Locked plate fixation – Principle and applications

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Comprehensive Bioskill Course on Fracture Fixation
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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

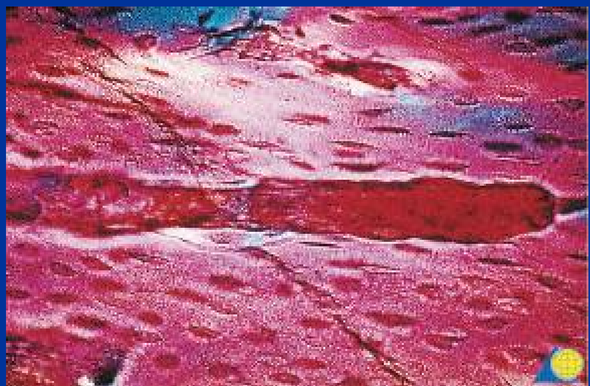
Relative Stability

- 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

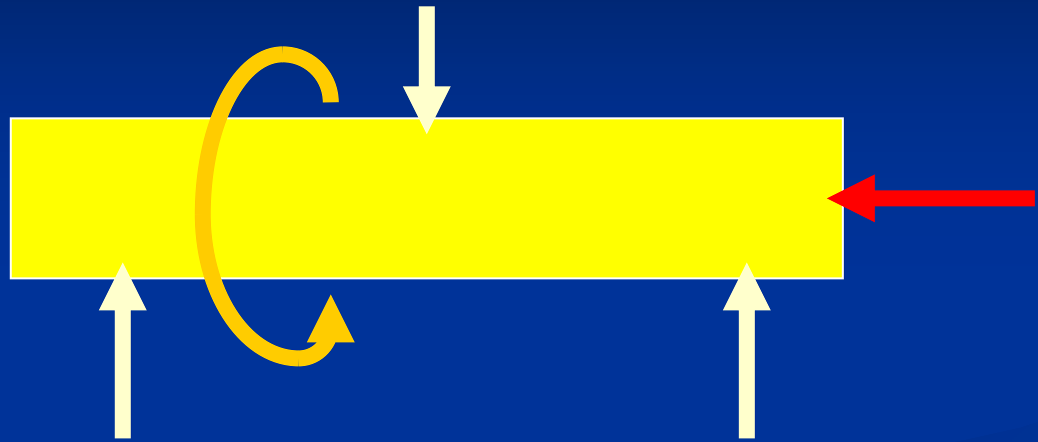


- Biologic fixation-
  - plate bridges the fractur site and allows controlle motion

  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

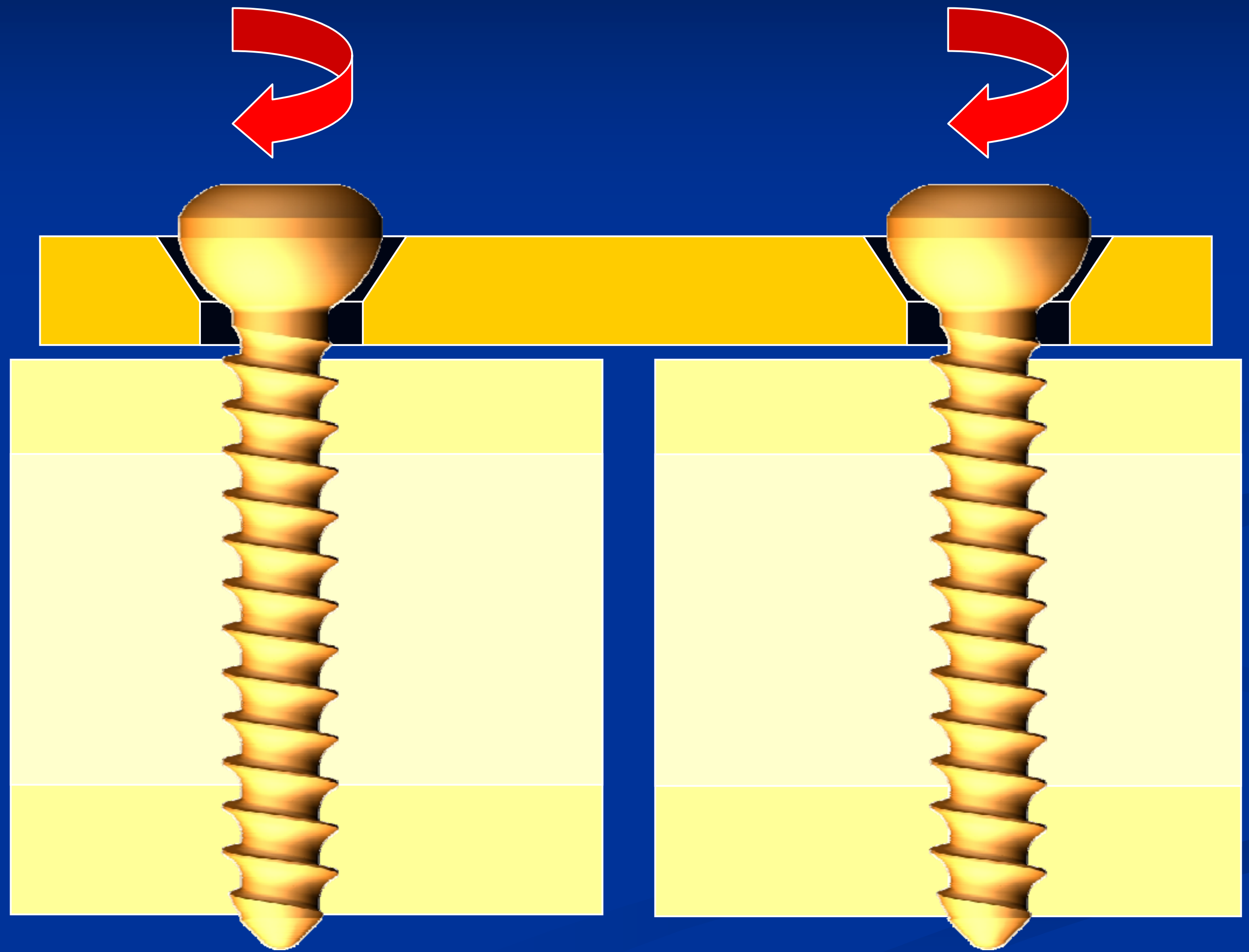
1. Axial Load
2. Bending Load
3. Torsion



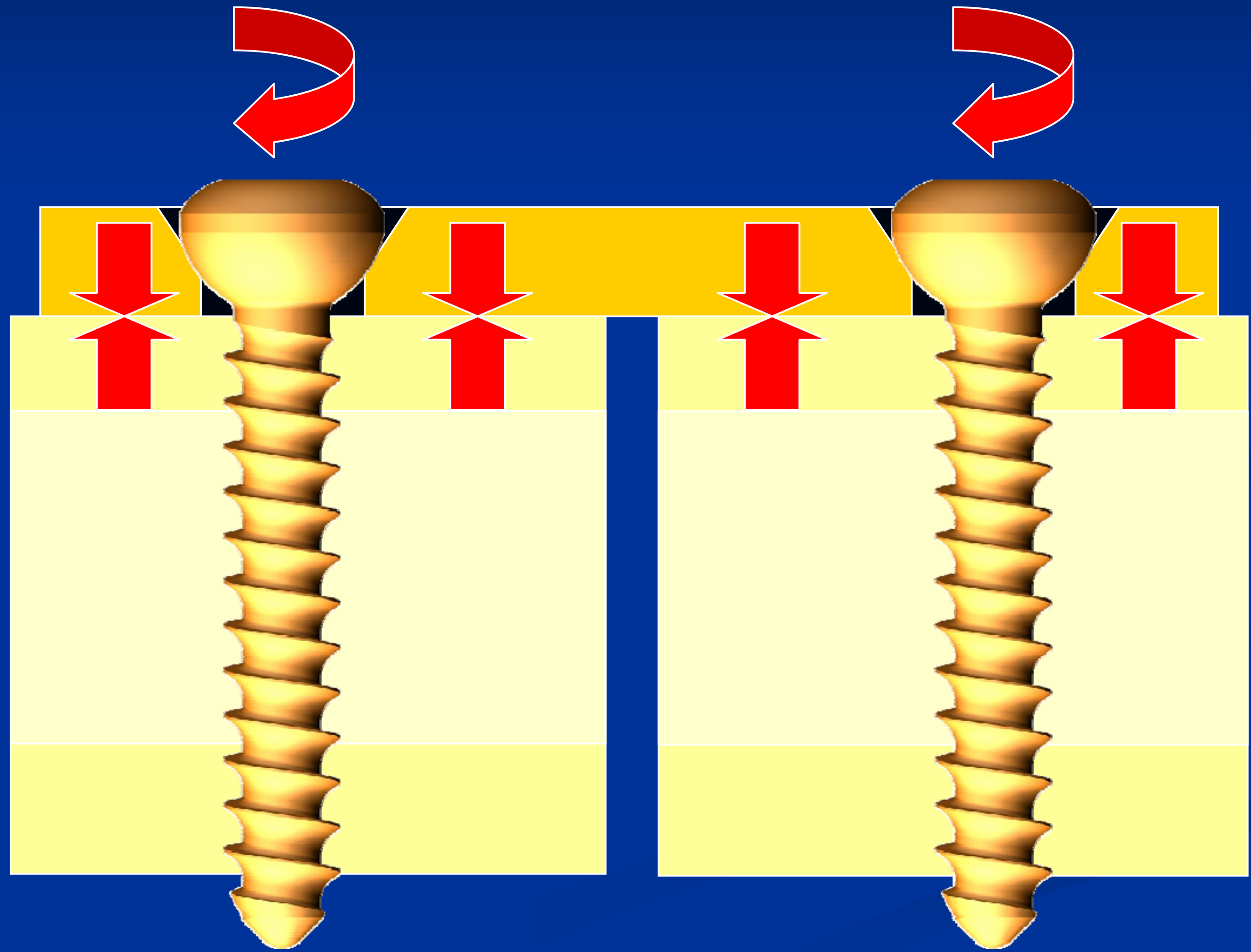
- Axial stress (tension and compression)
- Shear stress at plate bone interface

Conventional Plate Biomechanics

Stability by plate ⇔ bone friction

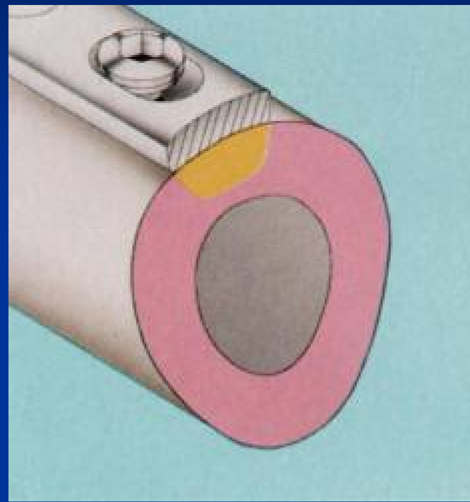


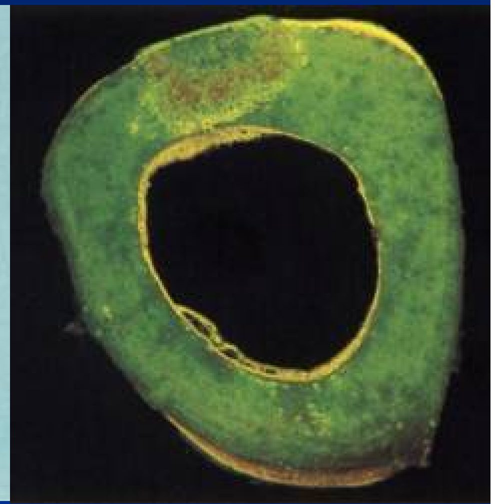
Stability by plate ⇔ bone friction



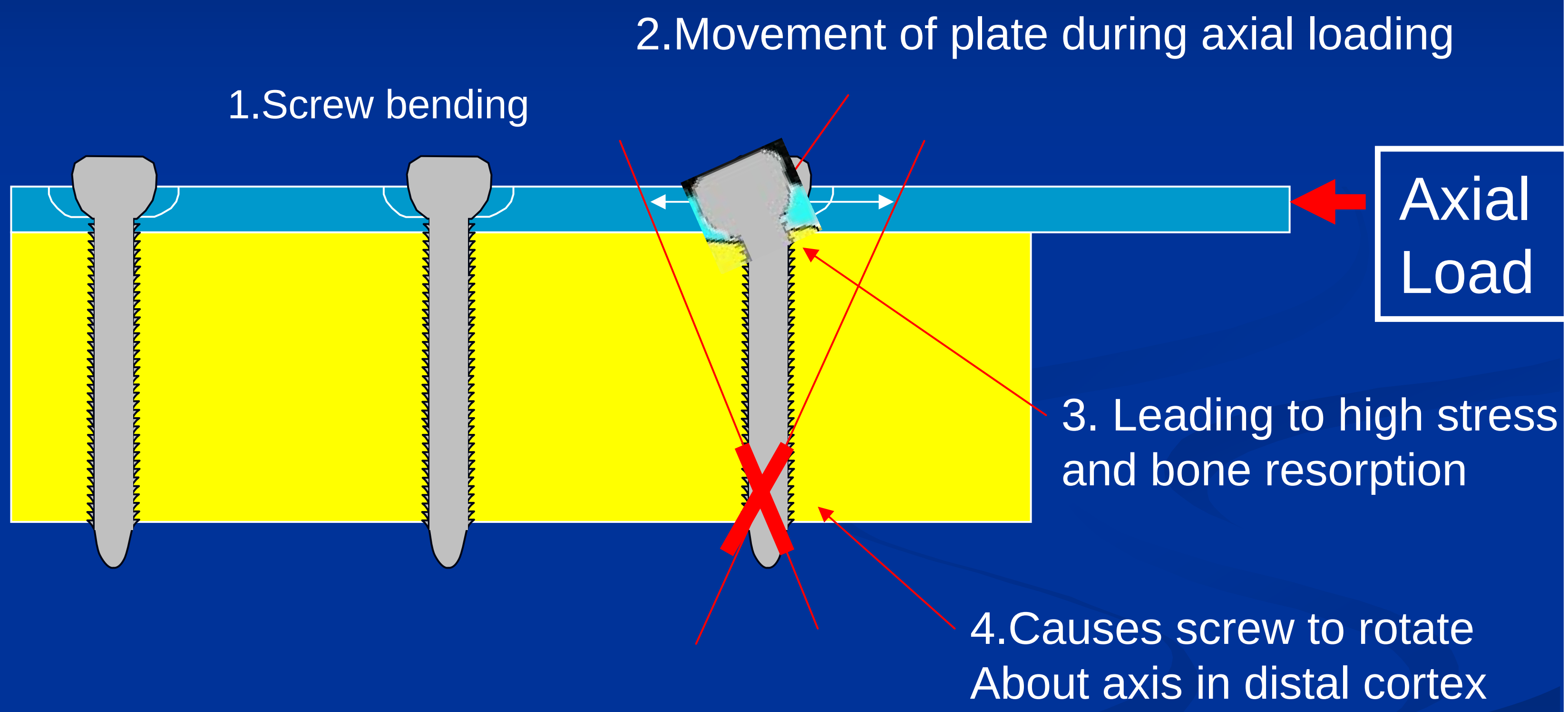
Periosteal Necrosis

- 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



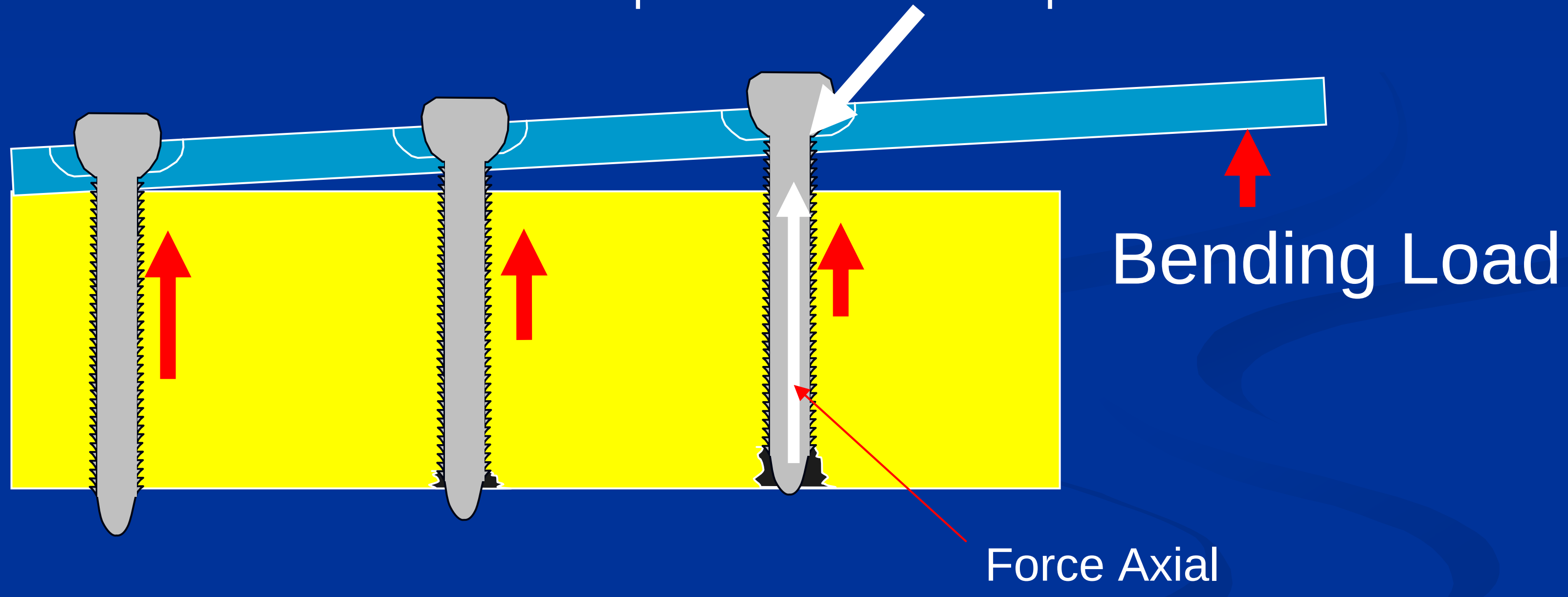


Conventional Plate



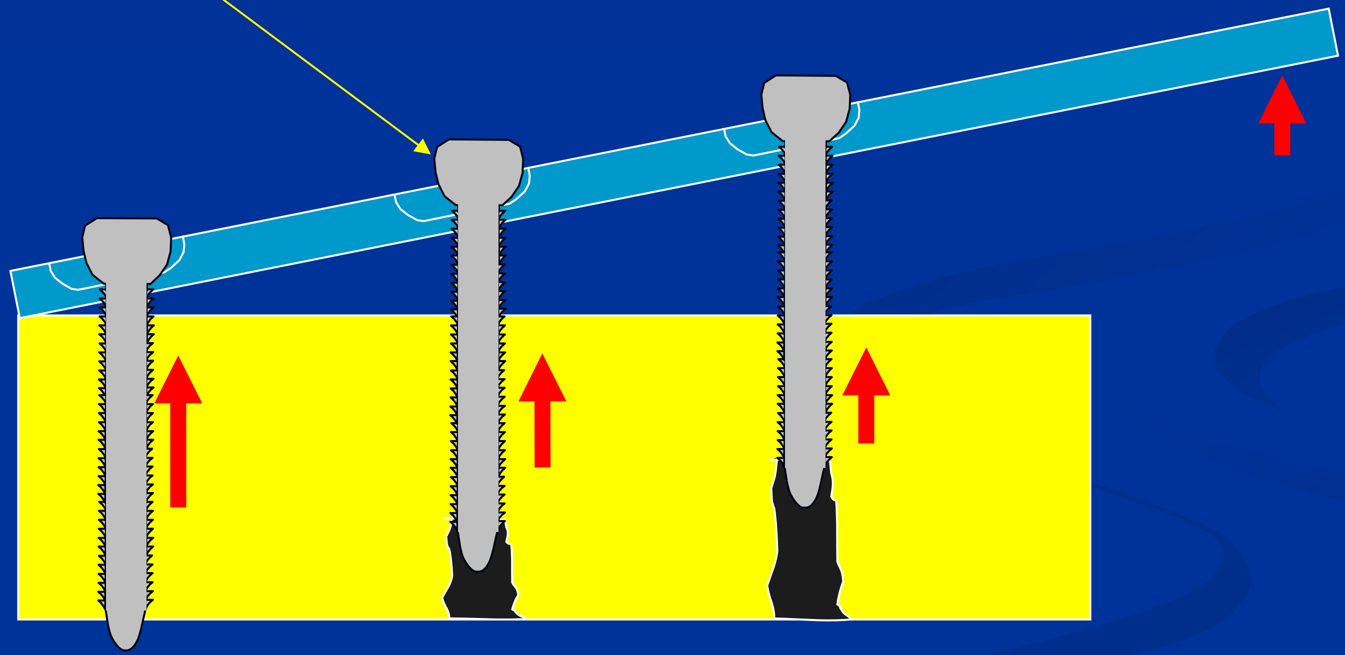
Conventional Plate

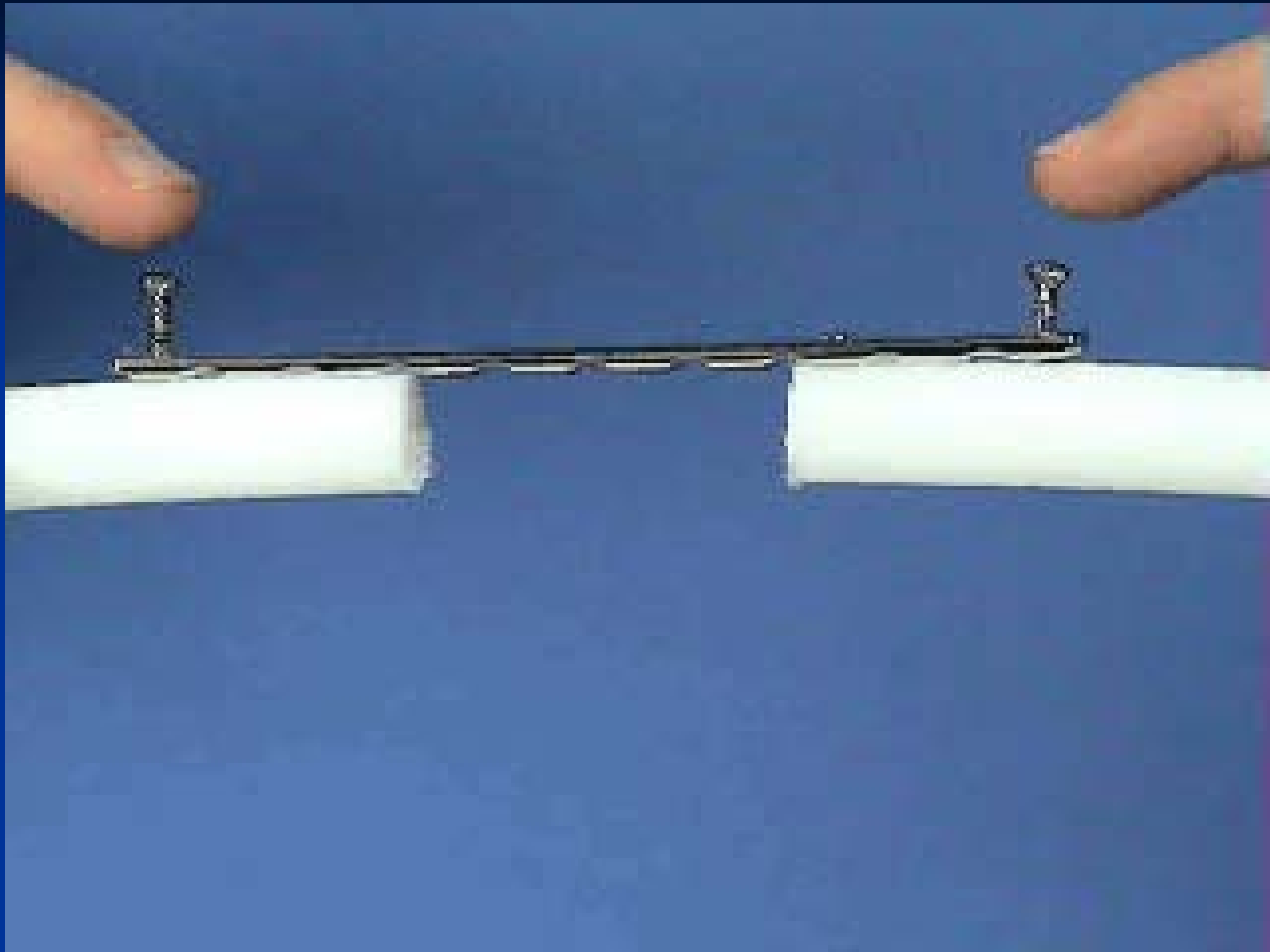
Force applied: screw orients to force. As this occurs strength of fixation equals thread pullout strength of single screw at the distal or proximal end of the plate.



Conventional Plate

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

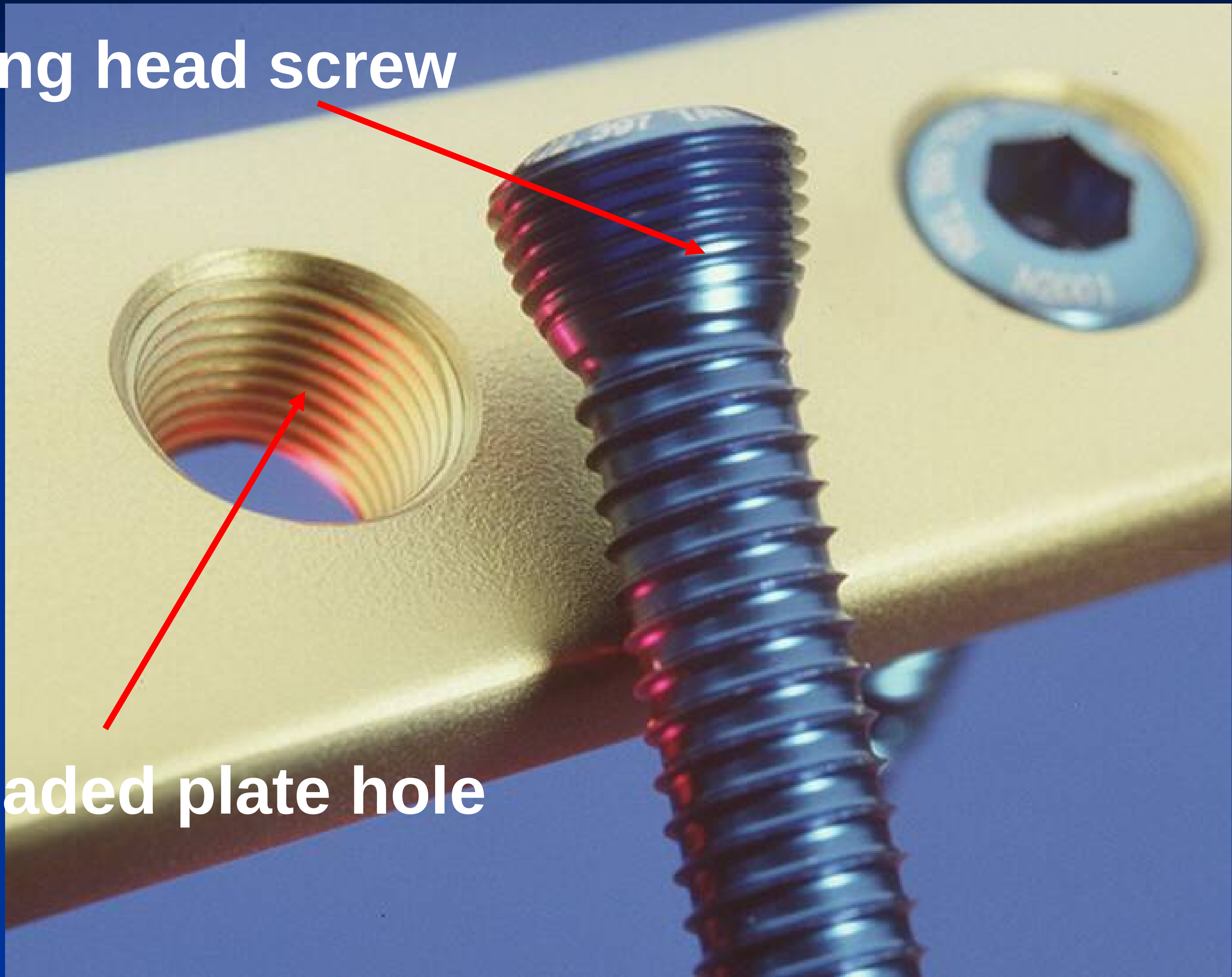




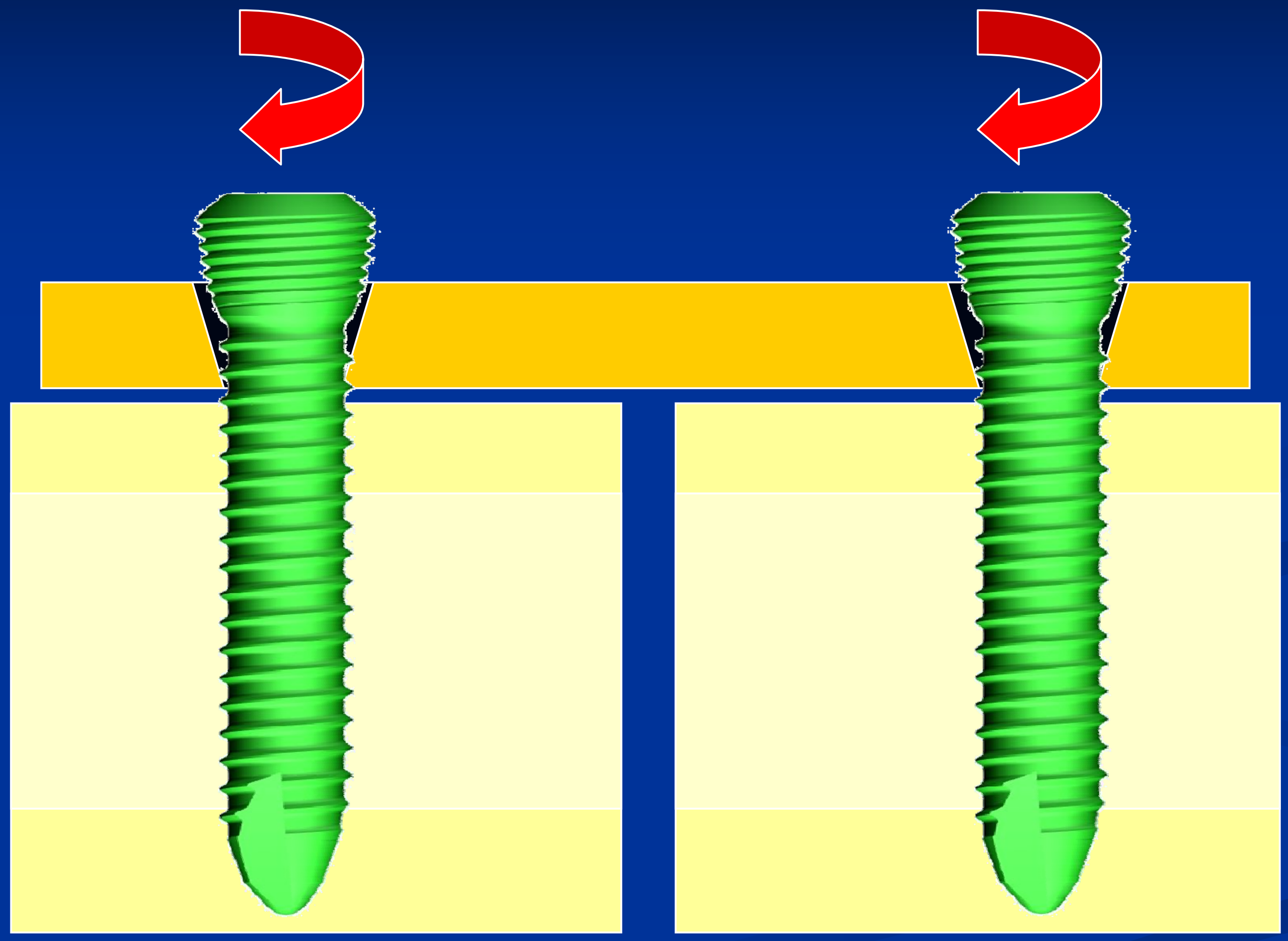
Limitations of Conventional Plates

- 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

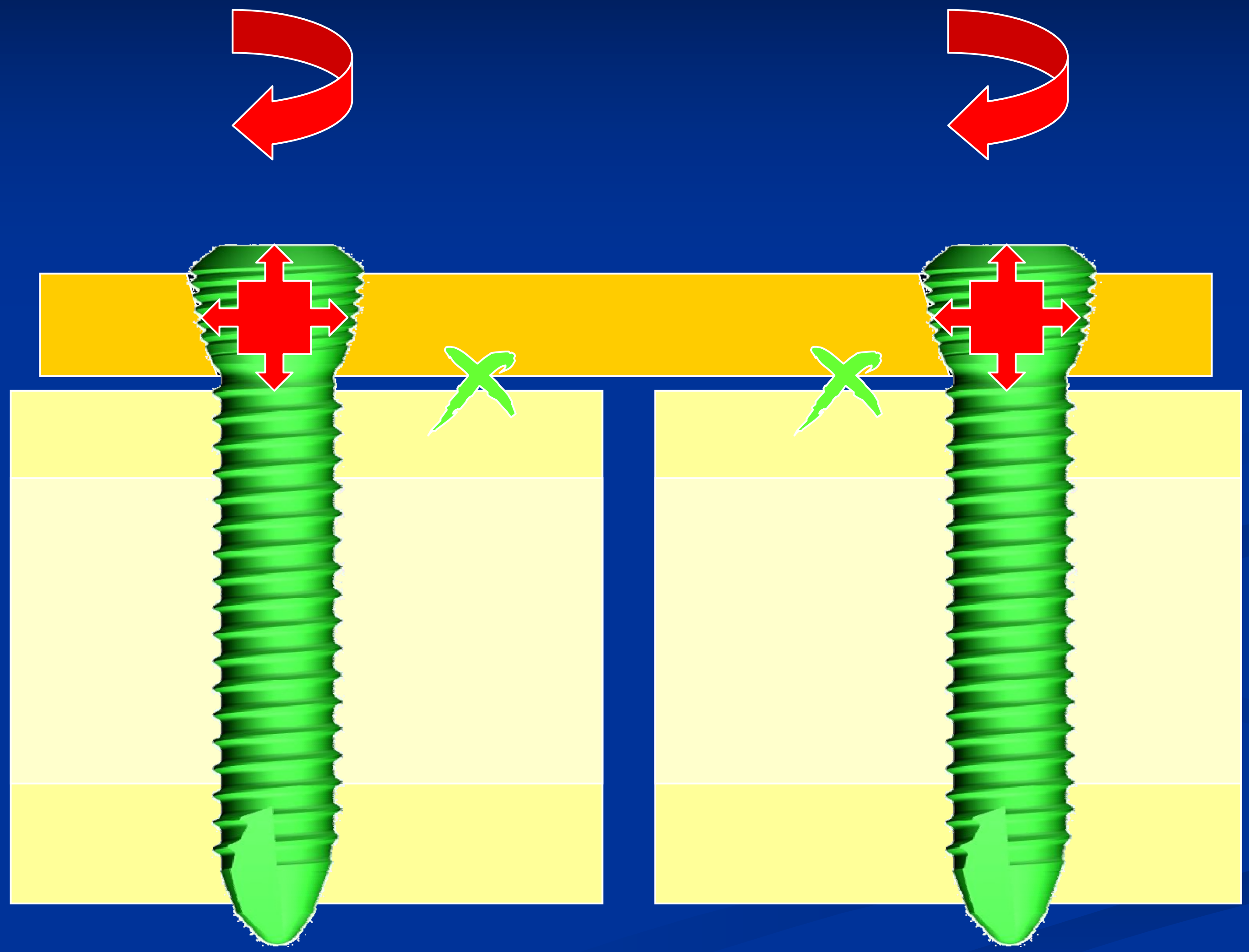
Locking plate - Internal Fixator



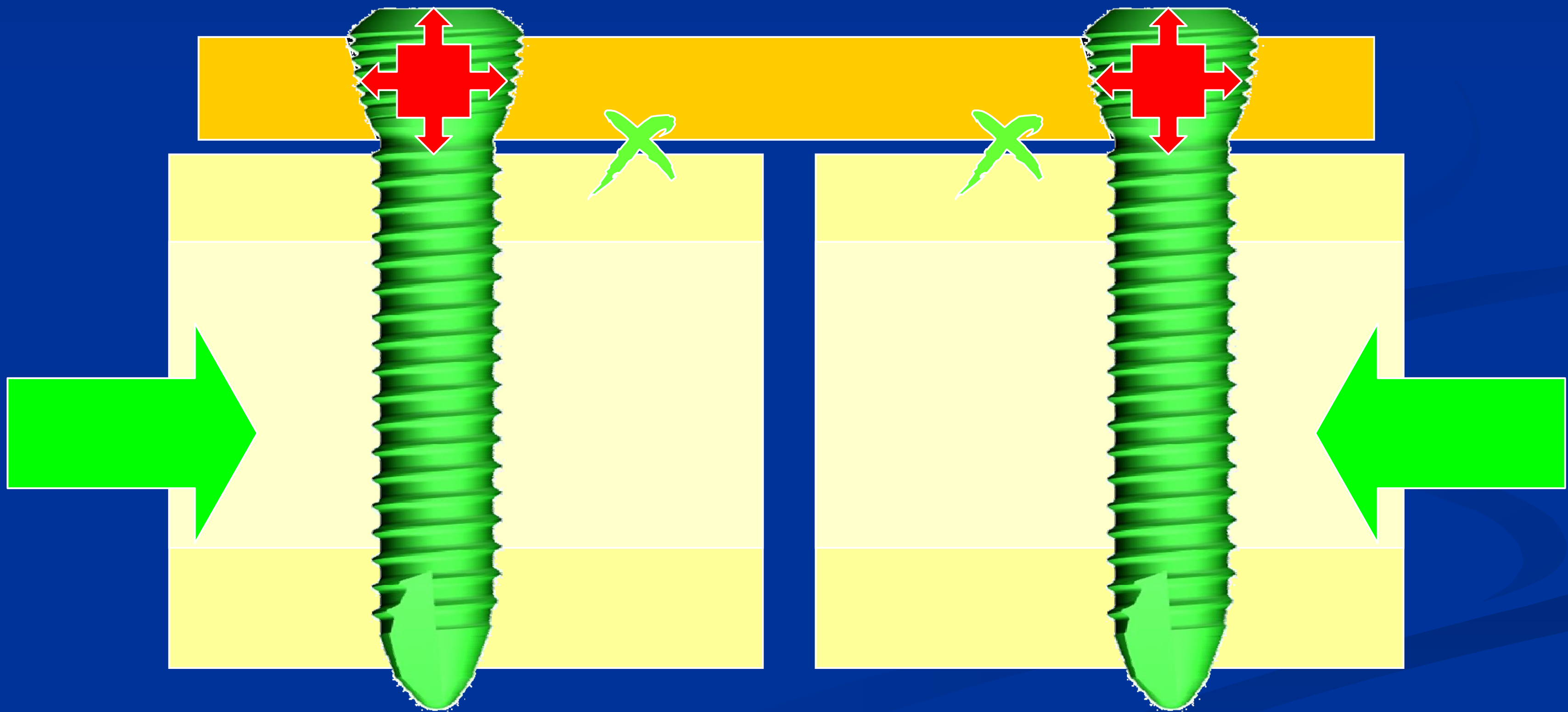
Internal Fixator



Internal Fixator

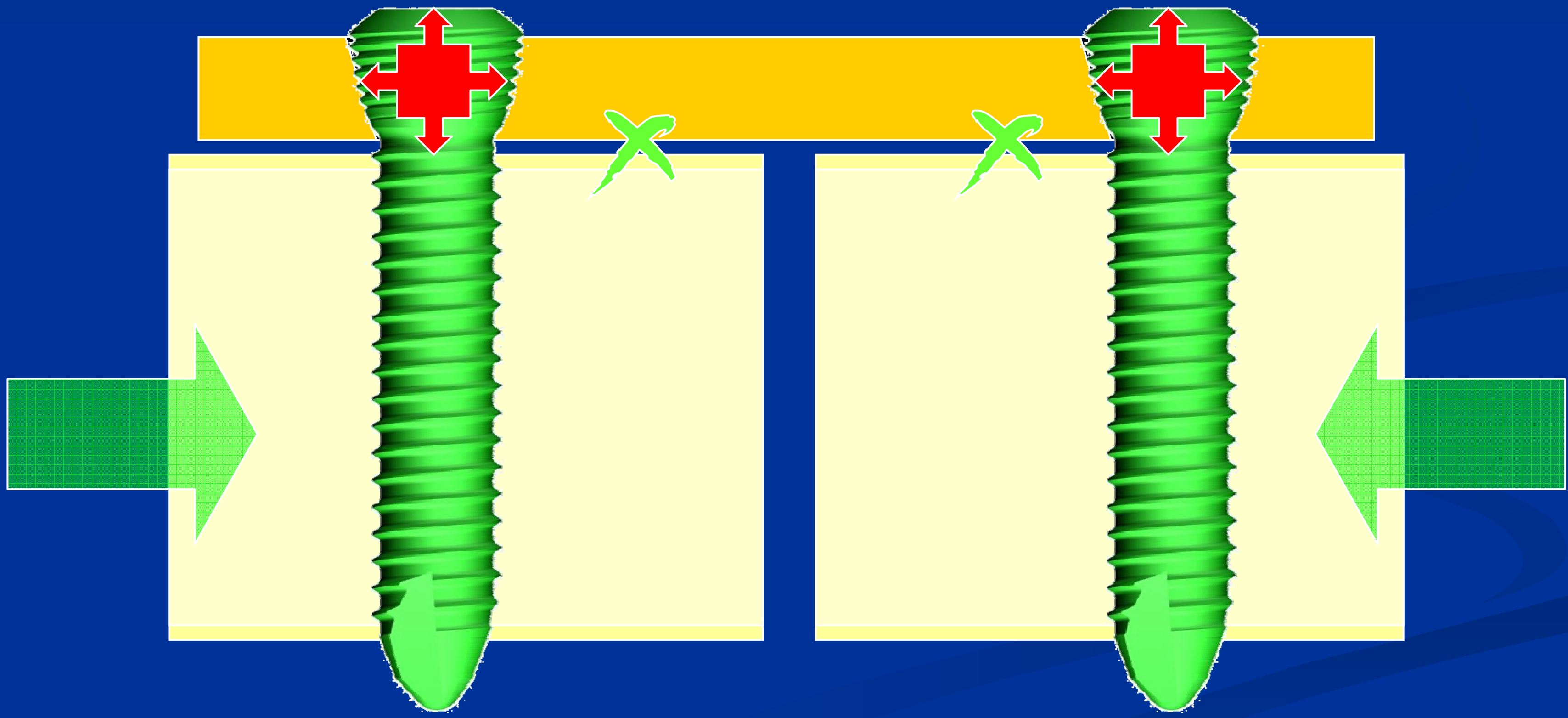


Internal Fixator



Internal Fixator

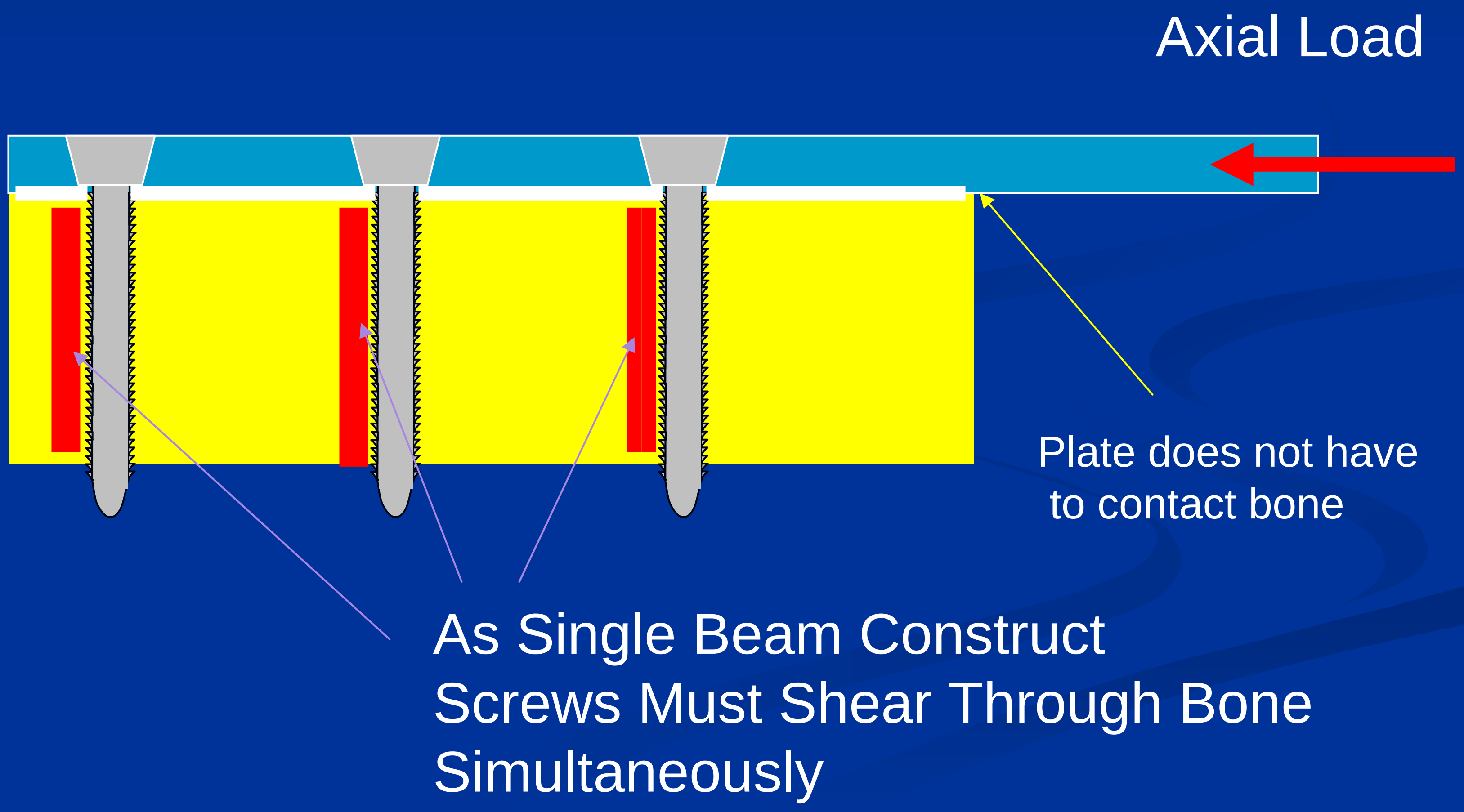
Porotic bone



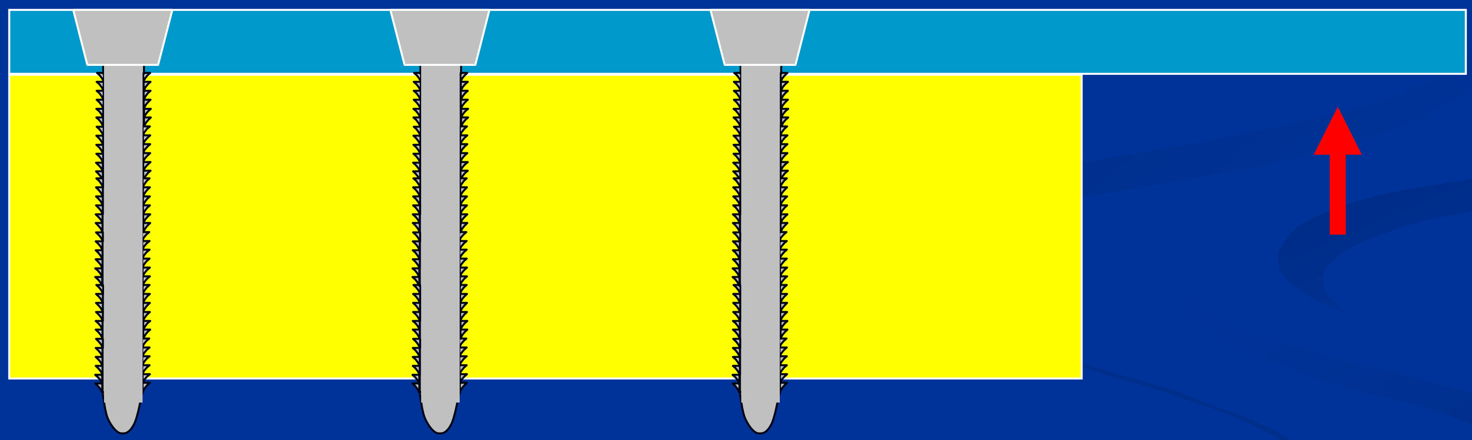
Theoretical Advantages

- 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

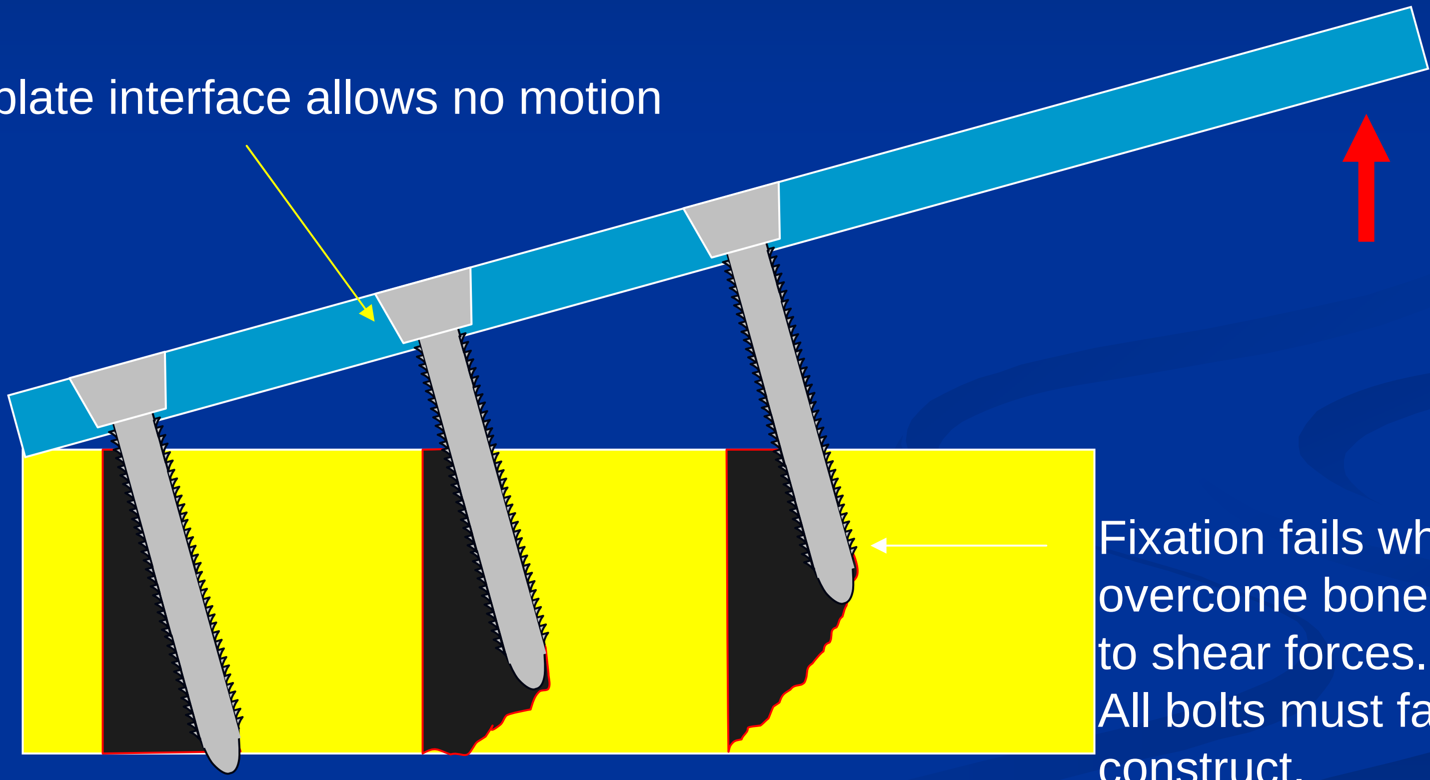
Locking Plate



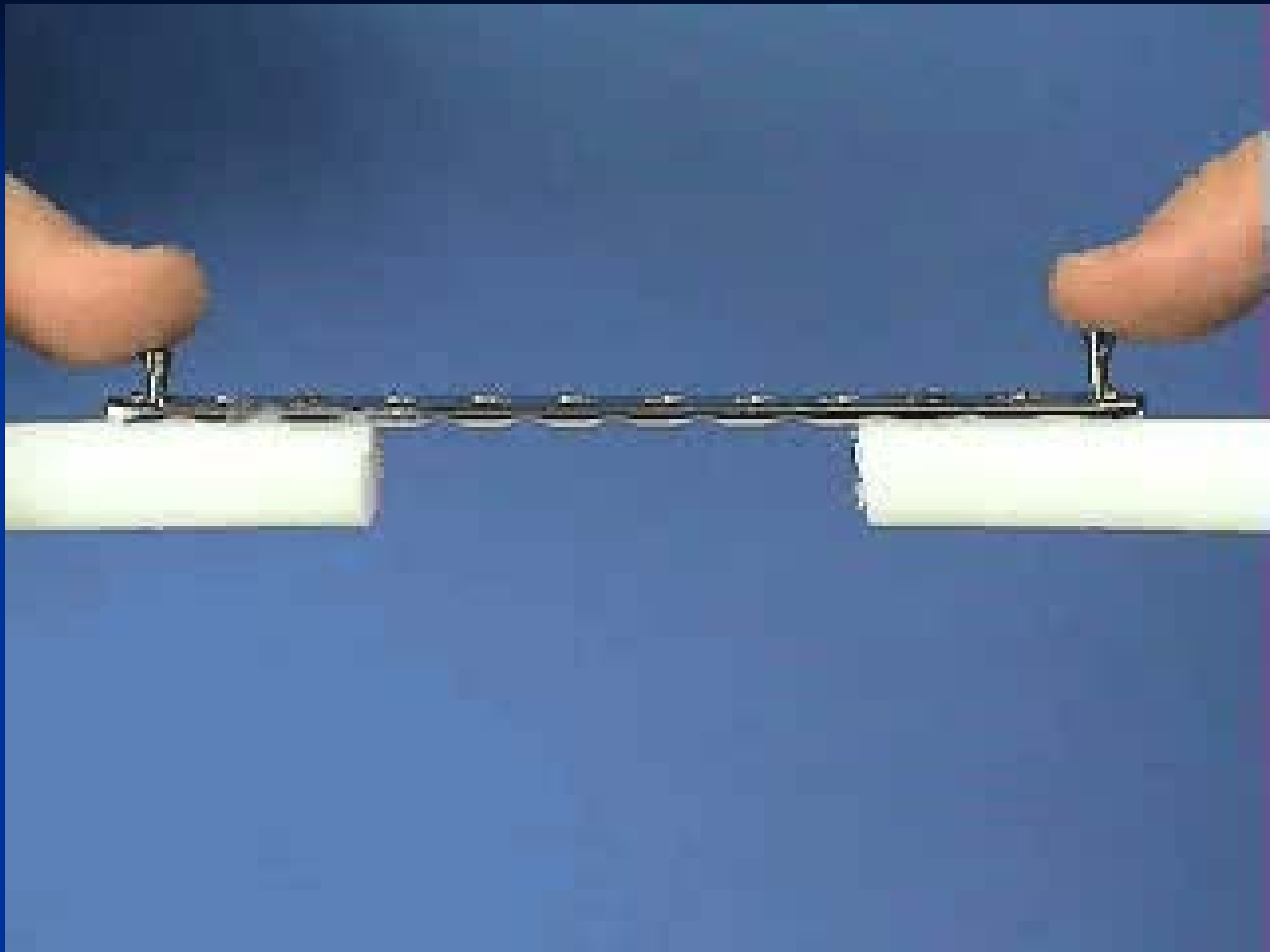
Locking Plate



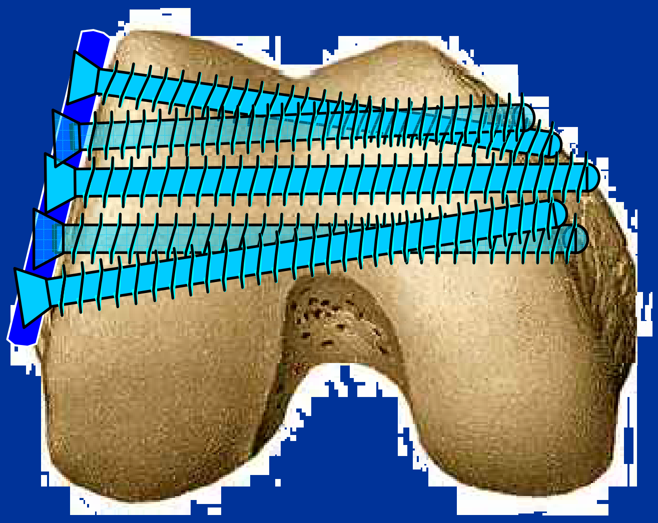
Locking Plate

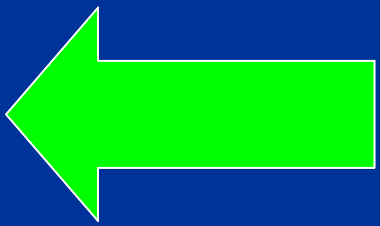


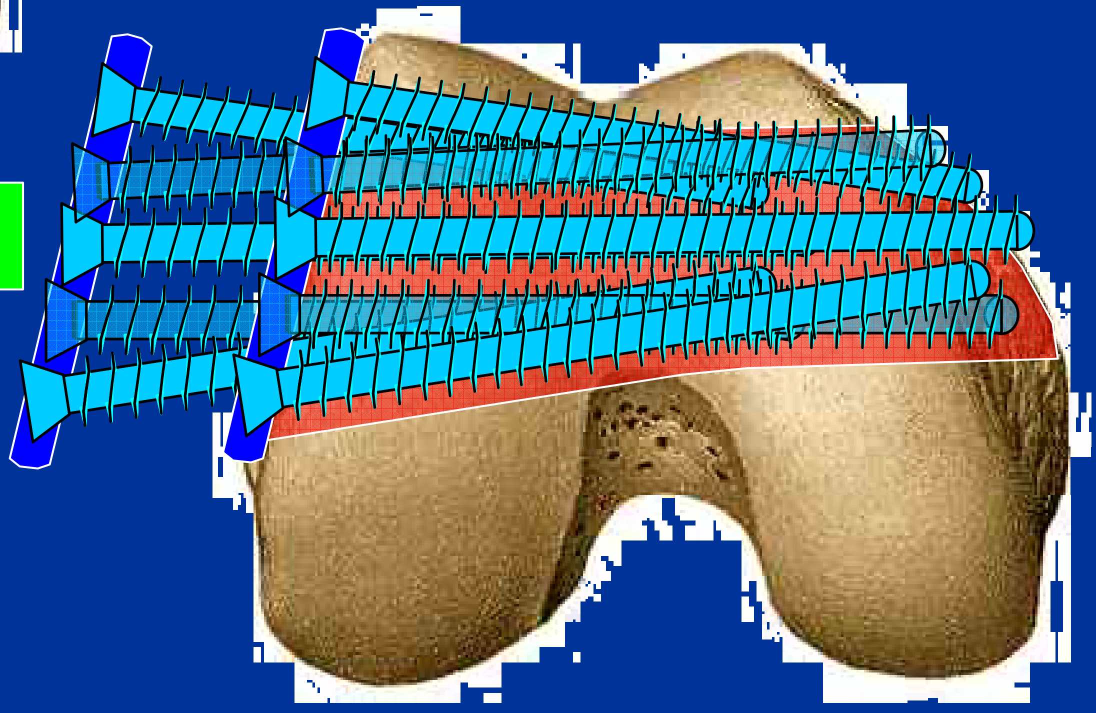
Fixation fails when bolts overcome bone's resistance to shear forces.
All bolts must fail as a single construct.

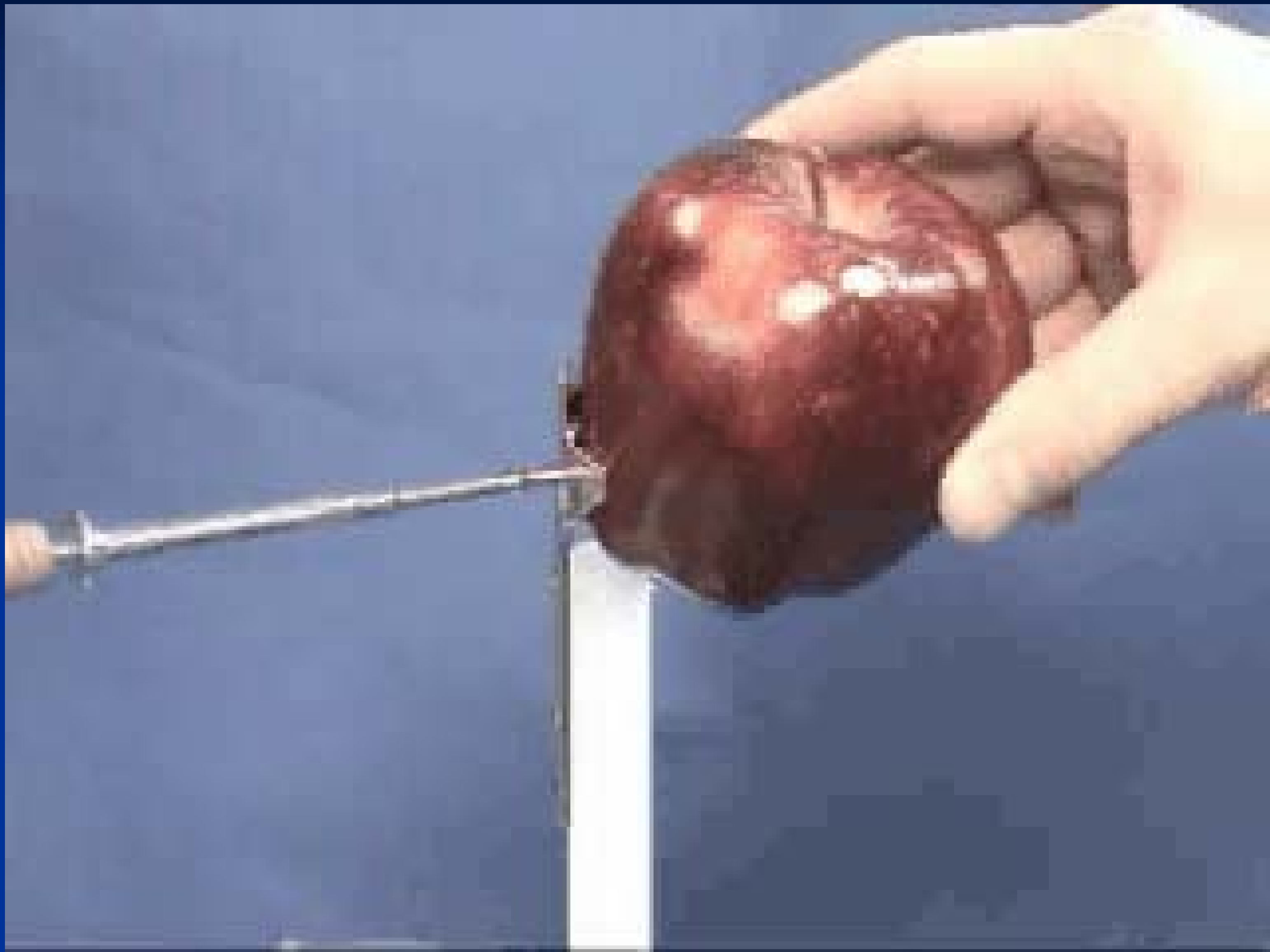


Screws with angular stability in different directions

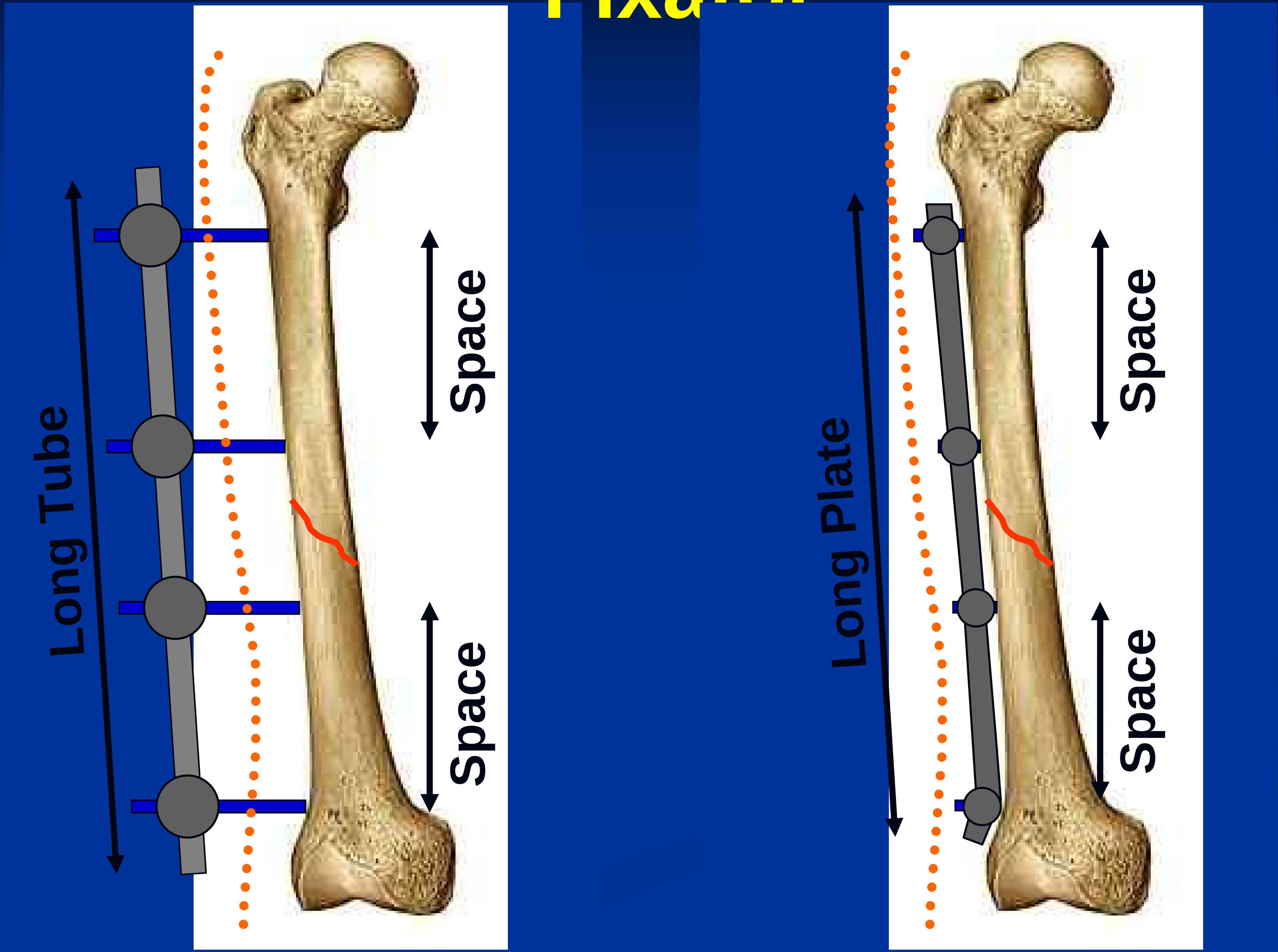




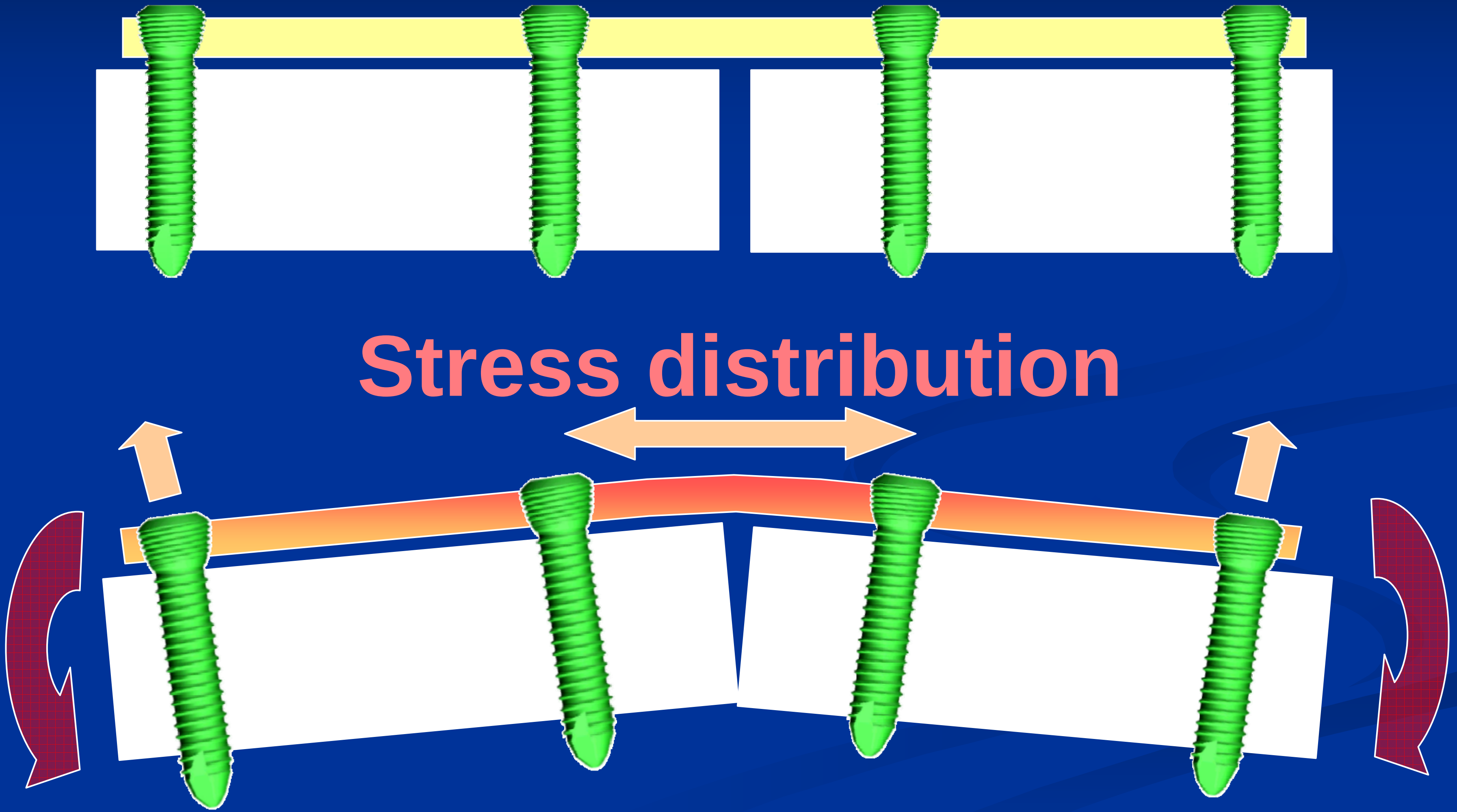




Locking plate = internal, external Fixator



Biomechanical principles similar to those of external fixators



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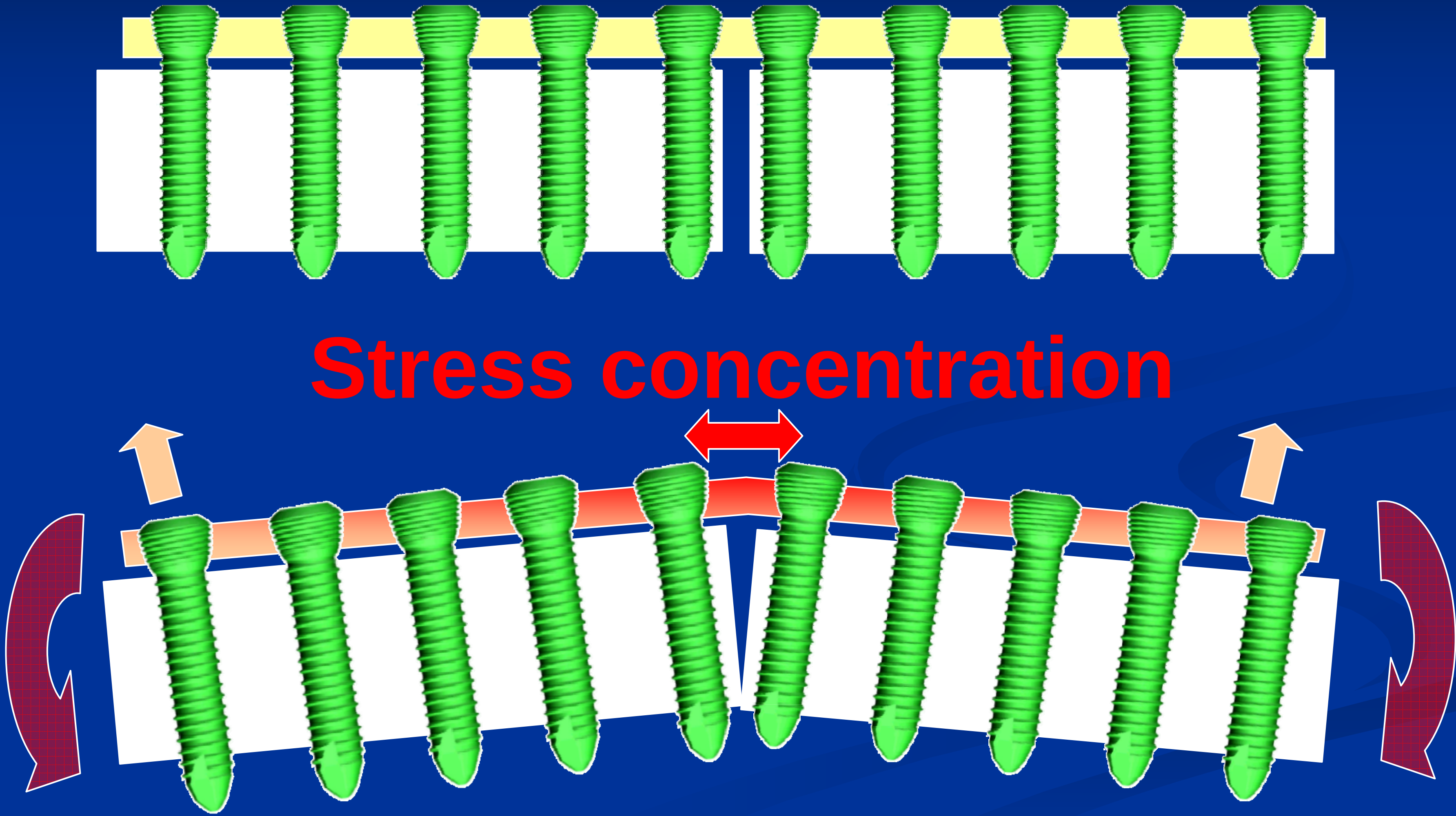
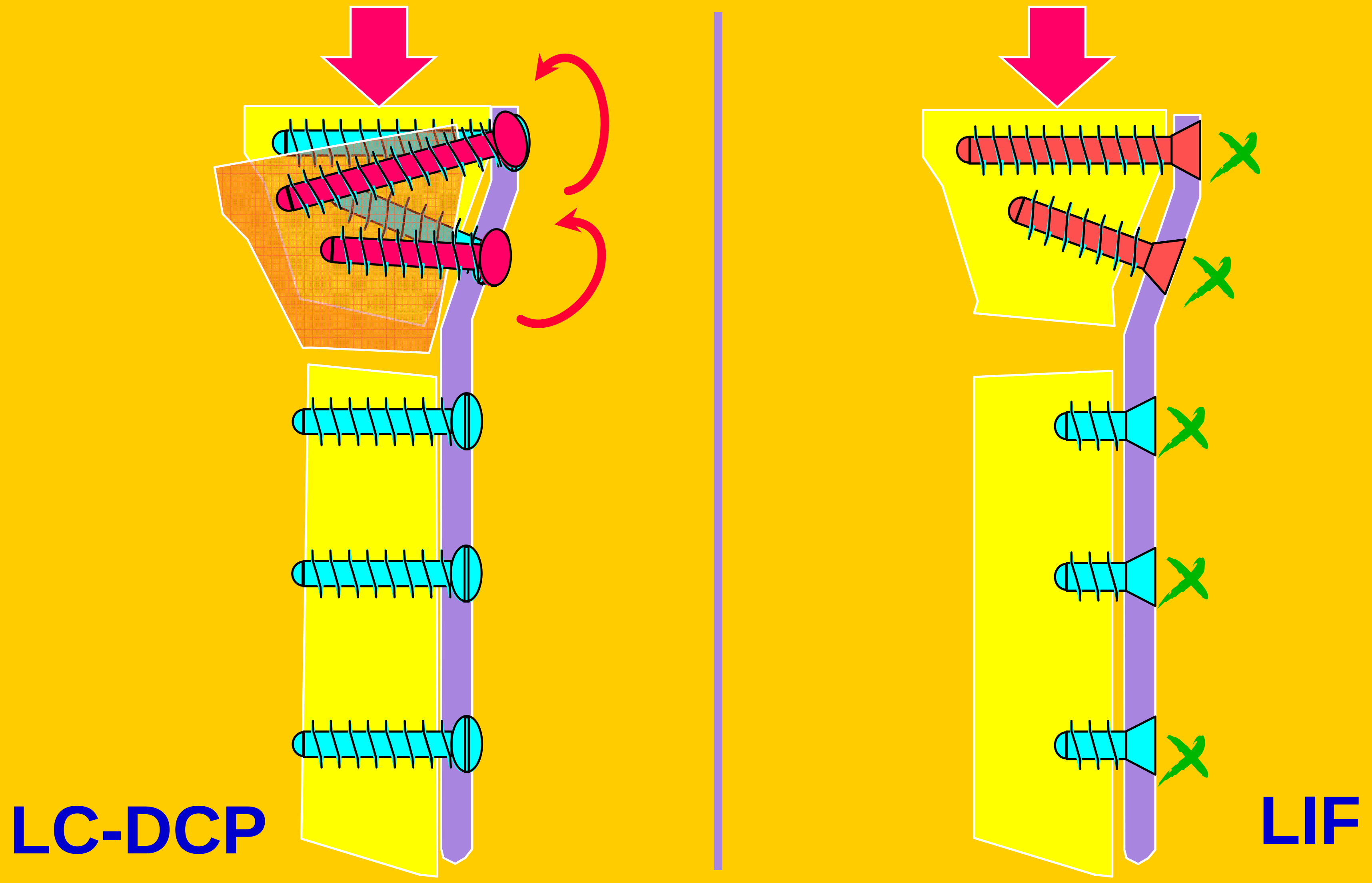


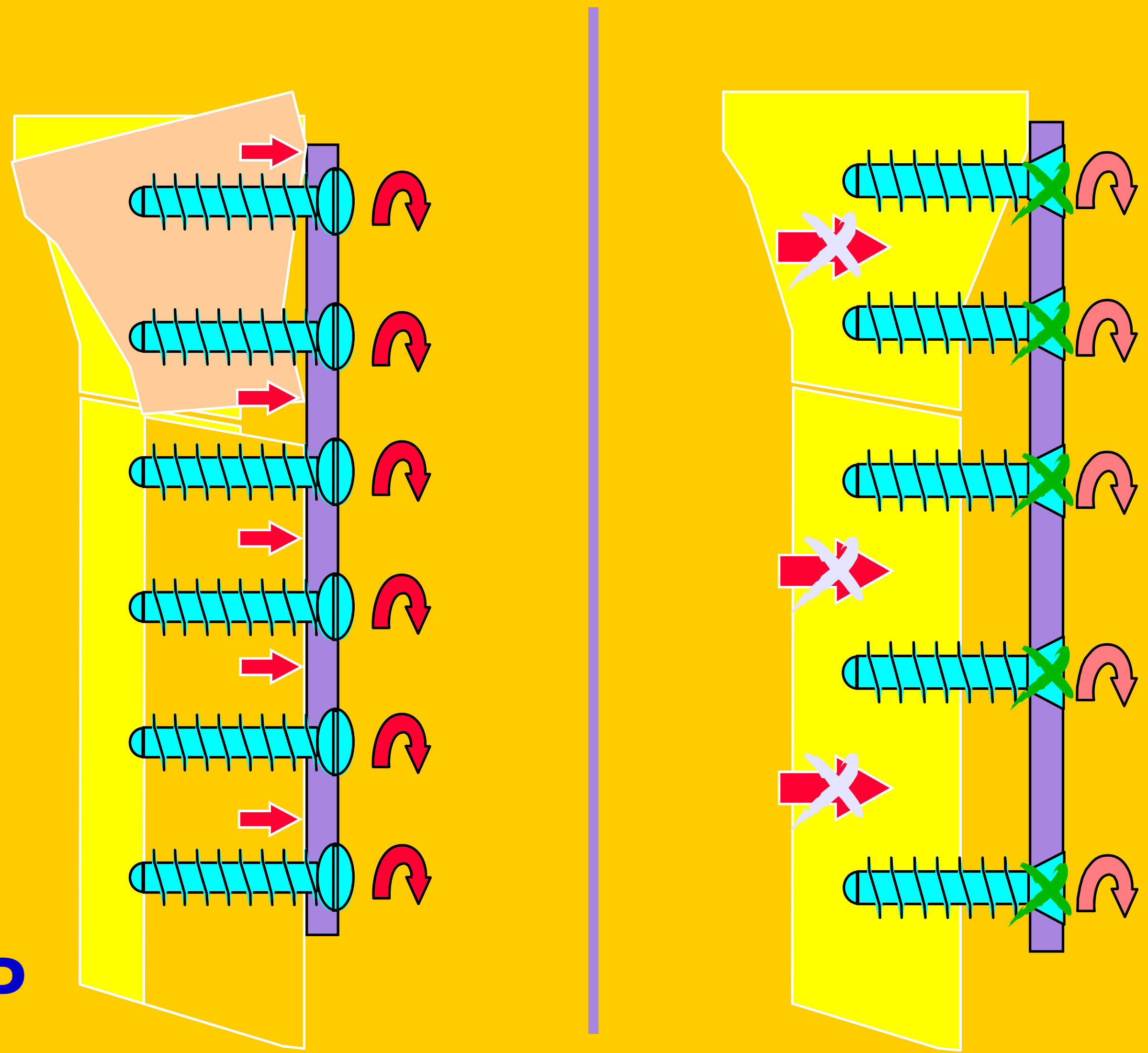
Advantages of int. Fixators

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



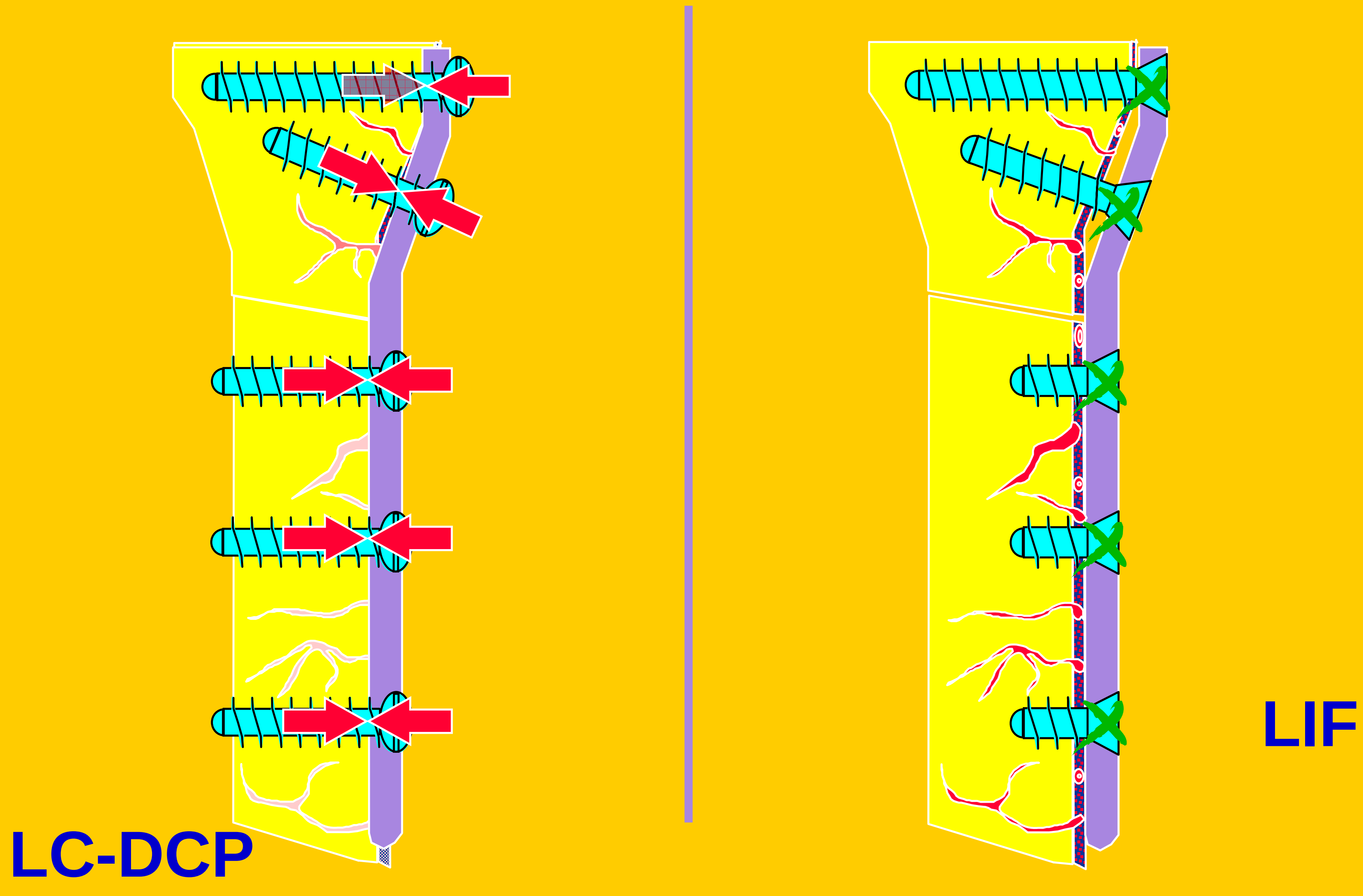
2. No accurate Plate Contouring required



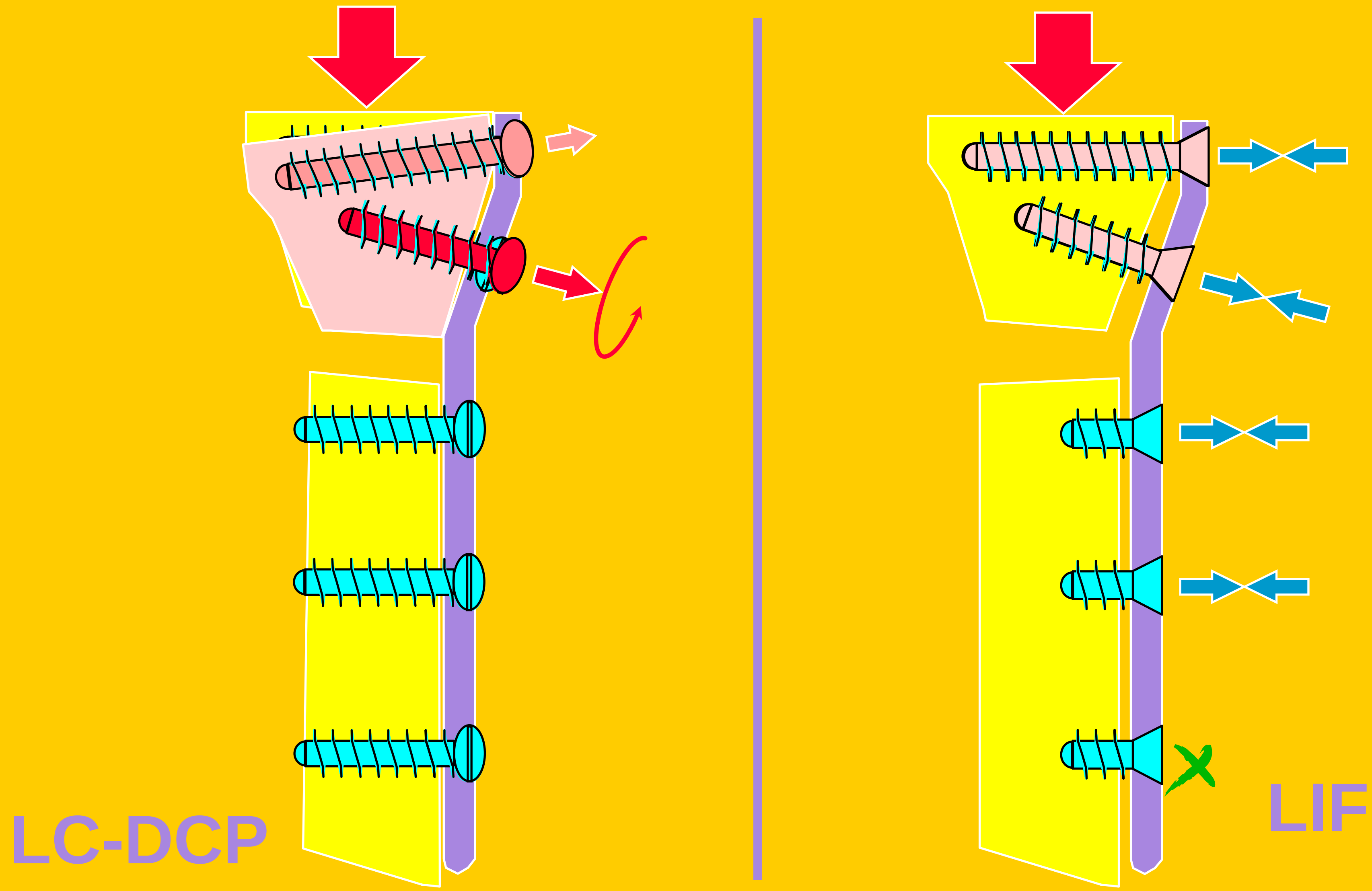
LC-DCP

LIF

3. Less Damage to Periosteum

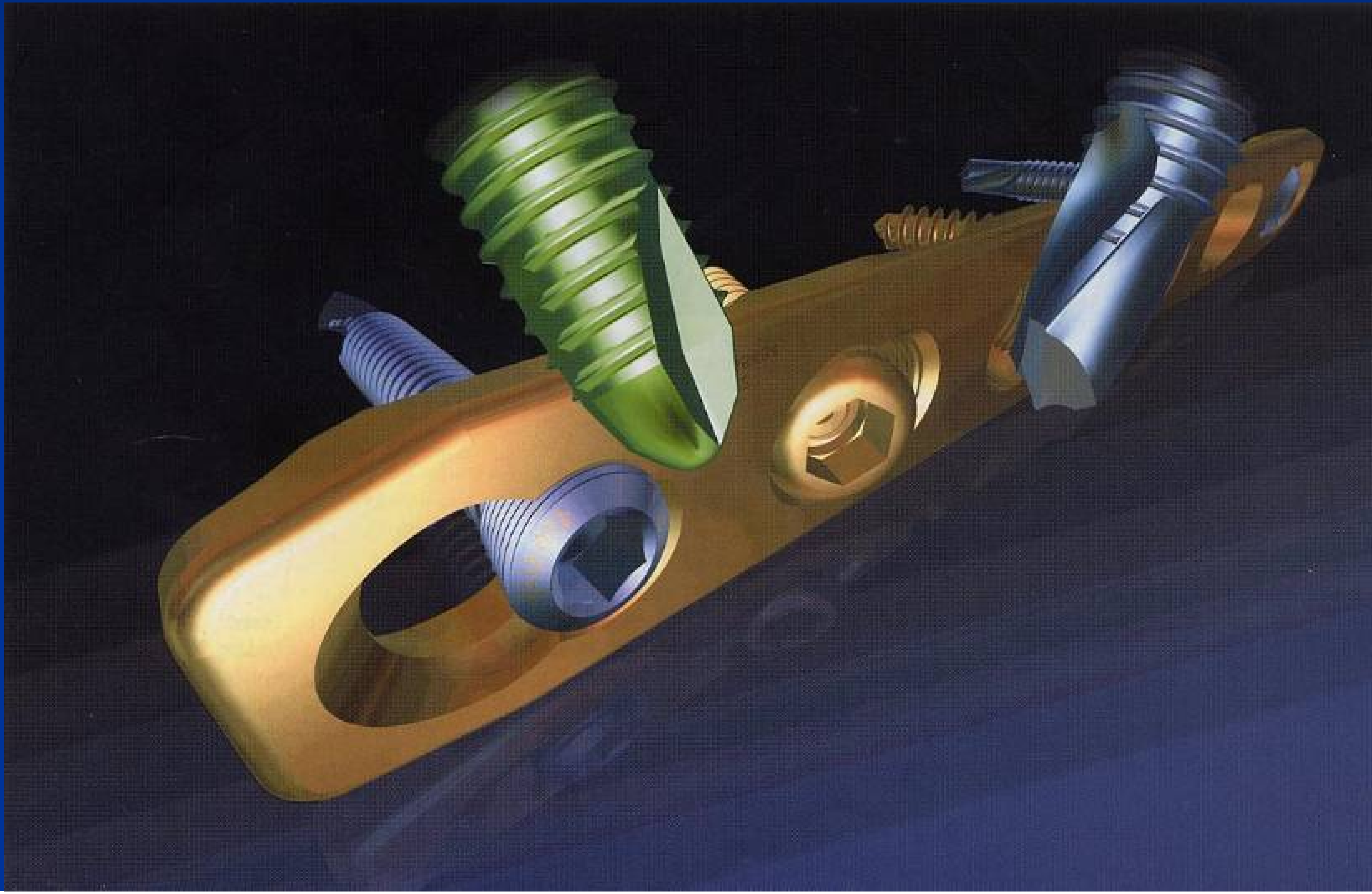


4. Less Screw Loosening

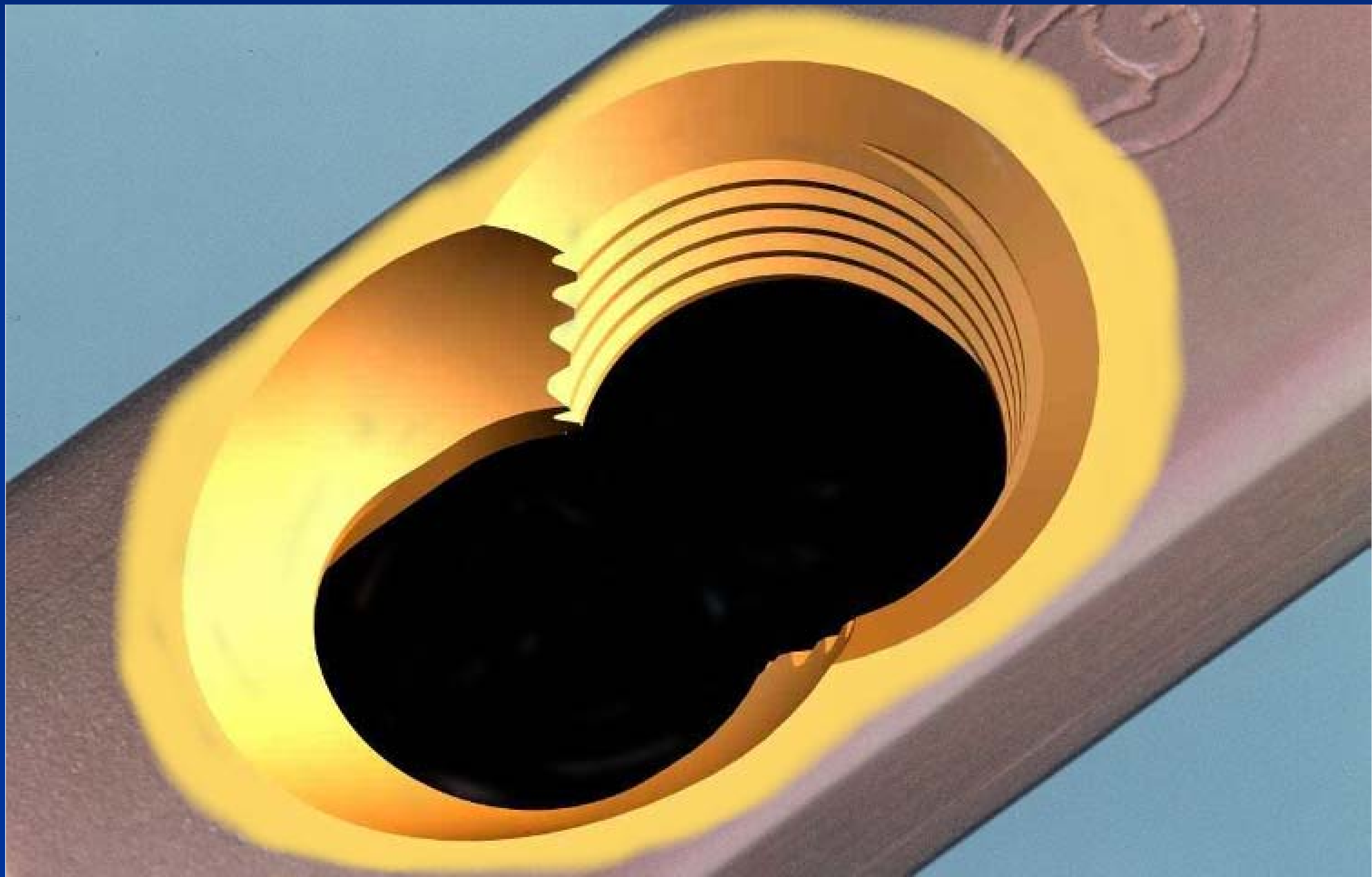


Application

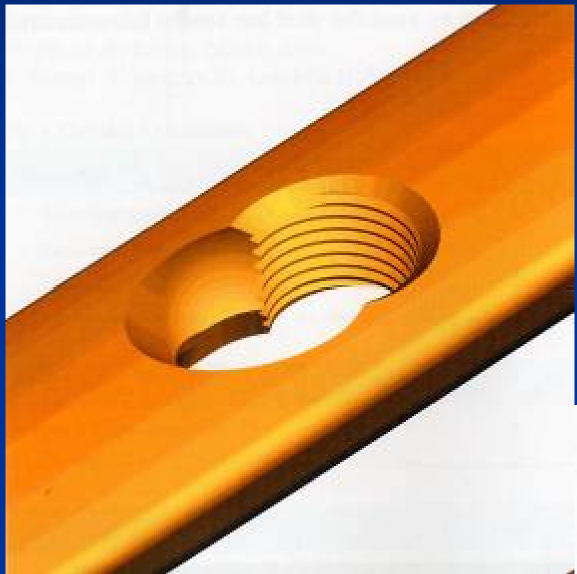
LCP
Locking Compression Plate



Compression Plate and Fixator



LCP
Locking Compression Plate



LCP
Locking Compression Plate

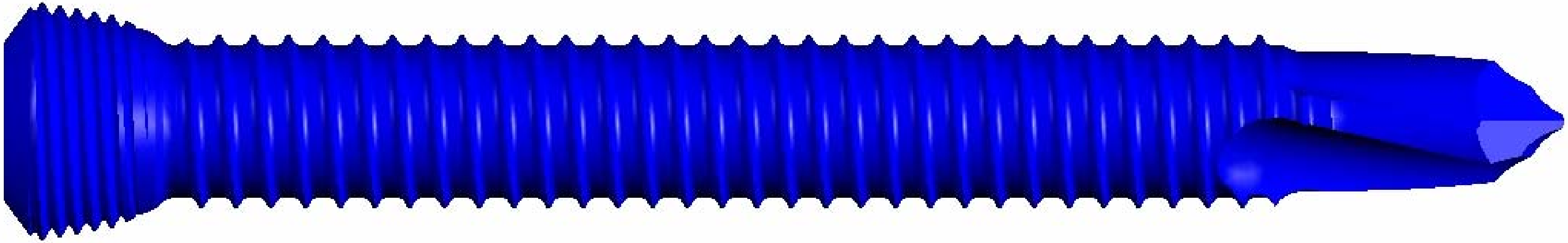
= DCP + Limited Contact + Locking Holes + Titanium

Some designed for specific sites.

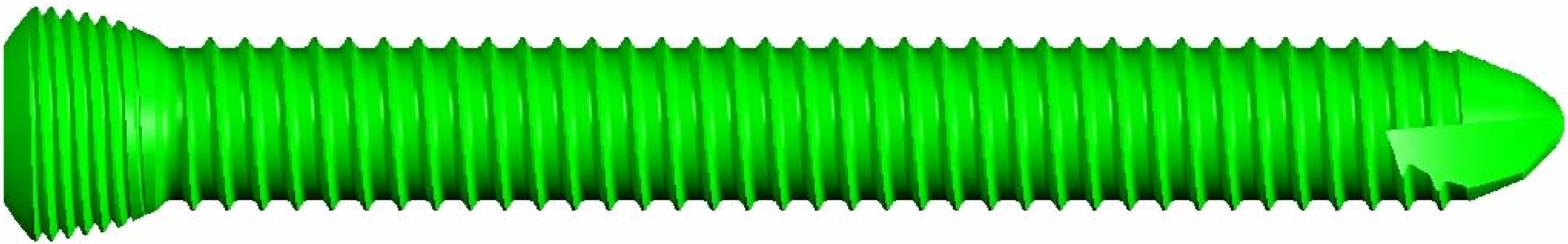
LCP
Locking Compression Plate

- 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

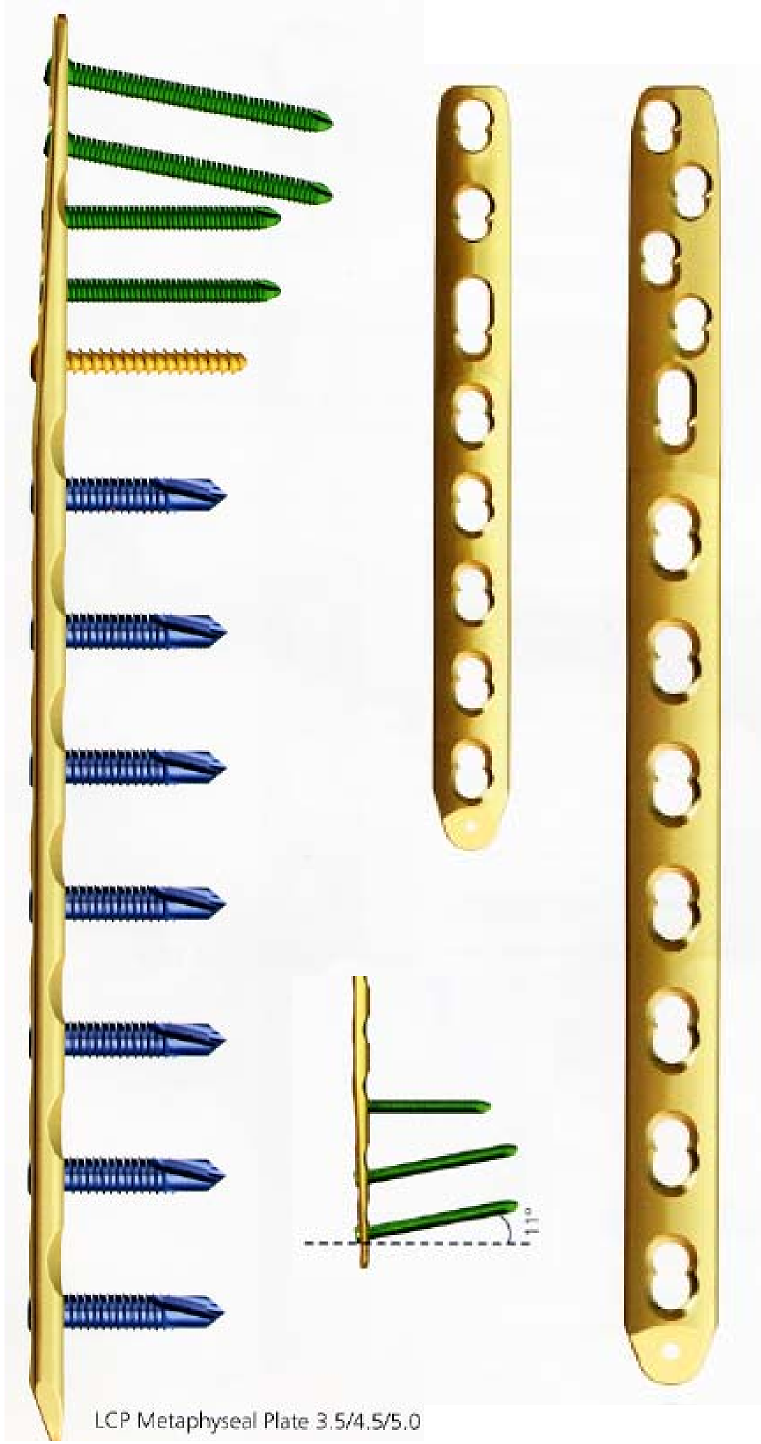


Self Taping & Self Drilling



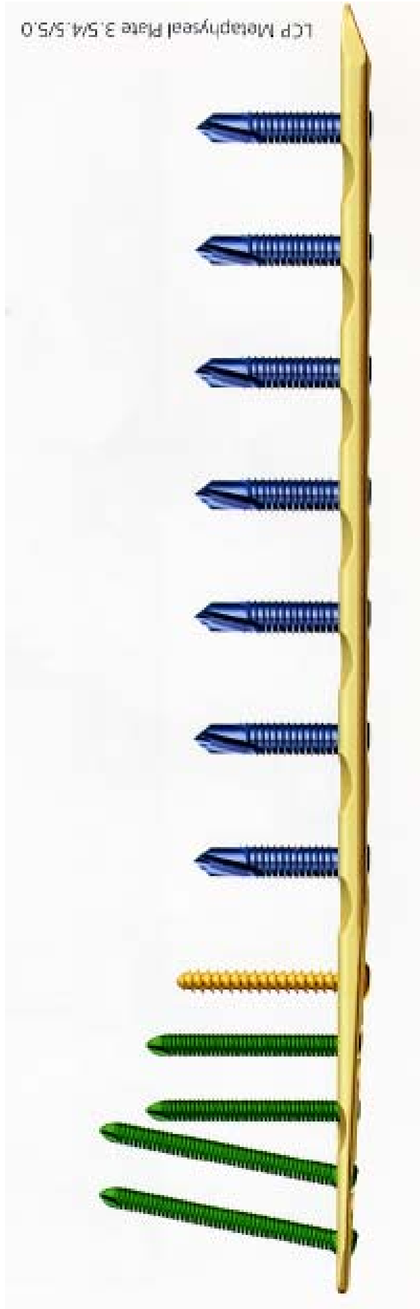
Self Taping

Metaphyseal plate

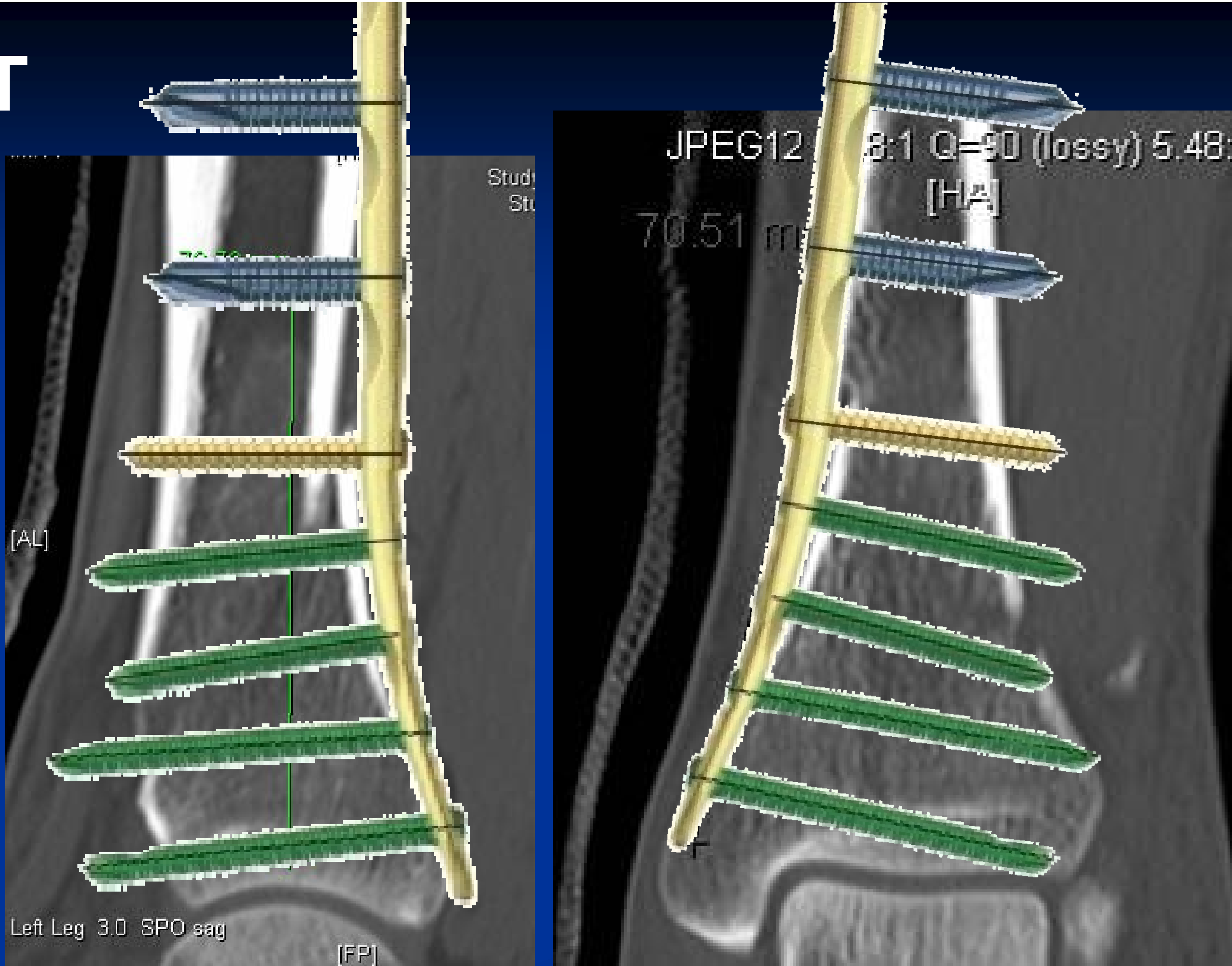


Pre-op planning

- XR



CT



Reduction

- Traction
- External fixation

Pre-contour of plate

Insertion of plate

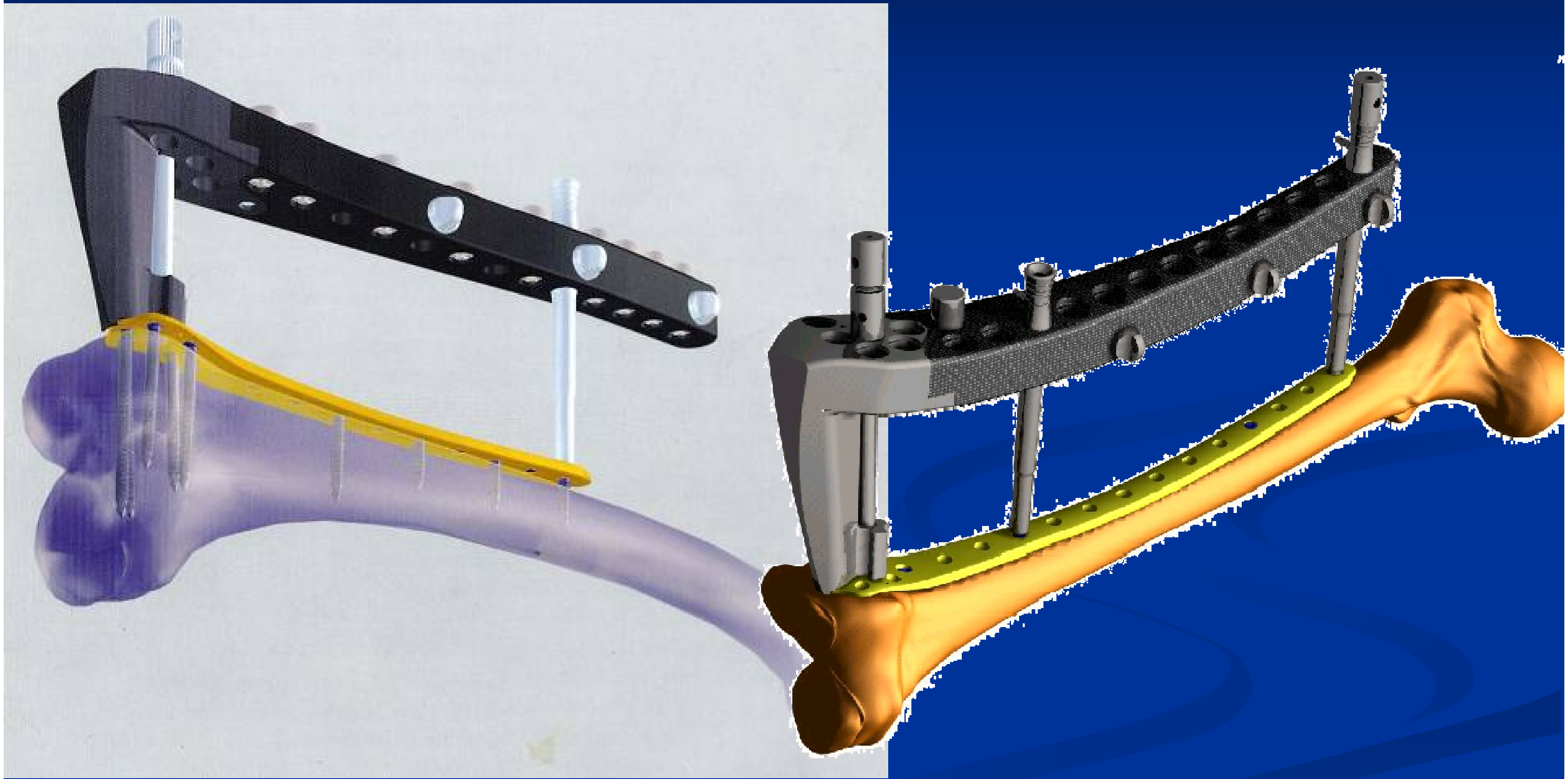
Place another plate on the surface of skin can guide your percutaneous skin incision for the locking screws.



Pre-contoured Locking plate

LISS

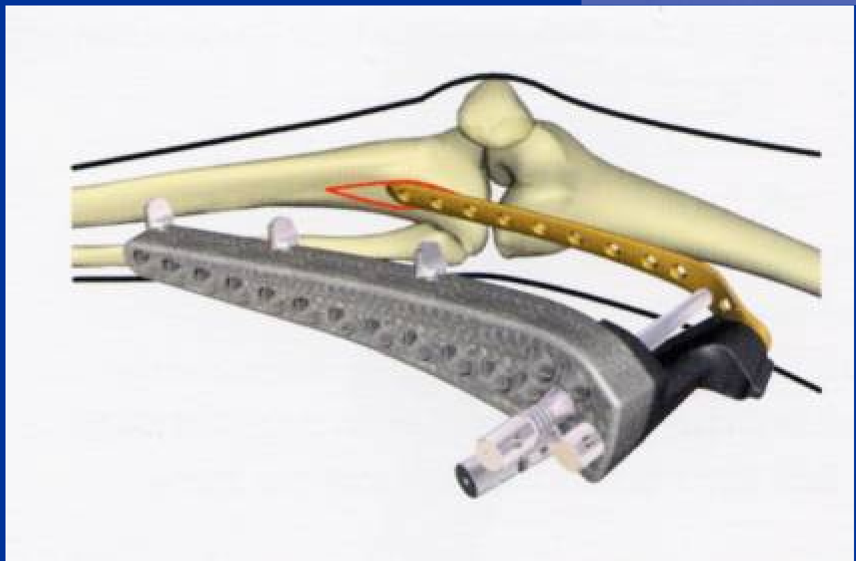
Less Invasive Stabilisation System

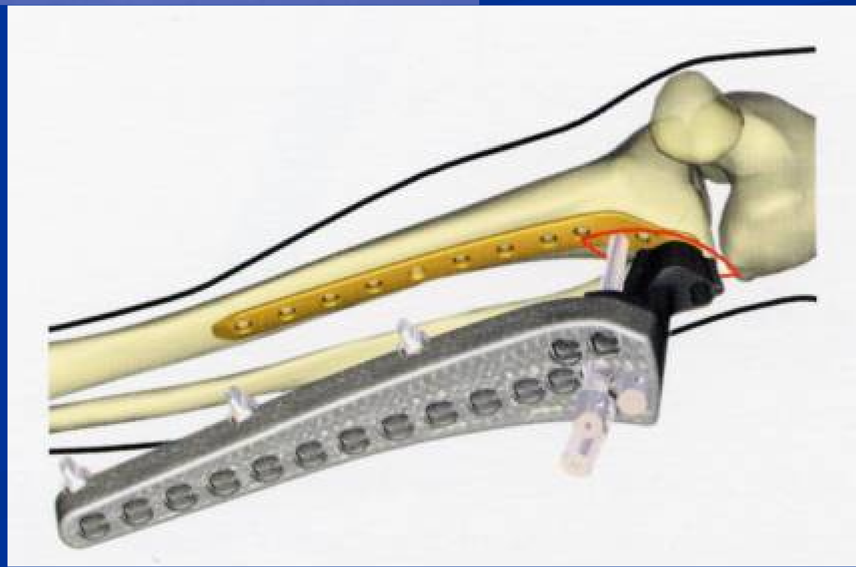


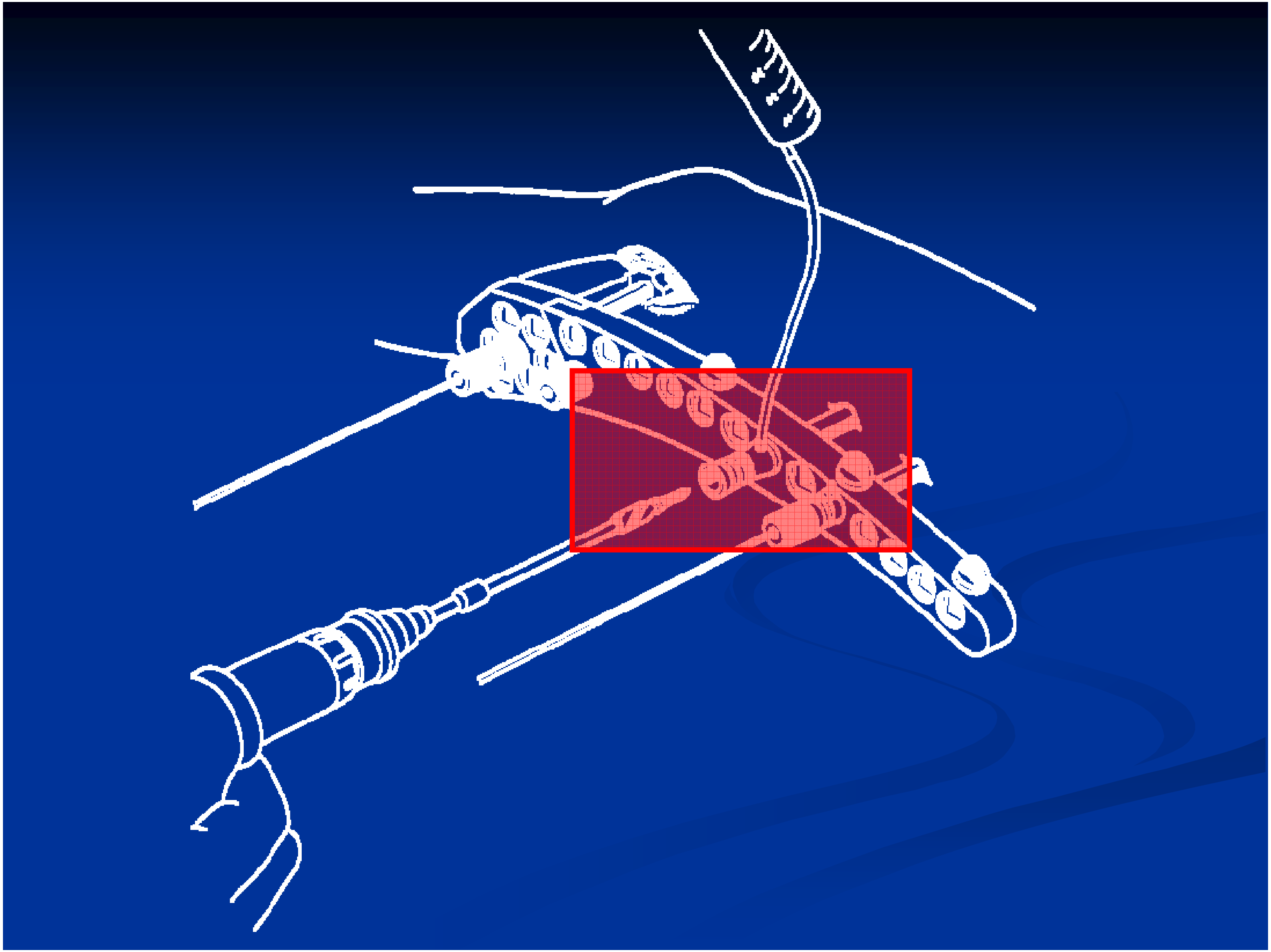
LISS
Less Invasive Stabilisation System

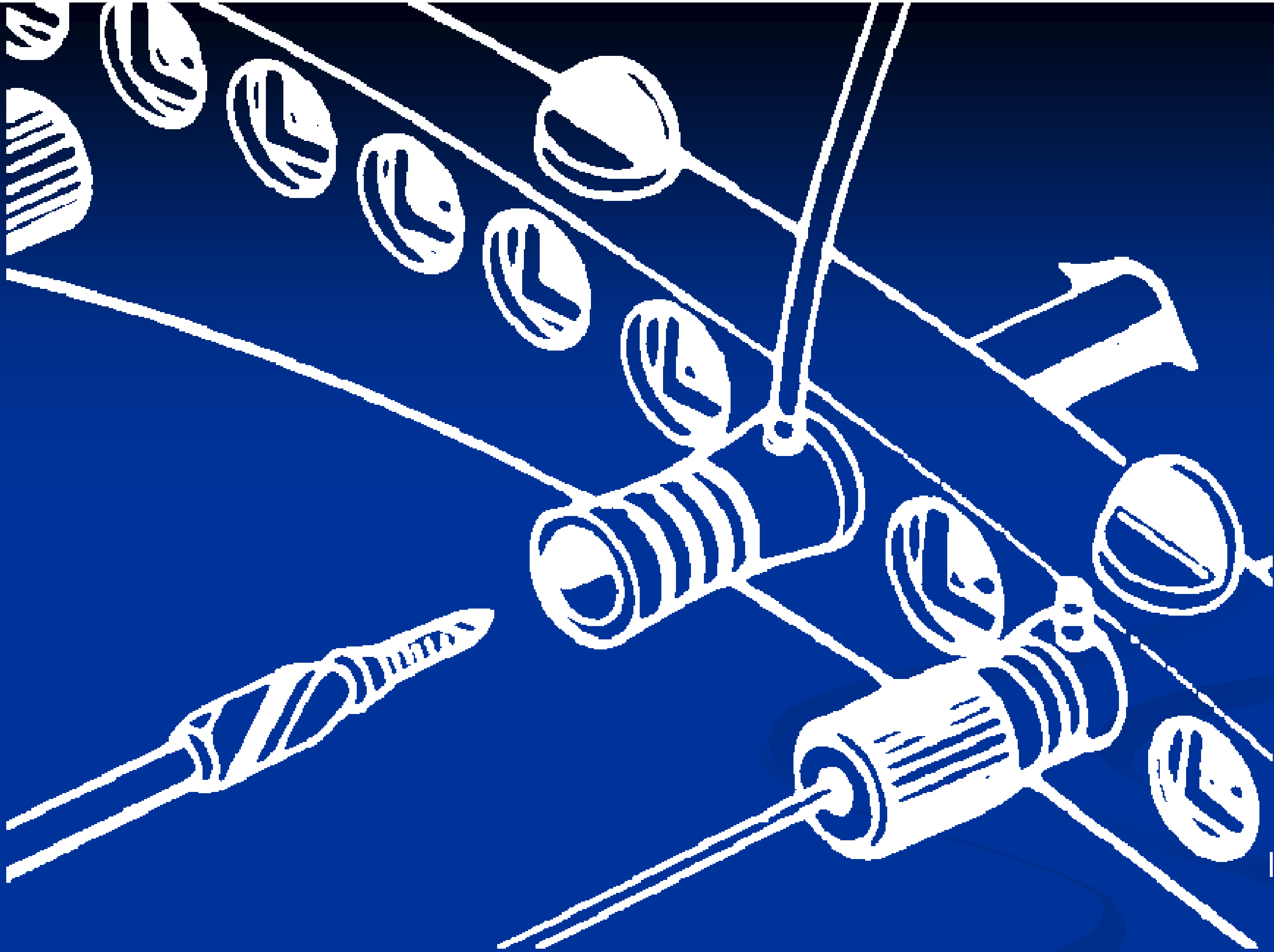
- A special kind of LCP
- Out-rigger for insertion and targetting
- So far, only distal femur and proximal tibia

LISS









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

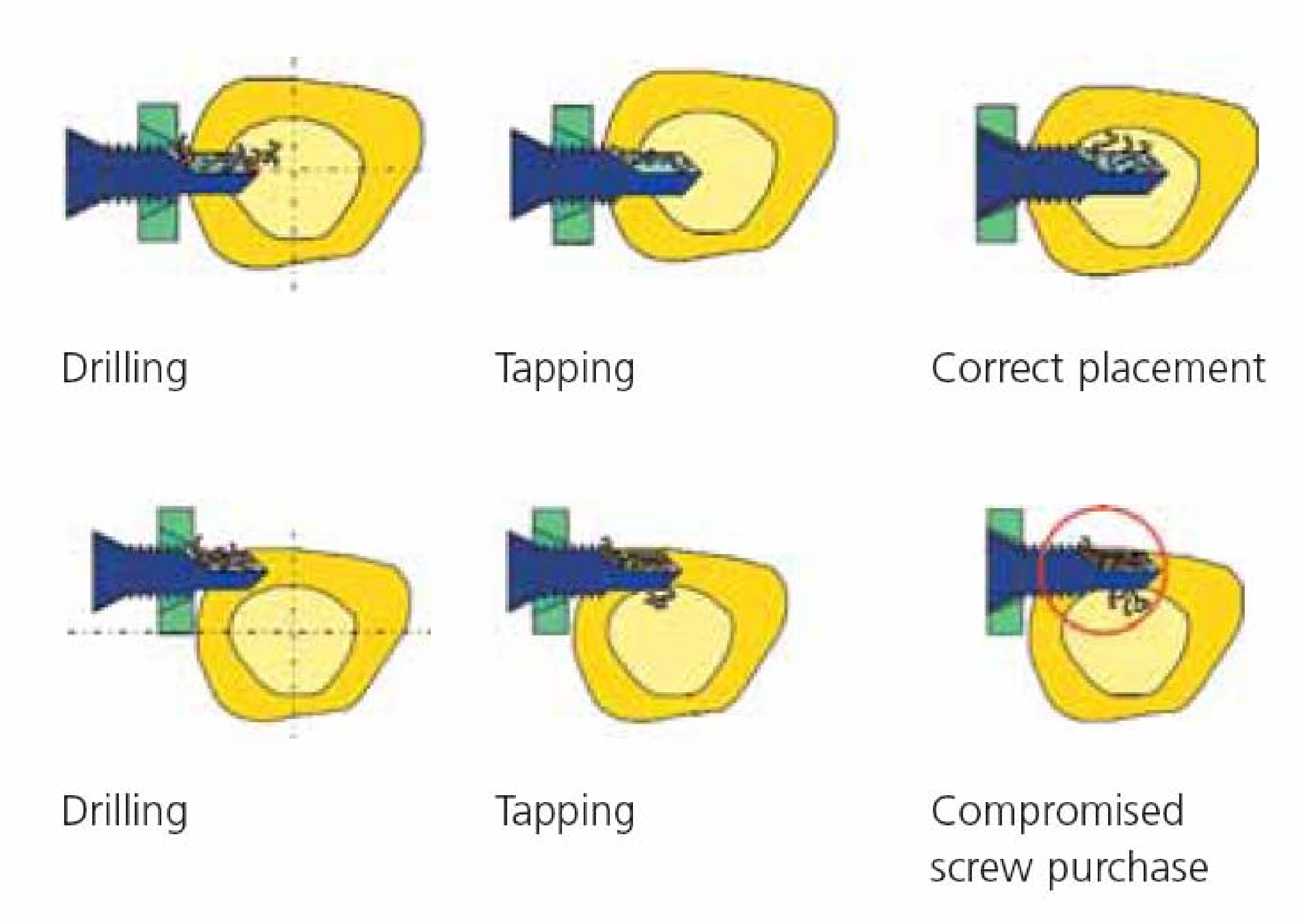
Precaution:

Important!

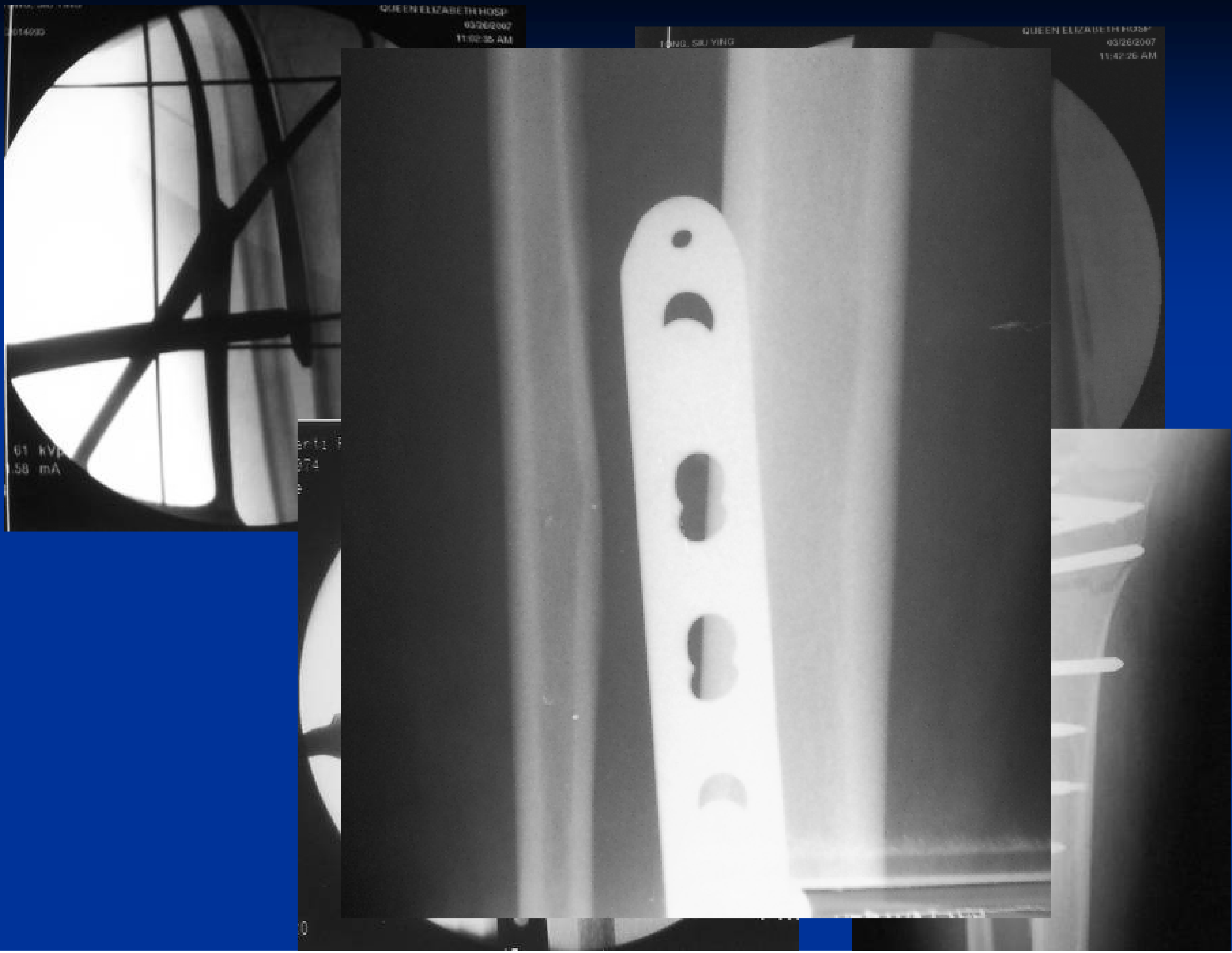
- If the first screw to be inserted is a Locking Head Screw, it is important to ensure that the plate shows good temporary fixation.
- Otherwise, the plate rotates simultaneously when locking the screw, and might cause soft-tissue injuries

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.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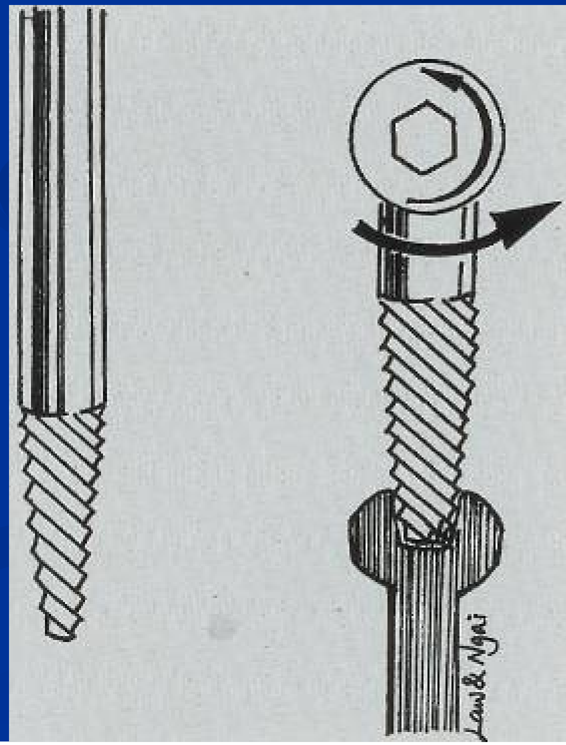
•Limited ability to compress fracture
•Can not use plate as a reduction aid
•Positioning and Compression Device (PCD)

Skin impingement

- Removal of locking screw from the plate sometimes is difficult:
  - need to prepare broken screw removal set



The End

Thank You