AO Foundation

Fracture healing

Mechanics of callus (1/2)

Tasks

1 Bend the two ends of the model, which represent bone fragments; note low stiffness

2 To simulate soft callus formation, inject beads into the flexible middle portion of the model; note increase in stiffness

3 To simulate tissue transformation, extend the other end of the model to extract air; note increase in stiffness

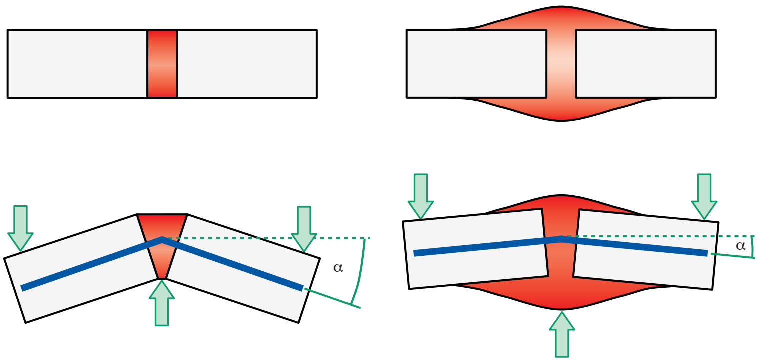
Learning outcomes

- Identify the importance of the increasing cross-section
- Identify the importance of tissue transformation between fragments

Take-home message

- Apposition of callus leads to an increase of cross-section and thus of stiffness in the fracture zone
- Callus transforms over time

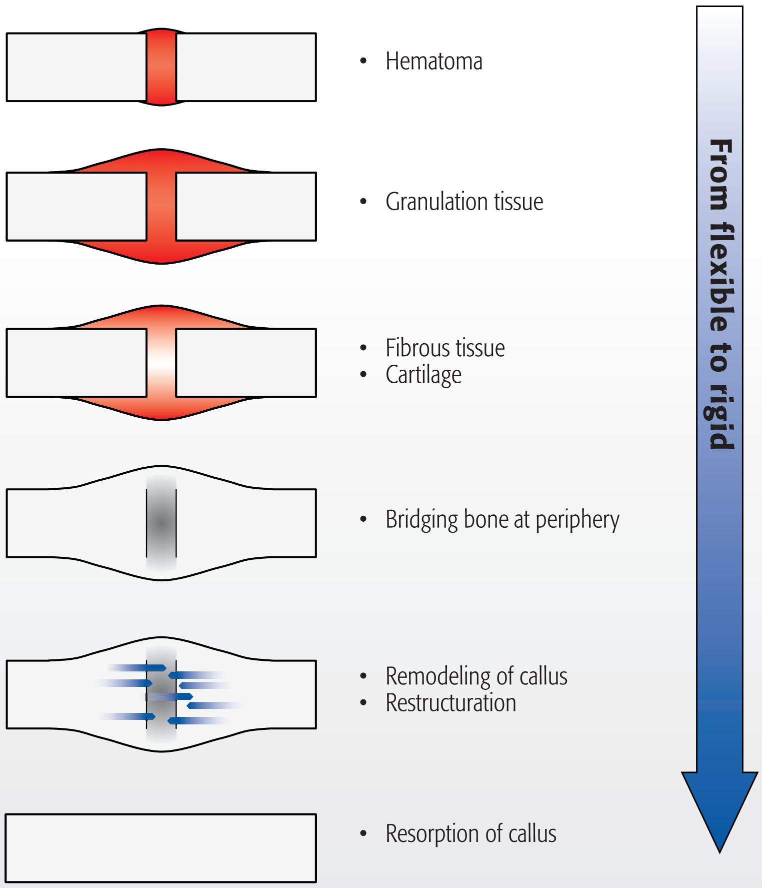
Increase of cross-section of callus



No callus
High angulation under external loading
→ High tissue strain, low stiffness

Callus
Low angulation under external loading
→ Low tissue strain, high stiffness

Transformation of callus



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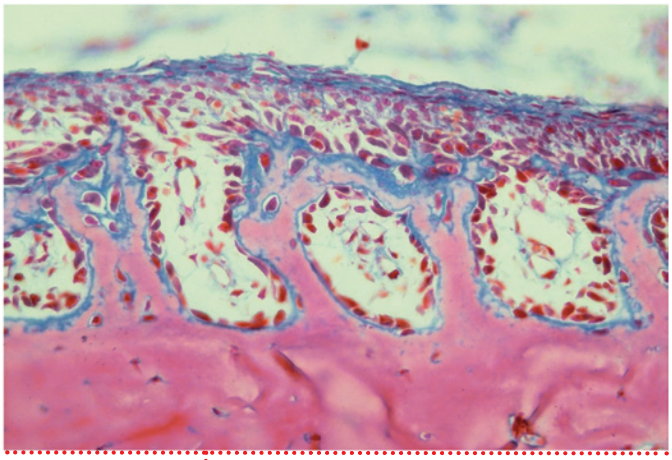
Fracture healing

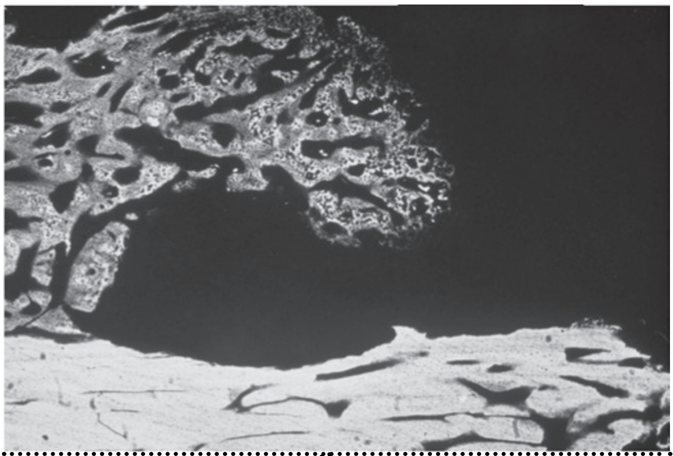
Mechanics of callus (2/2)

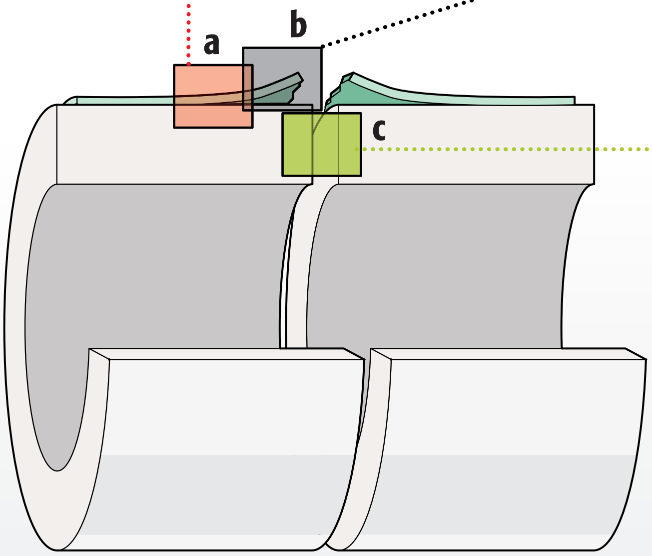
Histological callus formation

a Periosteal and primary angiogenic bone formation

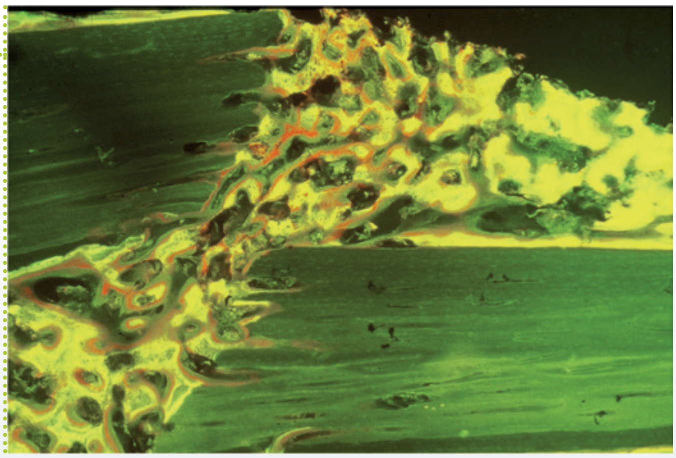


b Bone formation far from fragment end in vascularized zone





c Interfragmentary callus formation



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Fracture healing

Mechanics of interfragmentary tissues

Tasks

1 Slowly pull granulation model horizontally from one side

2 Note degree of cell deformation as a function of initial gap width

Learning outcomes

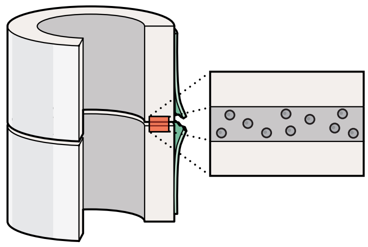
- Define absolute and relative stability
- Define the importance of initial gap width onto cell deformation under the condition of relative stability
- Define the effect of tissue differentiation on deformation

Take-home message

Under **relative stability** the cells in a small fracture gap can be destroyed because of too high strain

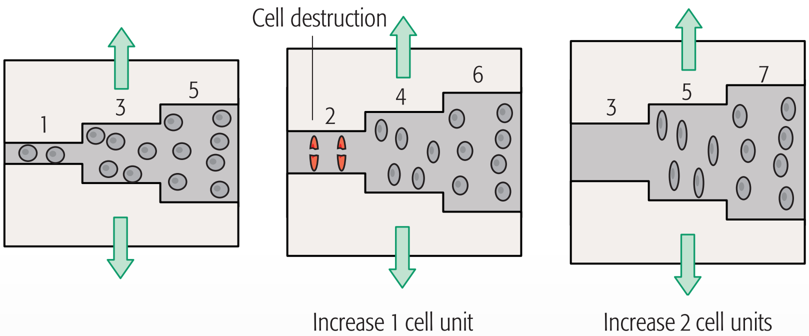
Model

Granulation tissue with cells between two bone fragments



Cell deformation under traction

- Numbers indicate cell diameter units
- In each step, the gap is increased by 1 unit
- Relative deformation of the cells is shown



Cell deformation under bending
(not shown in demonstration)

- Compression or distraction of cells in the gap under bending
- Cell destruction when elongation exceeds one cell unit