Locking plates
Concepts and Evolution

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Locked Plates - Hamburg 1886

- Carl Hansmann
- Monoaxial stability with impacted surfaces
- (reduction done by external device)
- Painting by J. Grützke, Auditorium of Berufsgenossen schaftliche Unfallklinik Hamburg, see J. Grützke “Das Wandbild”, Merlin Verlag,
Locked plates
First patent - first products

- Dr. Paul Reinhold, Paris
- Patent in 1931
- Monoaxial
- male filet mâle in female filet
- Sale by Collin (1935)
PC Fix
(point contact fix)
Locking Compression Plate

1. Used as a conventional plate

2. Used as a pure internal fixator using only locking screws

3. As a combination of the two principles

“which appears to bear some yet unknown hazards”

C Sommer Injury 2003
“Periarticular Locking Plates”

• Anatomically Shaped

• Allow locking into metaphysis with either fixed angle (monoaxial) or variable angle screws (poly or variable axial)

• Have option to lock or put conventional screws in shaft

• Comes with instrumentation to allow MIPO placement
Basics - Conventional (Friction) Plating Concept

Problems
- Screws in tension
- Screw interface loosening
- Bone quality important

Friction for Stability
Concept of axial Stability

• Plate like device and locking screws

• An Internal Fixator where the screws (pins) are the principal load transferring elements and lock in the plate (frame)

• The load forces are transferred from the bone to the plate across the screw neck

Blood supply is Secondary/biological (indirect) Healing
Mechanics - Conventional Plating

• ORIF

Reduction/Fixation

Weight Bearing

Patient Load ≤ Friction Force = √
Mechanics – Locked Plating

Monoaxial

Reduction/Fixation

Weight Bearing

Patient Load

\[ < \text{Compressive Strength of the Bone} = \checkmark \]
Theory – when Conventional Screws fail...

Volume of bone displacement required

When subjected to bending loads conventional screws are pulled out sequentially
Theory – when Locking Screws fail.

Locking Screws resist bending forces, the angular stability of the screws increases the area of resistance.

Increased Volume of bone displacement required
Conventional Vs. Locking Plates:

Loss of Primary reduction

- Standard screws pull bone to shape of plate ⇒ Affects reduction.

- As screws are locked to plate, the implant locks the bone segments in their relative positions.
Biomechanics
Axially Stable Overview

Conventional Vs. Locking Plates:

† Secondary Loss of Reduction

- Under load, reduction can be lost and screws cut out.
- Rigid locked construct holds reduction under load – the „Internal Ex-Fix.“
Conventional Vs. Locking Plates:

**Axially Stable Overview**

*↑ Screw back-out*

- Under axial load, conventional unlocked screws can back out.
- As screws are locked to plate load force is opposed \(\Rightarrow\) No back out.
When a screw can be locked in the plate, the plate and screws form one stable system:

- The stability of the fracture is dependent on the stiffness of the construct.
  - Angular and axial stability are ensured.
  - Possibility of screw toggle, sliding or dislodgment are minimized.

- No compression of the plate onto the bone is required:
  - Risk of primary loss of reduction is reduced
  - Periosteal blood supply is maintained.
When do we need Axial Stability?

For Intra and Extra articular Fractures  
(too distal or proximal to nail)

Bridging comminuted fractures  
RTA/Gunshot wounds  
Patients with high velocity trauma

Periprosthetic fractures

Elderly patients with Osteoporotic bone

Non unions
Locking plates through a small incision

Anatomical plates

Fracture anatomy

Locking plates

Mini Incision
Non Parallel Screws

- Increased Fixation
- Increased Stability
- Increased Rigidity
AxSOS Locking Screws

Locking Screw design

• Single thread with single pitch
• Screw is guided into plate or Locking Insert
• Reduced potential for cross threading and cold welding
Locking Plates - Questions?

- Uni-cortical or bi-cortical?
- Lock whole plate or just metaphysis?
- Plate on or off the bone?
- Titanium or stainless steel?
Bi-cortical  

Uni-cortical
Unicortical Screws

- Not sufficient with osteoporotic bone

- weaker in torsion
- shearing motion with bending
- fails through bone screw interface
Hybrid Fixation
combination of locked and non-locked screws

• Sawbone model locked vs non locked tested with cyclical loading

Compared with initial stiffness
• Locked plate 80%
• Non locked 30%

Gardner  JBJS A 2006
Plate on or off the bone?

- On the bone to help in fracture reduction and stability
- Affect on periosteal blood supply minimal and not proven clinically
- If plate off the bone must use locking screws
How many screws?

- Traditionally 6 cortices above and below fracture

- Locking plates – at least 2 screws in each segment (no advantage to more than 3 – Stoffel 2003)
DANGERS

• Tightening locked screw in plate gives the surgeon a feeling of excellent stability, but the effective hold of the screw in the bone cannot be felt
  - overestimate the achieved stability

• Locked plating not a substitute for anatomical articular reduction and careful soft tissue handling
  - will not reduce the fracture for you
Locking Plates

- Biomechanical data - good
- Clinical data - Level 3 / 4 at best
Conclusion

AxSOS – a strong and reliable Plating System for metaphyseal and diaphyseal plating fixation

Let's see!