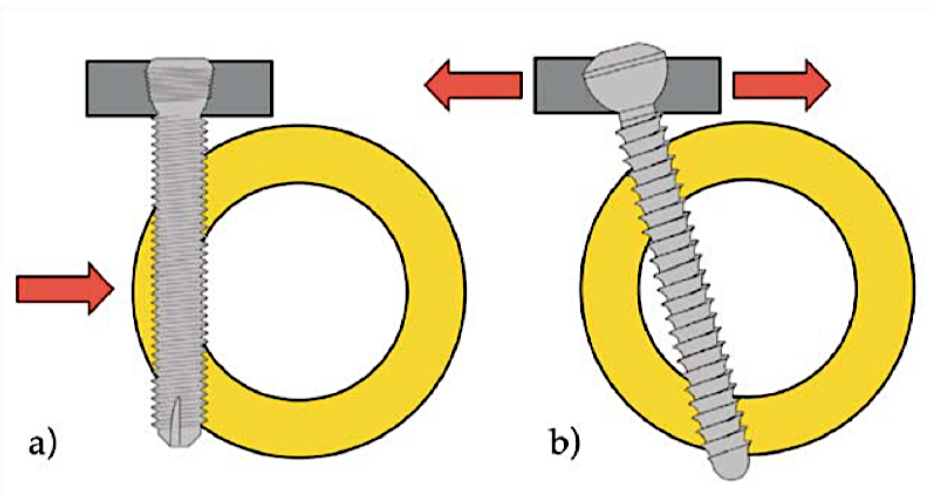
Lag /compress before you lock

How locking plates differ?-surgical technique



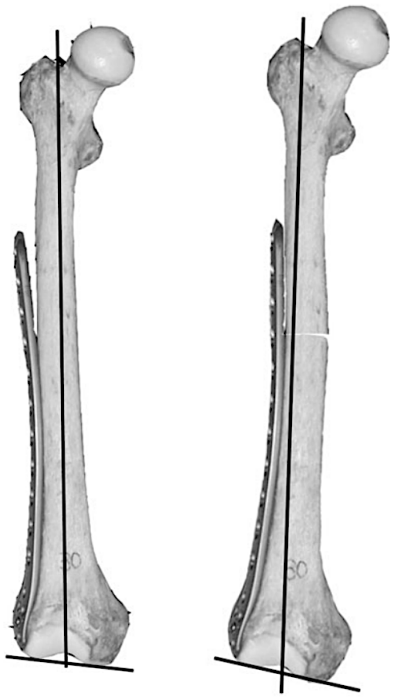


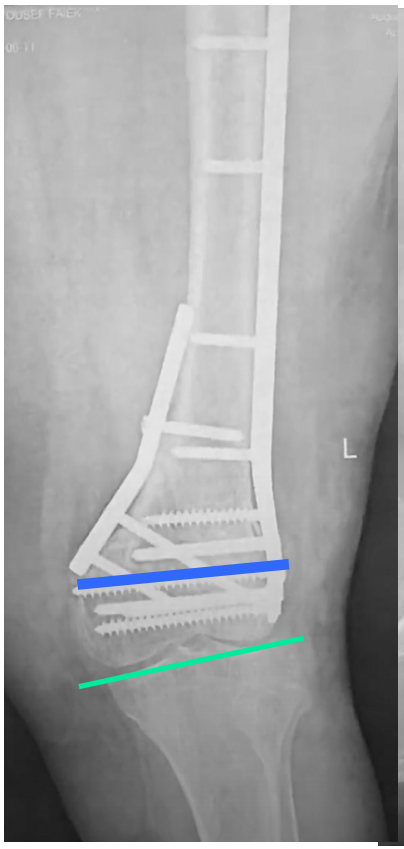




Align the plate properly before final fixation

How locking plates differ?-surgical technique





Mismatch of anatomically pre-shaped locking plate on asian femurs could lead to malalignment in the minimally invasive plating of distal femoral fractures: a cadaveric study

Jin-Ho Hwang · Jong-Keon Oh · Chang-Wug Oh · Yong-Cheol Yoon · Hyeuk Woo Choi

Respect the patient preinjury anatomy

Bridge plating with relative stability

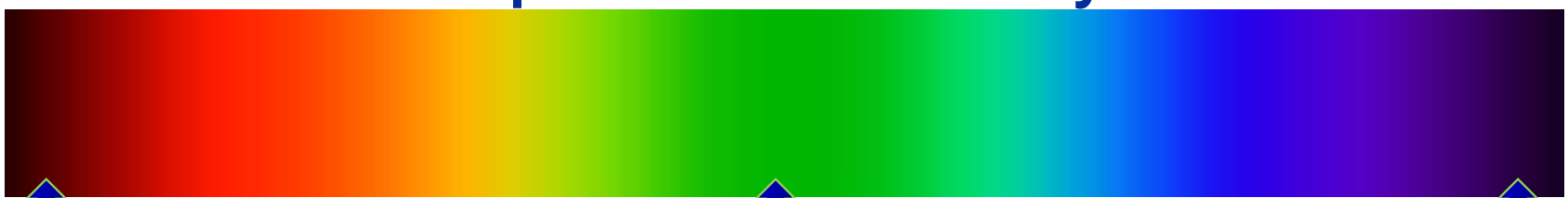
:

- Without anatomical reduction at each fracture line
- Allows controlled micromotion
- when Working length increases the rigidity of construct decreases

- when Forces distributed over larger length of plate the fatigue failure less likely

How to Optimize fixation?

Spectrum of stability



No motion	Some motion	Excessive motion
Absolute stability	***Relative stability***	***Instability***
Simple fr. + good quality bone	✓ Multifragmentary fr. ✓ Simple fracture + osteopenia	✓ Disturbed bone healing ✓ Implant failure / 2ry loss of reduction

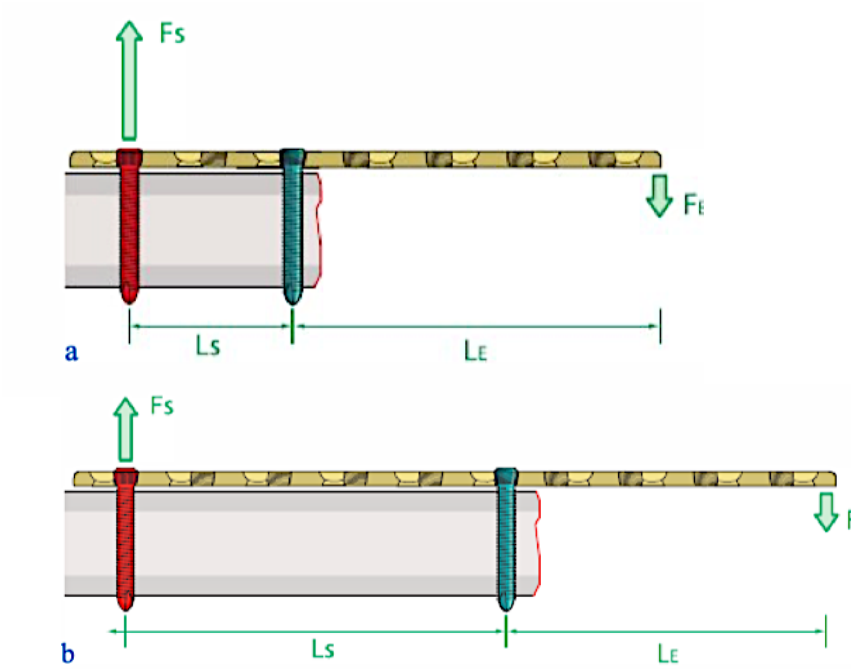
How to Optimize fixation?

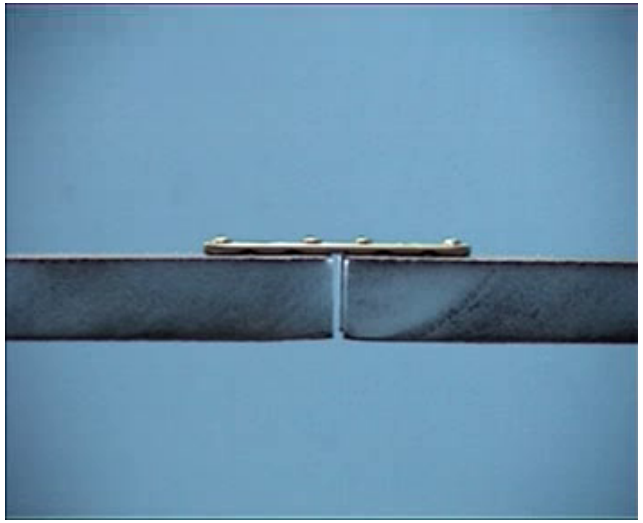
The strength and stability of a fixation performed using the LCP can be altered by the following factors:

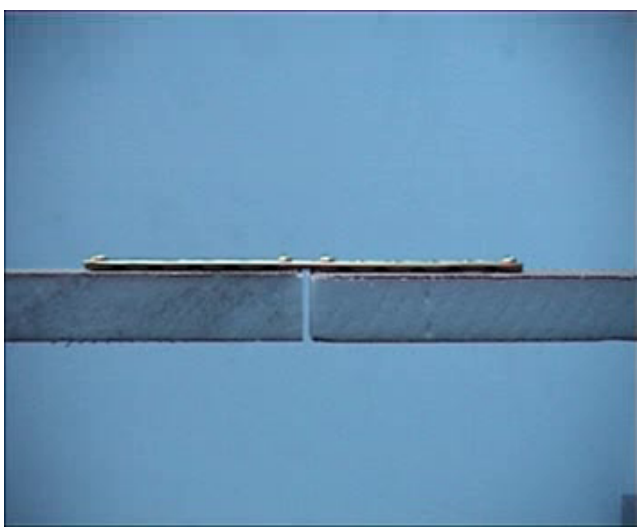
- Plate length
- Placement/position of screws
- Number of screws

How to Optimize fixation?

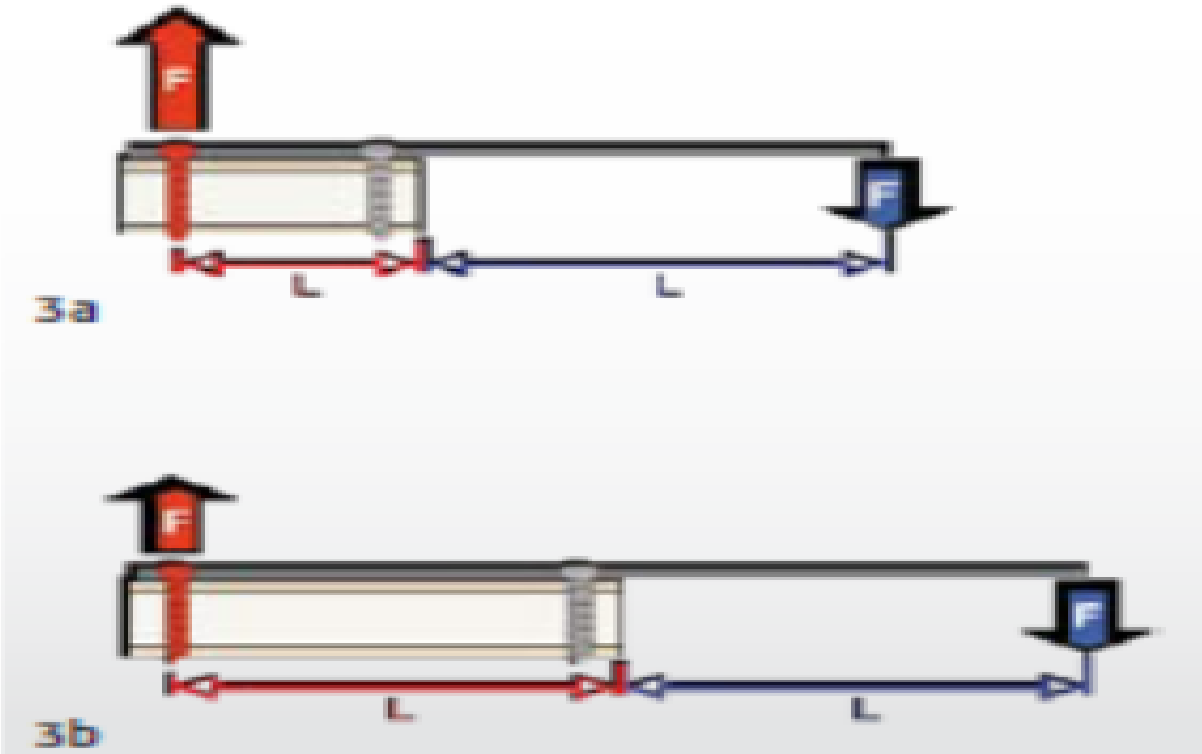
Plate length







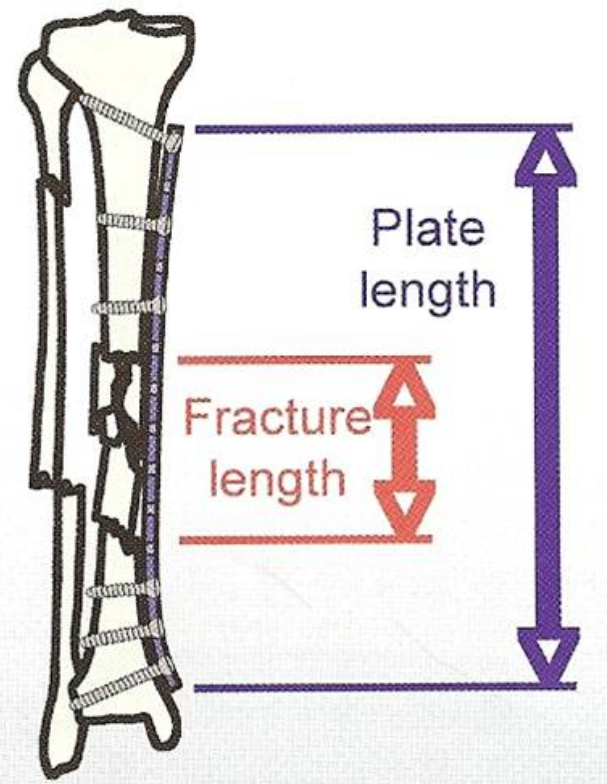
Longer plate→Increased Pull-out strength of LHS



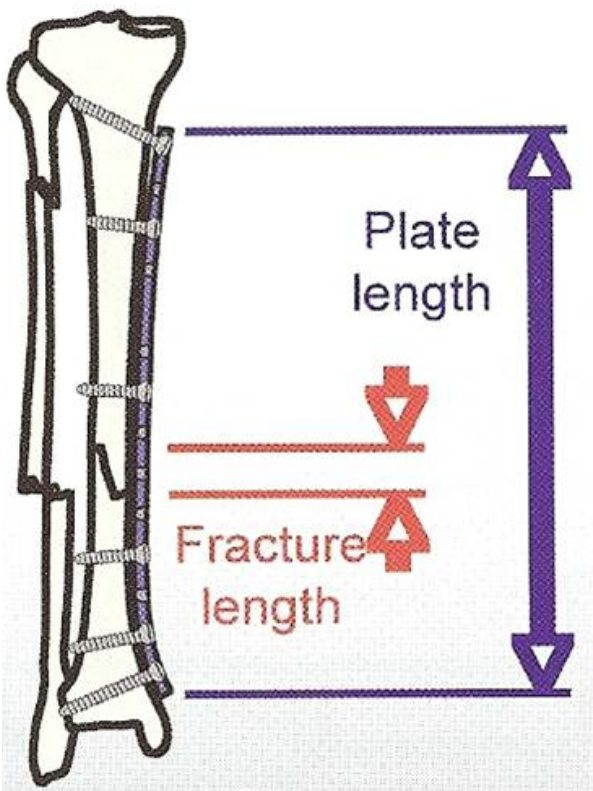
Increasing plate length and screw spanning decrease the load on the screw by ↑their lever arm

How to Optimize fixation?

PLATE-SPAN RATIO = plate length / fracture length



In multifragmentary fr. → 2-3

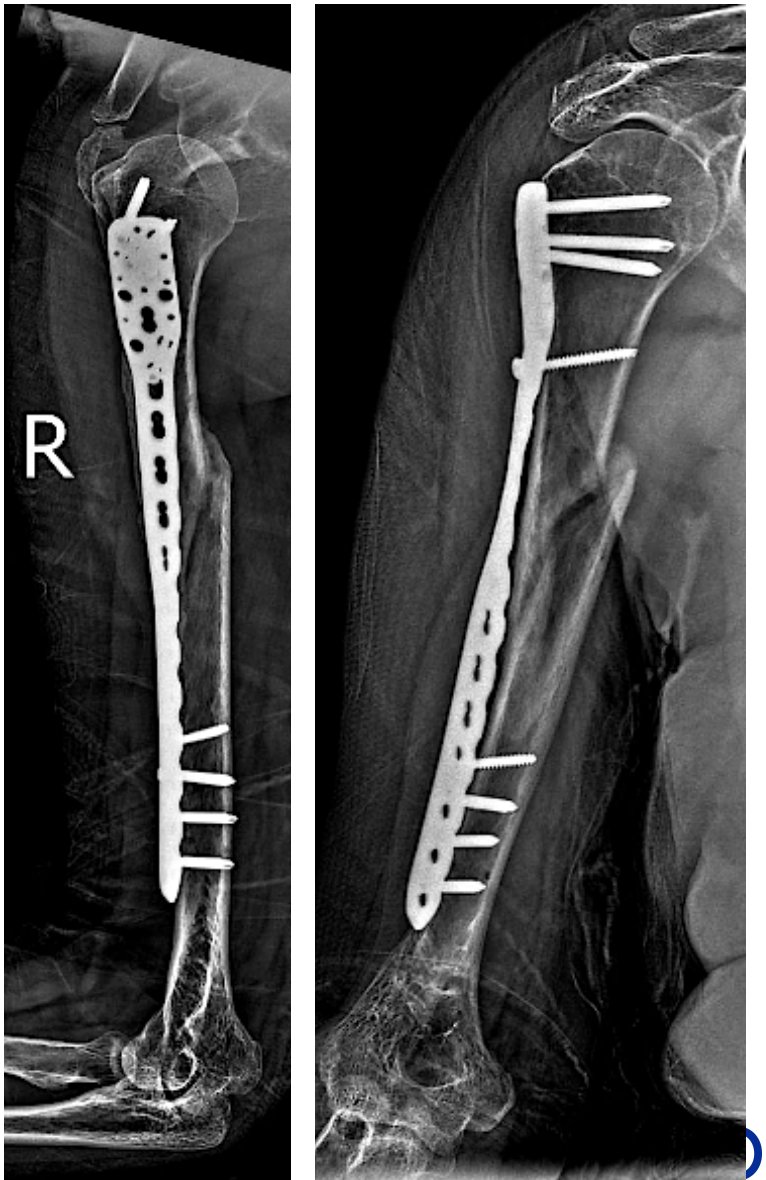


In simple fr → 8-10

How to Optimize fixation?

Number of screws

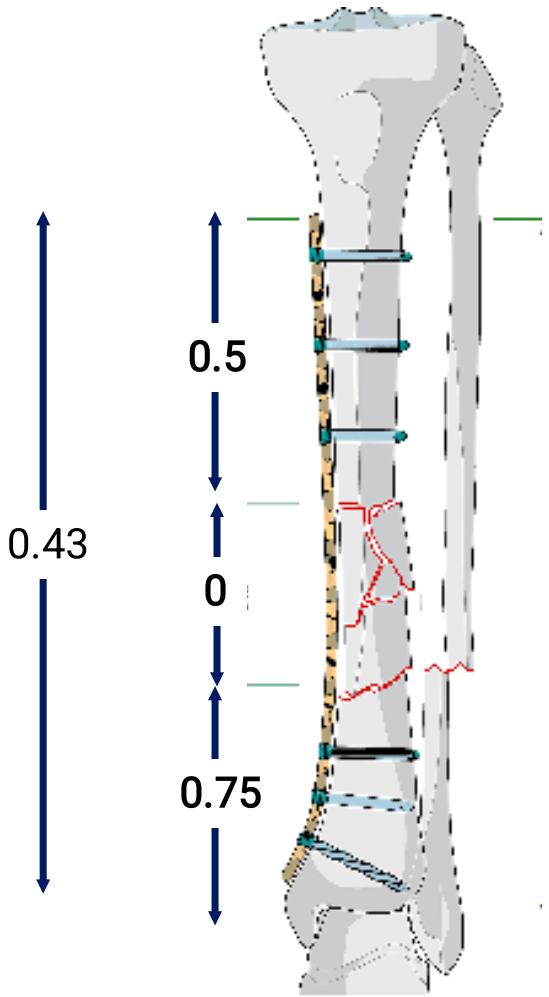
- Upper extremity: 3 of 4 screws on either side (torsional)
- Lower extremity: 2 of 3 screws on either side (axial)



How to Optimize fixation?

PLATE SCREW DENSITY RATIO= number of screws/no of plate holes

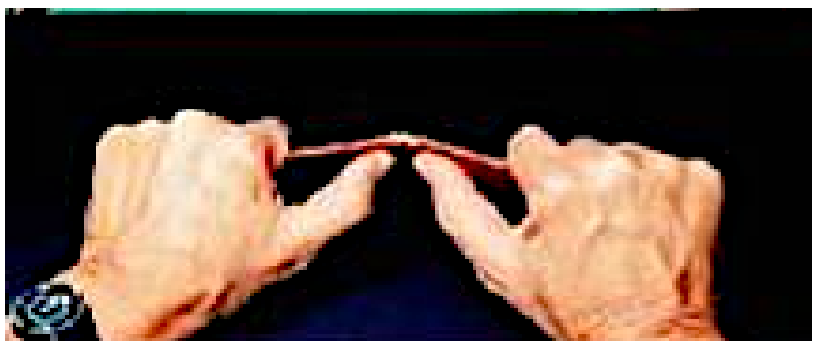
- Simple fracture → **0.3-0.4**
- Multifragmentary → **0.4-0.5**

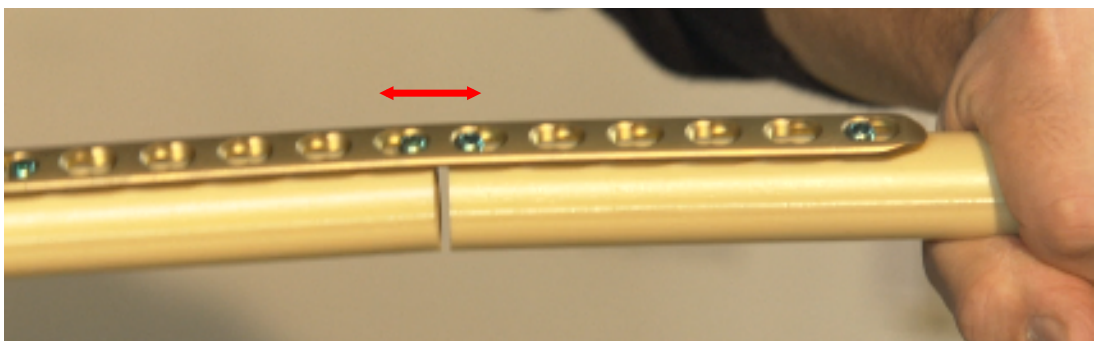


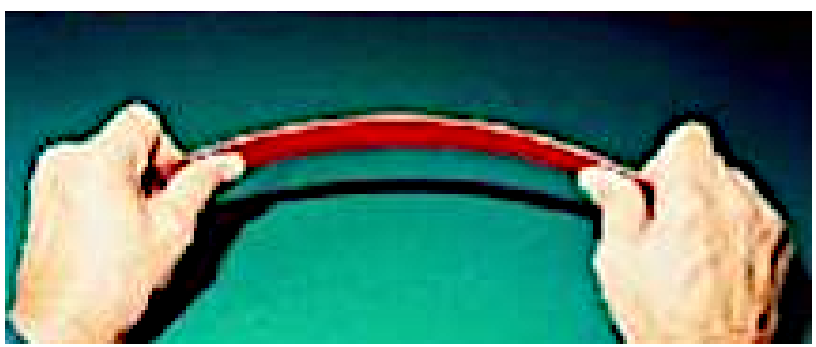
How to Optimize fixation?

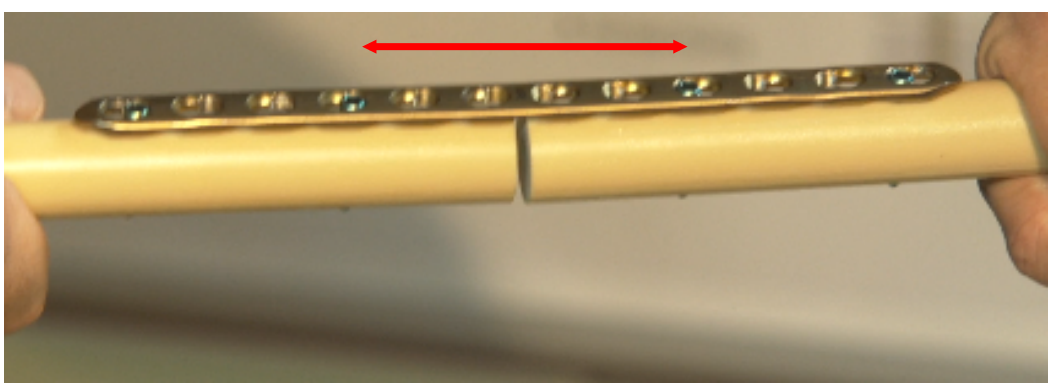
Screw position relative to fracture

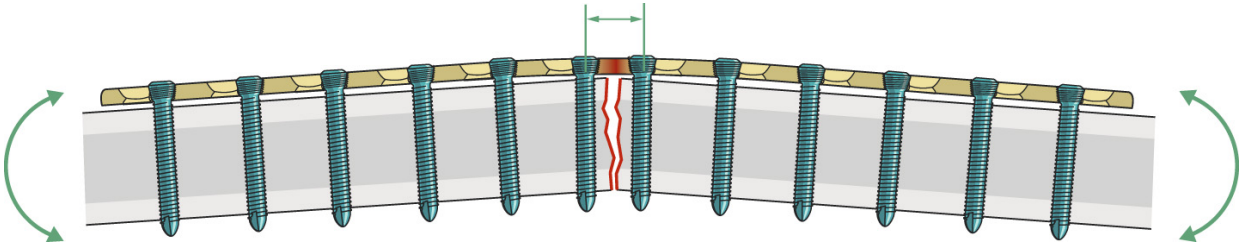
WORKING LENGTH of the construct



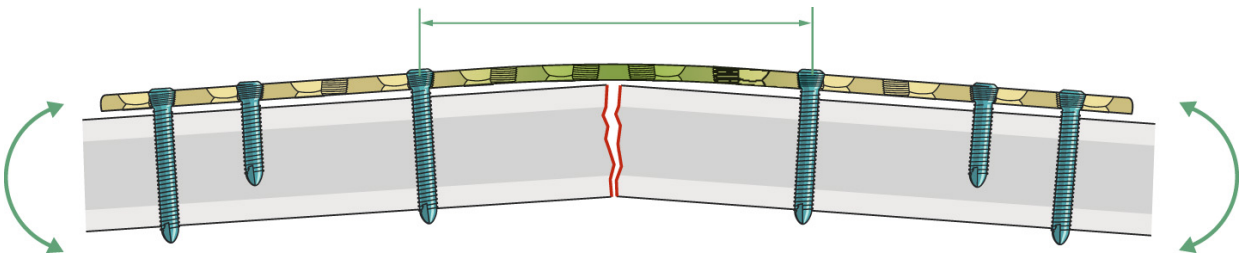




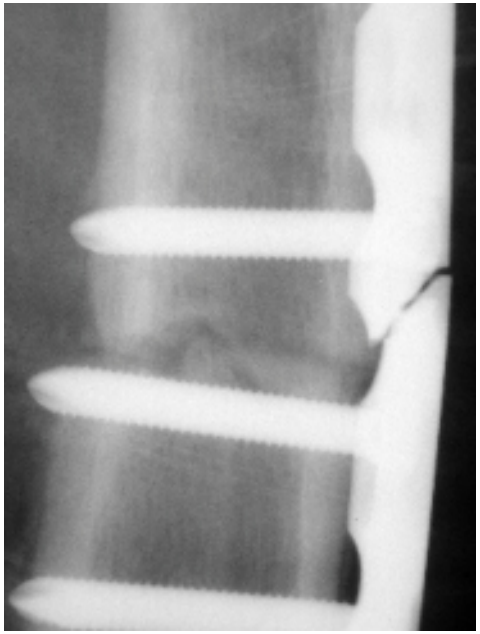




Stress concentration → Low fatigue resistance



Stress distribution→ High fatigue resistance

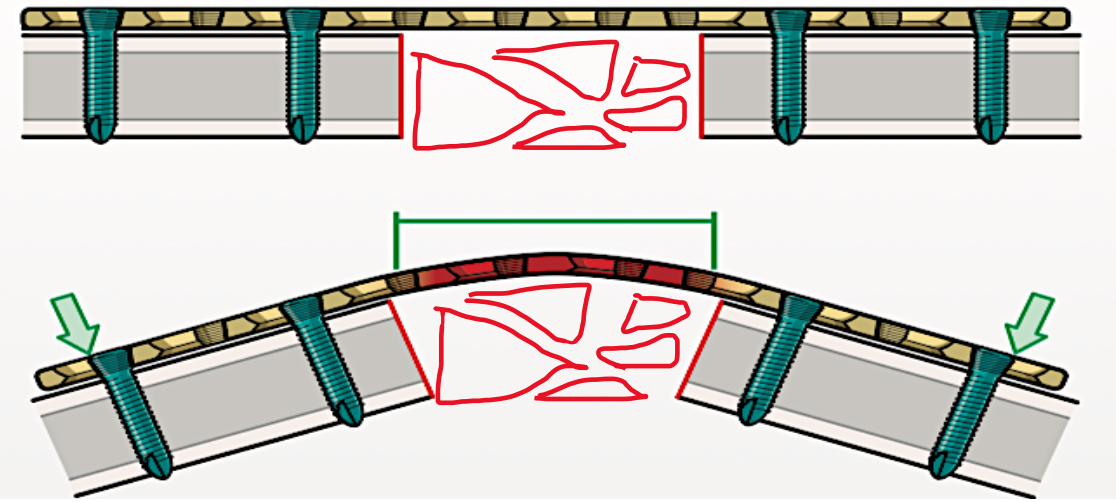


Simple fracture needing relative stability

→ omit screws on either side of the fracture gap

→ Inc. Construct flexibility

→ avoid **delayed union and implant failure**



Comminuted fractures/ bone gaps (needing relative stability)

→ insert screws close to fracture to avoid instability

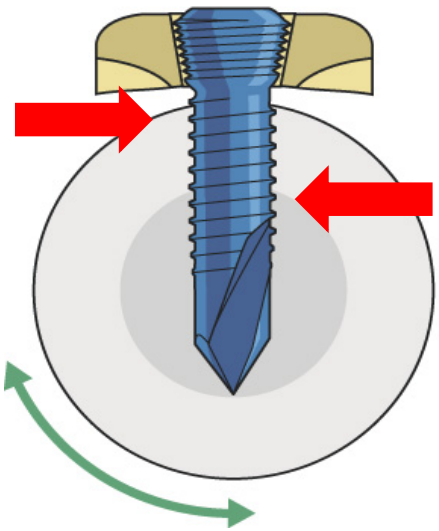
→ avoid **delayed union and 2ry loss of reduction**

What else?

Delay weight-bearing

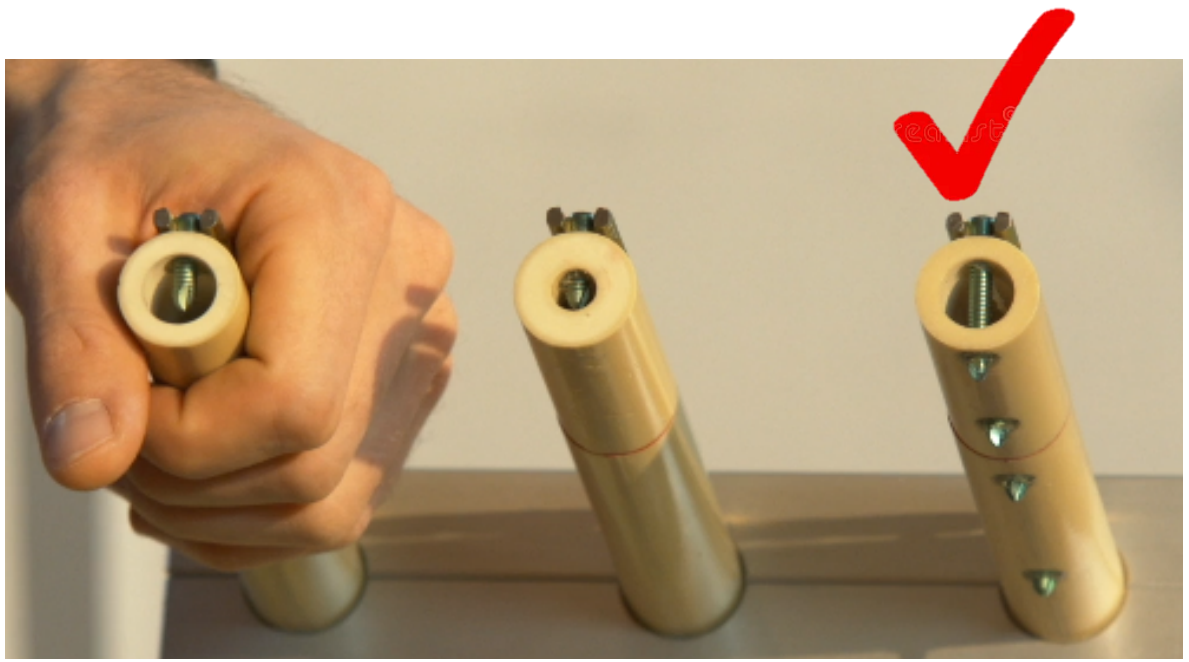
Other side fixation

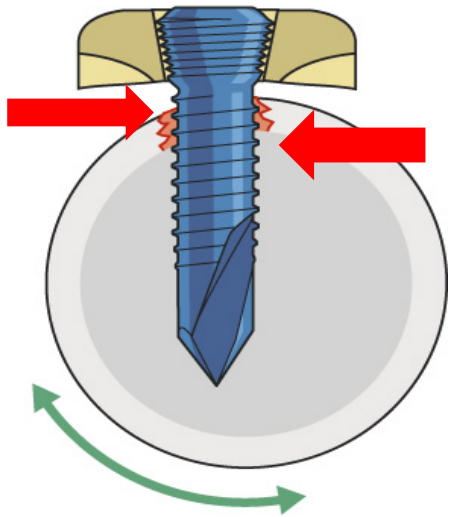
How to Optimize fixation?



Torque loading
(humerus)

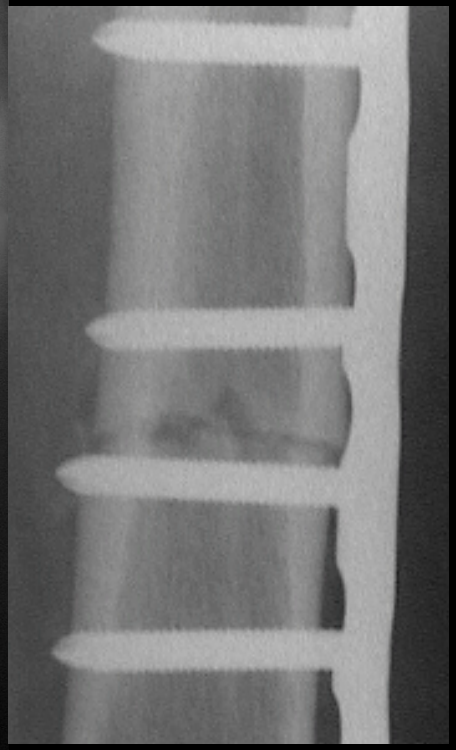
Screw length /screw working length
Distance of cortical engagement



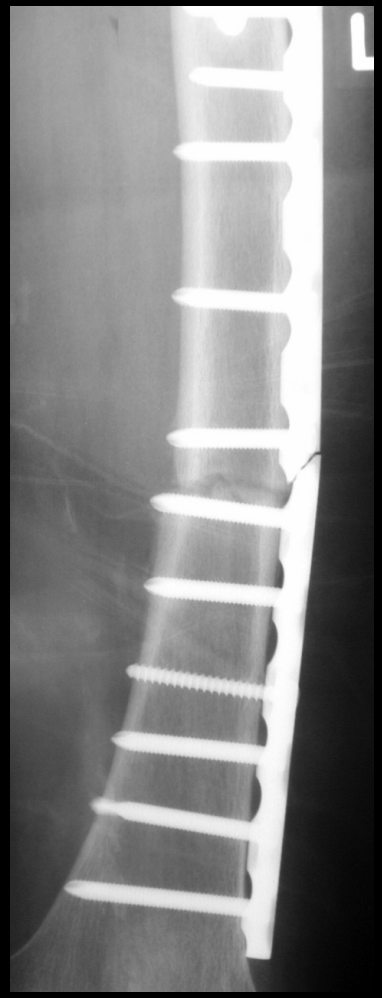


When possible, use bicortical screws especially in osteoporosis

Post-op.



7th w



?

22y, polytrauma

12 w

?

Summary

- ✓ Improved stability:
  - Osteoporosis
  - Metaphyseal areas.
  - Less room for fixation

Locked plates serve AO principles

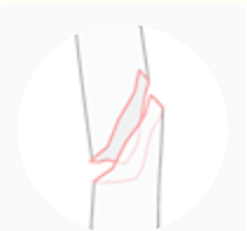
- Minimal foot-print
- MIPO

- Stable construct
- Modify rehab with flexible fixation

Reduce before you fix

Direct reduction

- ✓ Simple fracture +good bone

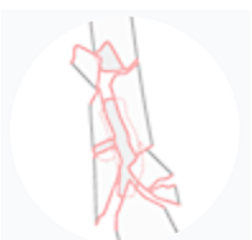


lag →lock

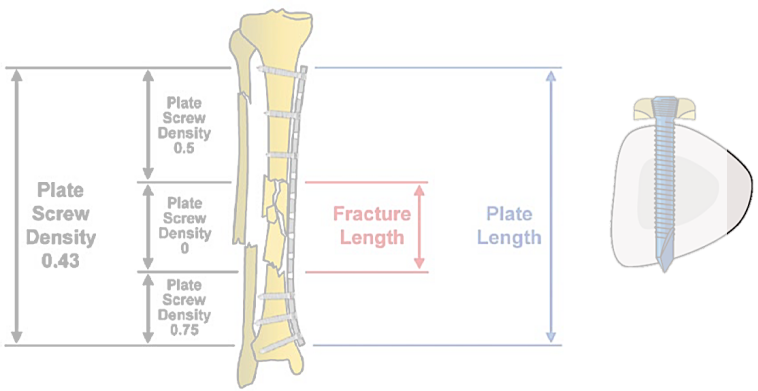
Compress→ lock

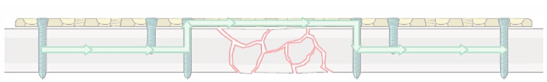
Indirect reduction

- ✓ Simple fracture /osteopenia
- ✓ Multifragmentary fracture

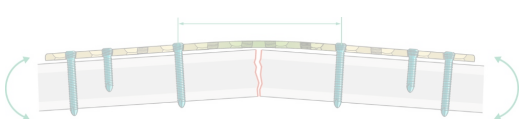


Manipulate stability as needed





Stay close to comminuted fr.



Move away from simple fr.

Pitfalls

- Application of Locking screws before nonlocking screws

- Misconception: Locking plate will reduce the fracture.

While implants may facilitate achieving alignment if used with appropriate techniques, they do NOT reduce the fracture

pearls

• Reduction BEFORE fixation

• Application of Nonlocking screws (Lagging or approximation of bone plate interface) BEFORE locking screws

• Can exchange non-locked screw for locked screw after construct complete if need added stability in periarticular region

•

NOT needed in good bone quality with large area/long segment for fixation

• Screw Density <0.5 to distribute forces (fill every other screw hole at most)

• Plate Length in comminuted fractures: Fracture Length X2-3

• Working length in simple fractures with non-anatomic reduction: Longer= improved stability

• Check the reduction twice before bending any periarticular plate

The surgeon, not the designer of the plate, determines how a plate will function and how it will be applied.


Thank
you!