AO Foundation

STATION J

Skills Lab Faculty Guide

Mechanics of plate fixation II

At this station, you will teach how the stiffness of a bone-plate construct differs under a bending load. The goal is that participants can feel and learn how the implant as well as the direction of bending influences the stiffness of the bone-plate construct.

Plate fixation is a very versatile method of bone fracture management. Since the same plate can be used in many different ways (eg, to compress, buttress, or bridge fractures) it is essential for the surgeon to be familiar with the mechanics of plating to achieve acceptable and predictable outcomes when treating a fracture by these means. The extent of this topic made it necessary to divide it in two complementary stations (stations H and J).

Learning outcomes

After completing this station, participants will be able to:

- Describe the bending stiffness of isolated beams with respect to composite beams
- Recognize plate fixation of fractures as a composite beam system
- Describe the importance of plate position on overall stiffness of internal fixation using plates

Take-home message

- Plate alone is relatively weak
- Stiffness of a plate depends on bending direction
- Important increase of bending stiffness when bone and plate are tightly connected
- Composite system with plate on tension side is the most rigid construct under the condition that the fracture can be axially loaded

Station sequences (your tasks)

When you arrive at the station for the Skills Lab module:

- Familiarize yourself with the poster which includes information about the station learning outcomes and task.
- Check the set-up before participants arrive at this station.

During the group activity (to be repeated for each group):

- Start with the four models without fractures. Let the participants carefully push down on the ends of the various constructs with the tip of one finger. Let them explain what they feel, which construct is the most flexible, and which the most rigid (you will find the answers in the top half of the poster).
- Then move to the upright standing, white model. Show the participants how the gliding between the beams can be eliminated when the single beams are connected by a bolt which then leads to an increase in stiffness of the beam system.
- Move to the third model on the table and let the participants load these as well by carefully pushing down on the ends with the tip of one finger. Explain why the models with the plate on the underside—the compression side— feel less stiff than the constructs with the plate on the upper side—the tension side. Point out how a large gap impacts the ability of the construct to share load between plate and bone, regardless of plate position.

Discussion points

- Discuss the importance of plate position in the stiffness of a bone-plate construct.
- Discuss the difference between stiffness (the ability of a material to withstand deformation) and strength (the ability of a material to withstand destruction). Where the stiffness of an osteosynthesis can be measured clinically, strength cannot be determined without doing harm to the patient.
- Summarize the take-home messages.

While participants are changing tables:

- Remove the bolt from the upright standing model, if necessary.

Before you leave the station after the Skills Lab module:

- Ensure the bolt is on the table.

Frequently asked questions (FAQs)

What is a composite beam system?
A composite beam system is a construct of two or more separate beams connected to each other. By connecting the beams their stiffness (resistance against deformation) is multiplied by eliminating the shear stress between them.

How does a composite beam system relate to plate fixation?
Plate fixation is a composite beam system in which the plate (one beam) is connected to the bone (second beam) by screws. As the two structures are connected, shear stresses are reduced and the stiffness of the construct is greatly improved.

What elements contribute to the stiffness and strength of plate fixation?
Almost every element that is involved in plate osteosynthesis contributes in one way or another to the construct's stiffness and strength. Plate characteristics (ie, locking versus conventional plate, steel versus titanium), plate position (tension or compression side), plate size (cross section and length), screw characteristics (size, number, anchorage), bone characteristics (quality, cross section), fracture pattern (simple versus complex and comminuted bone defects), and fixation technique (compression, bridging, buttress, or neutralization plate) all play an important role in the mechanical behavior of fracture fixation and in the healing process of the bone.

How is all this clinically relevant?
Understanding the principles of plate fixation is necessary to create an adequate preoperative plan and choose the right implant for every specific fracture and patient.