AO TRAUMA

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

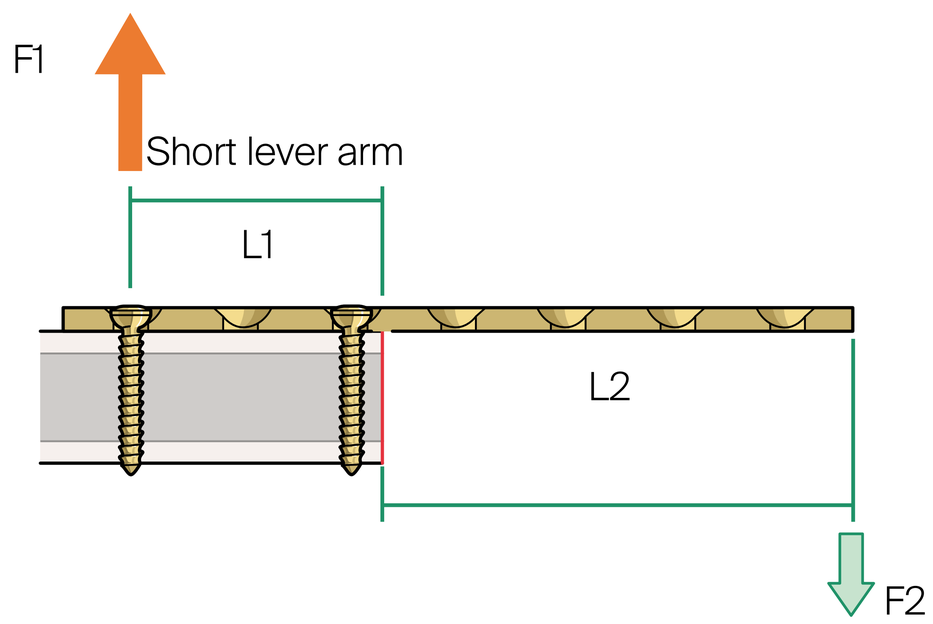
- The resistance to pull-out of a screw is always constant
- Increasing the distance from the fracture site to the screw increases the lever arm, which leads to a decreased pull-out force on the screw

Lever arm and pull-out force

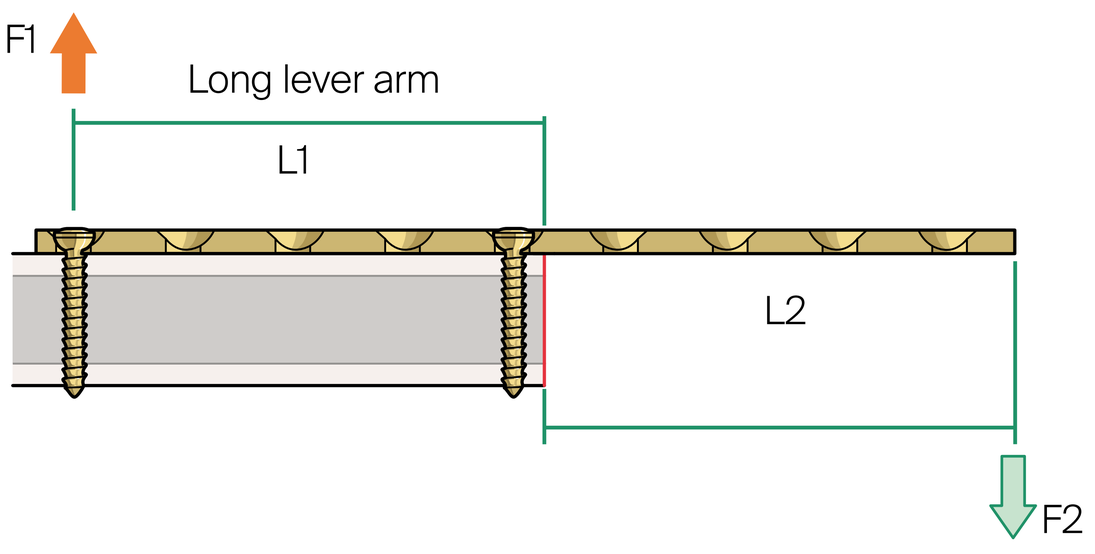
Long lever arms decrease screw loading

A short lever arm leads to a high pull-out force on the screw. Increasing the lever arm reduces the pull-out force. Thus, screws far from the fracture need a very high pullout force to fail.

High force



Low force

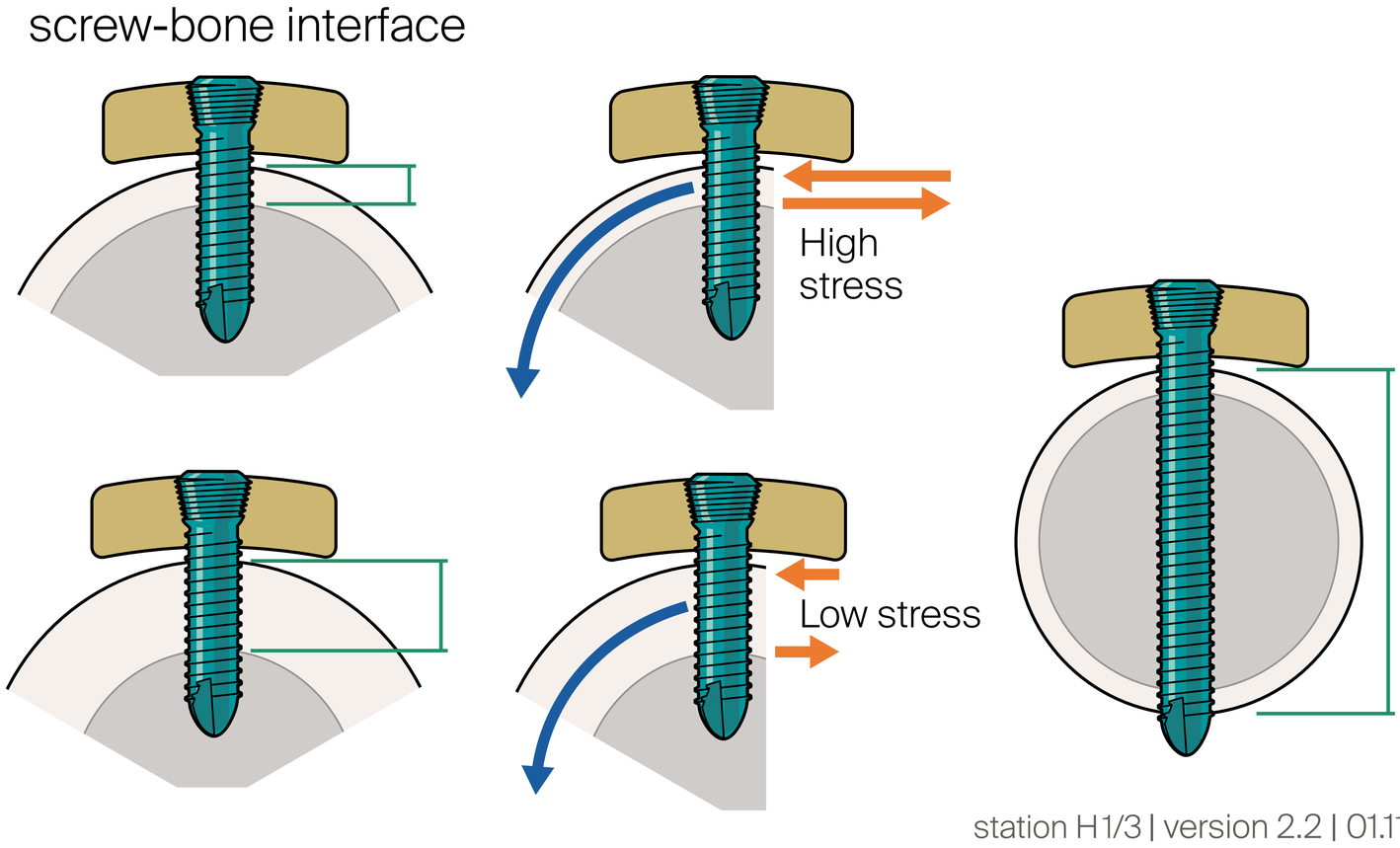


Working length of screw

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.



AO TRAUMA

Mechanics of plate fixation

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

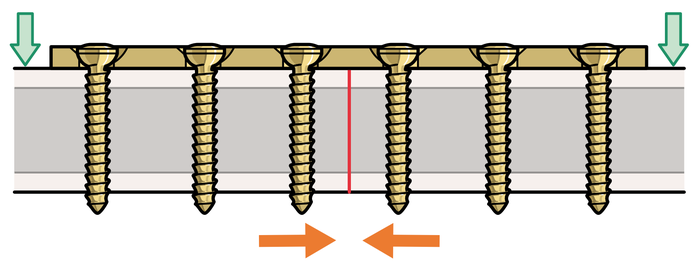
Take-home message

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

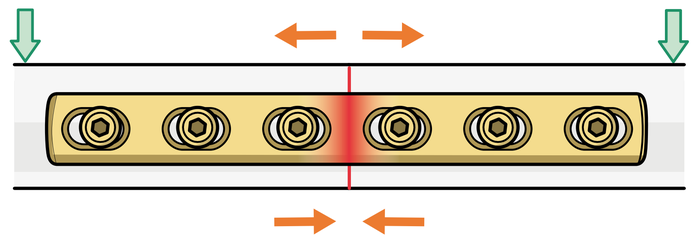
Internal fixation without gap

Bending of plate-bone construct; different bending directions

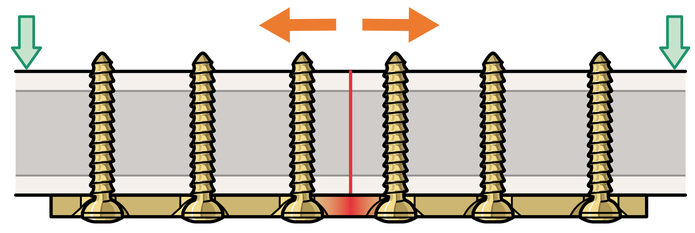
1 Load sharing



2 Partial load sharing



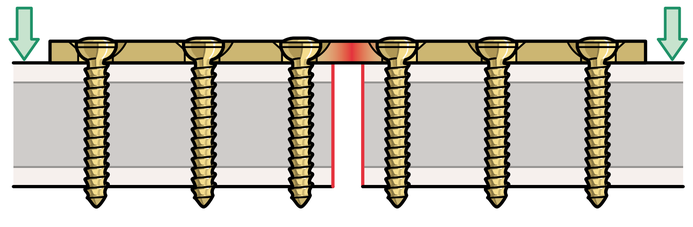
3 No load sharing



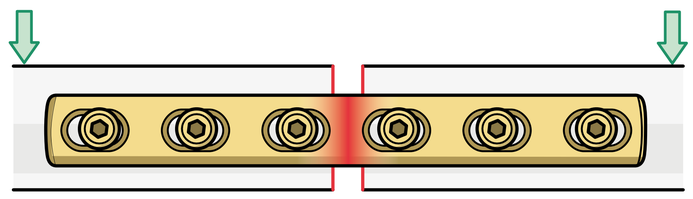
Internal fixation with large gap

No load sharing for all bending directions

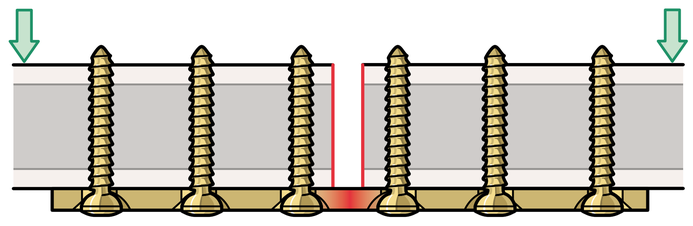
1 No load sharing



2 No load sharing



3 No load sharing



TRAUMA

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

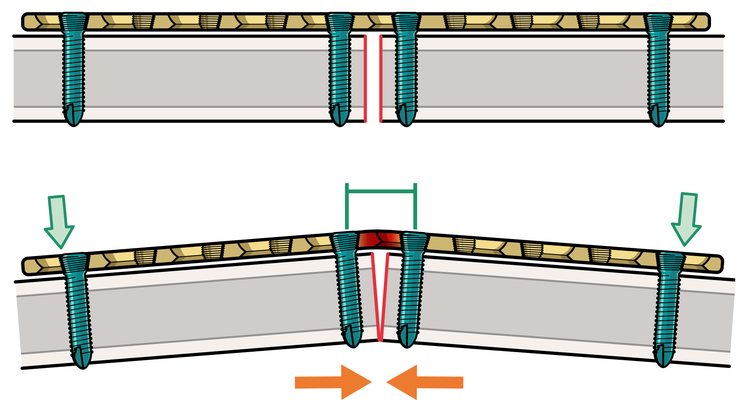
Take-home message

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

Plate loading and overspan width

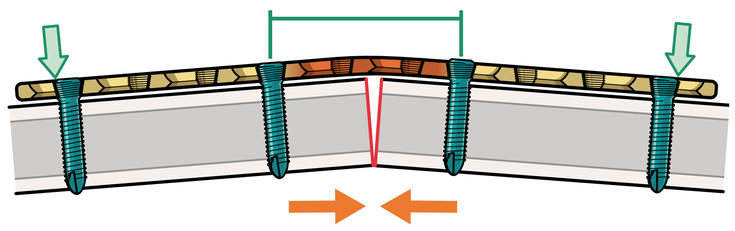
Small gap with screws inserted **close** to gap

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



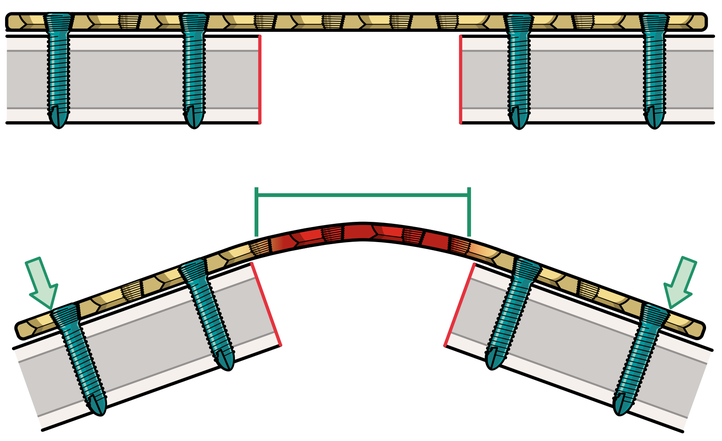
Small gap with screws inserted **at a distance** from gap

- 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