AO Foundation

Mechanics of plate fixation

# Loading of the plate screws

## Tasks

1 Compare screw holding force by weighting each plate model

2 Compare effect of working length of screws by rotating handles on the three bone-plate constructs

## Learning outcomes

- Explain how lever arm length influences screw loading
- Define the term "screw working length"

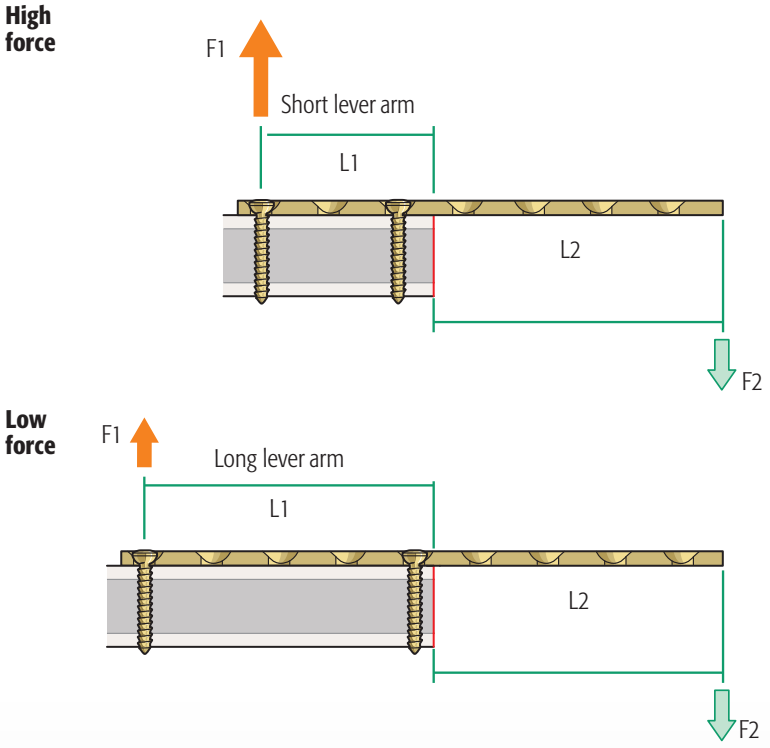
## Take-home message

- Short lever arm = high pull-out force on the screw
- Long working length = low stress on the screw

### Lever arm and pull-out force

#### Long lever arms decrease screw loading

A short lever arm leads to a high pull-out force on the screw. Increasing the lever arm reduces the pull-out force.

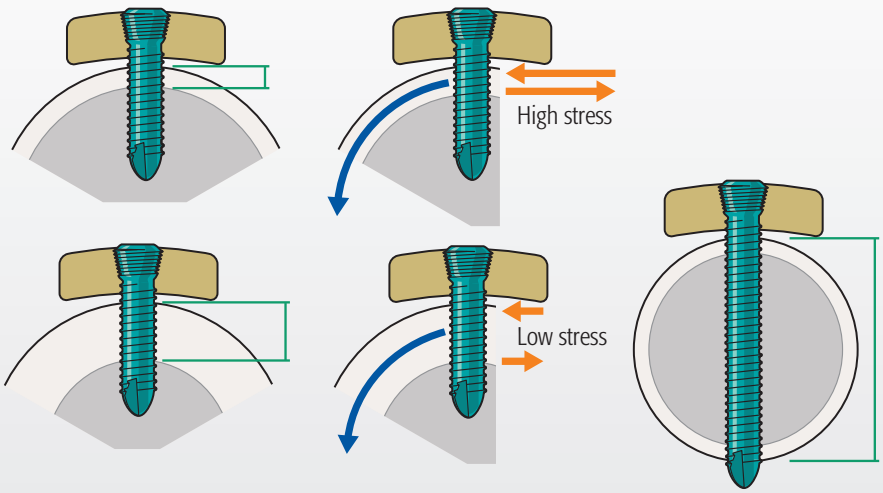



### Working length of screw

Length of screw thread in contact with bone influences stress at screw-bone interface

A **short working length** exists when there is thin bone cortex or monocortical screw insertion. This results in **high stress** at the interface.

A **long working length** exists when there is thick bone cortex or bicortical screw insertion. This results in **low stress** at the interface.



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# Stiffness of plate fixation

## Tasks

Test bending stiffness of plate-bone models under different bending directions or plate positions

**1** Plate on tension side

**2** Plate in lateral position

**3** Plate on compression side

## Learning outcomes

- Explain principle of load sharing between implant and bone
- Identify influence of a fracture gap on stiffness of fixation and on plate loading
- Explain the influence of the bending direction on the load sharing of the plate-bone composite construct

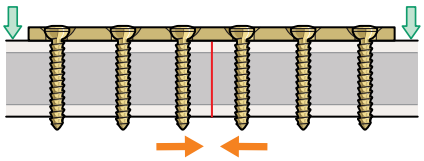
## Take-home message

To share load, an implant must be attached to the **tension side** of the bone

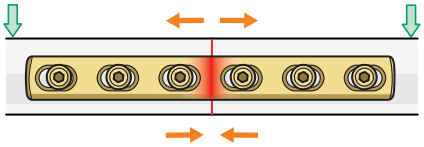
### Internal fixation without gap

Bending of plate-bone construct; different bending directions

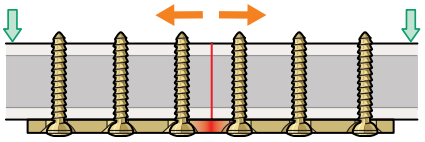
**1** Load sharing



**2** Partial load sharing



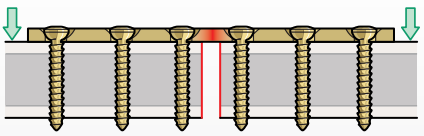
**3** No load sharing



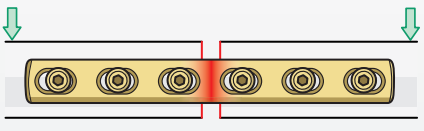
### Internal fixation with large gap

No load sharing for all bending directions

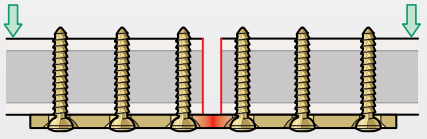
**1** No load sharing



**2** No load sharing



**3** No load sharing



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Mechanics of plate fixation

# Loading of the plate

## Tasks

**1** Test bending stiffness of plated bone models by loading each with your hands

**2** Compare and discuss

## Learning outcomes

- List reasons for plate failure
- Identify actions to avoid plate failure
- Explain importance of overspan width and screw position on plate loading

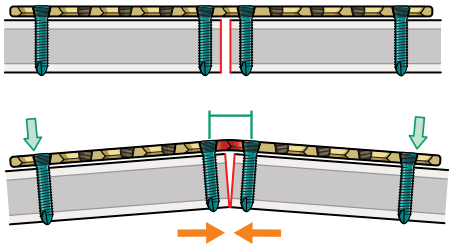
## Take-home message

- Short segments of plate will break under repetitive stress
- Incarcerated bone fragments lead to load sharing

### Plate loading and overspan width

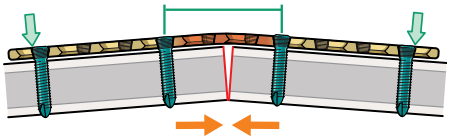
**Small gap** with screws inserted **close** to gap

- Short segment of plate loaded
- Stress **concentration**



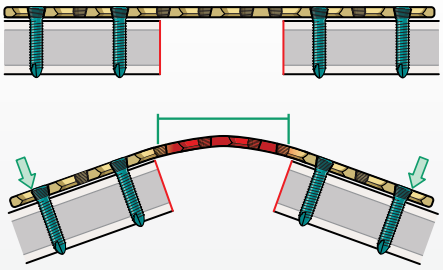
**Small gap** with screws inserted **at a distance** from gap

- Long segment of plate loaded
- Stress **distribution**



### Gap width and plate deformation

A large gap leads to high angulation and thus a high deformation of the plate under load



Incarcerated bone fragments, even with relatively loose connection to soft-tissues, reduce maximum angulation and thus plate deformation