

## Osteosynthesis involving a joint

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### Editing

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## Learning outcomes

At the end of this lecture you will:

- Understand the pathophysiology of articular cartilage
- Describe the need for anatomical reduction and rigid fixation in articular fractures
- Discuss “staged surgery”

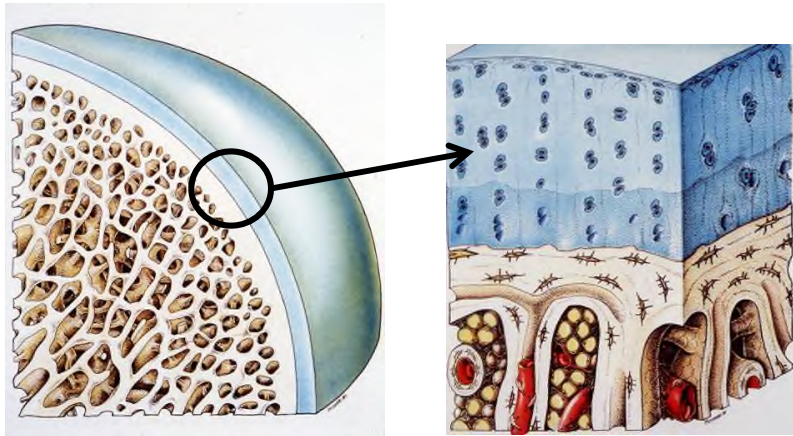
AO

At the end of this lecture you will be able to:

- Outline the pathophysiology of articular cartilage
- Describe the need for anatomical reduction and rigid fixation
- Discuss “staged surgery”

## Articular cartilage—anatomy

- Normal cartilage

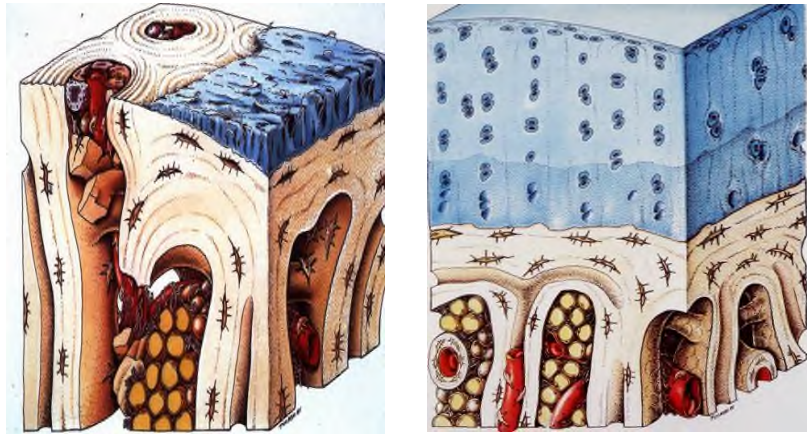


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Articular cartilage and chondrocytes stay alive because they receive oxygen and nutrients by diffusion from joint fluids. This only works if there is both regular movement and physiological loading forces.

## Articular cartilage—pathology

- Arthrosis/arthritis



To work properly, the articular cartilage must be very smooth. This minimizes friction. When a fracture occurs near to the cartilage, it can change this environment. Any changes in the axial alignment or step-offs in the articular surface may lead to rapid degenerative change in the joint, eg, posttraumatic arthrosis and arthritis.

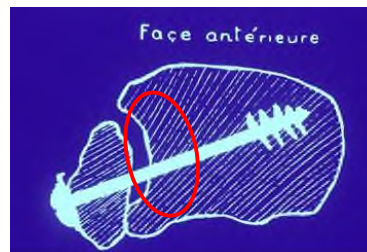
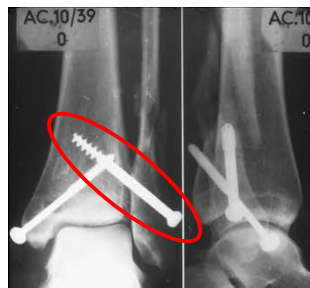
Arthrosis: Degenerative cartilage

Arthritis: Inflammation of the joint

## Historical introduction

1913, A Lambotte, Belgium:

- Perfect anatomical reduction and stable fixation
- Early motion
- Transfixation screw in unreduced fibula



Case from the early AO days

AO

Over 100 years ago, Lambotte observed that only “perfect anatomical reduction and stable fixation” by screws combined with early motion allows to obtain a good functional outcome in articular fractures.

Lambotte described that a transfixation screw (between fibula and tibia) in an unreduced fibula must result in a severe osteoarthritis. The drawing and the x-rays show a clinical example of such a situation from the early days of AO.

## Historical introduction

1913, A Lambotte, Belgium:

- Perfect anatomical reduction and stable fixation
- Early motion
- Transfixation screw in unreduced fibula

20 years later:

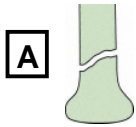
- Osteoarthritis
- Joint fusion



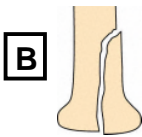
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The same case 20 years later with severe posttraumatic osteoarthritis resulting in spontaneous fusion (ankylosis).

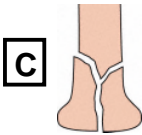
## Classification—Types



Extra articular



Partial articular



Complete articular

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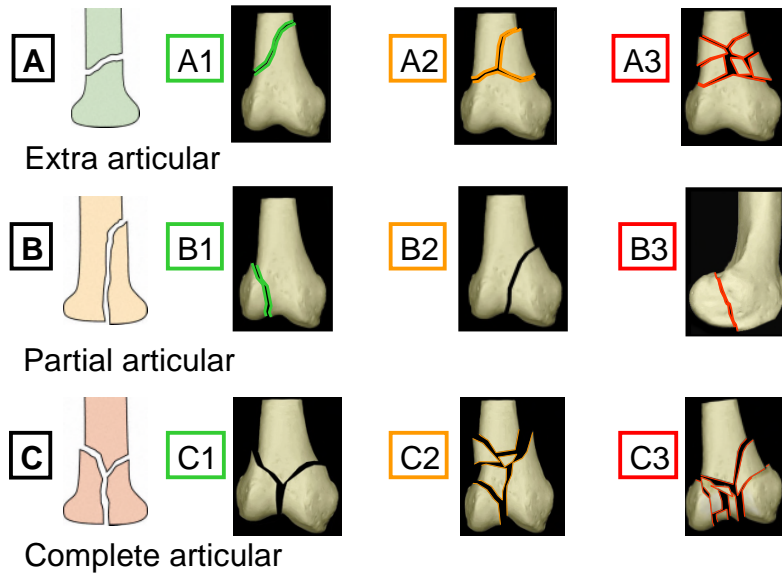
Classification of articular fractures:

Each bone segment, proximal and distal, is divided in three types of fractures:

- A – Extra articular fracture
- B – Partial articular fracture
- C – Complete articular fracture

On the slide a distal femur (no. 31 in the AO Classification) is shown as an example.

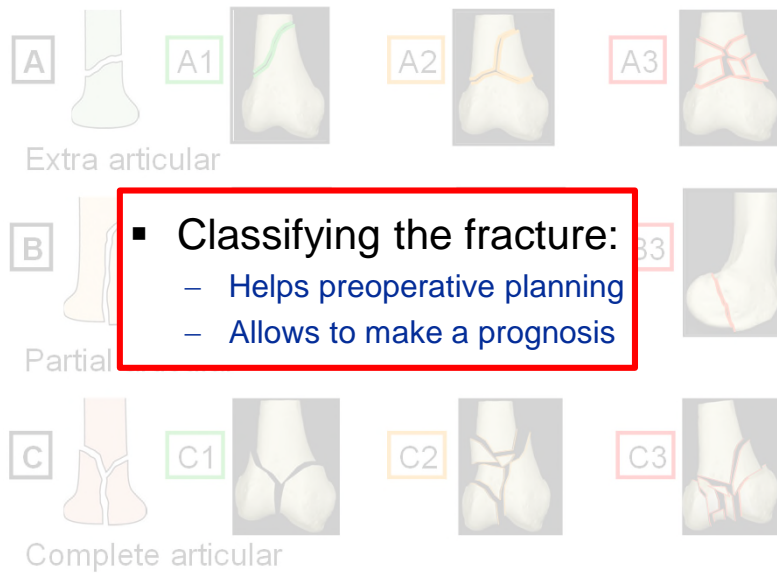
## Classification—Subgroups



Each type is divided in three subgroups.



## Classification—Subgroups

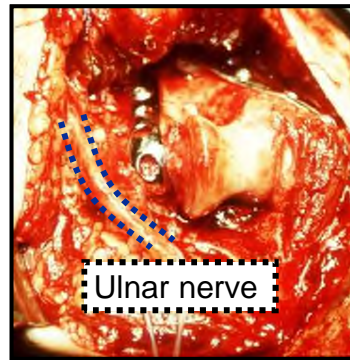


Classifying the fracture helps preoperative planning.

A fractures have a better prognosis than B and C fractures. Type 1 fractures have a better prognosis than type 3 fractures.

## Reduction

- Anatomical reduction of joint surface:
  - Mandatory
  - Requires good visualization (open incision):
    - Entire joint
    - Critical structures



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Articular fractures must be reduced anatomically, which requires good visualization of the entire joint, including critical structures like eg, the ulnar nerve.

## Fixation

- Anatomical reconstruction
- Rigid fixation:
  - Essential for early joint movement



In displaced articular fractures anatomical reduction and reconstruction with rigid fixation is the treatment of choice. Early rehabilitation is important.

## Complications of operative fracture treatment

- Can result from:
  - Poor reduction of joint surface
  - Inadequate fixation
  - Wrong implant
  - Poor soft-tissue care
  - Wrong timing
- Can be avoided:
  - With careful planning



AO

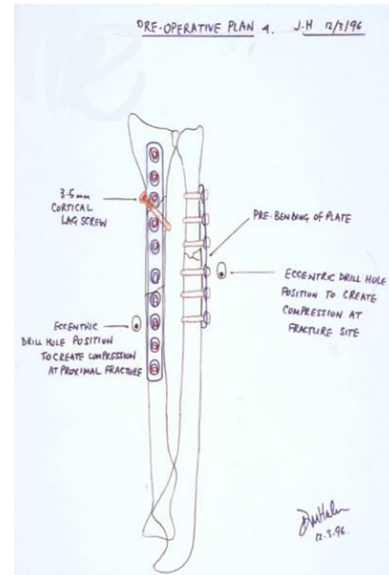
Complications of surgery can be a result of:

- Poor reduction
- Inadequate fixation
- Wrong implant choice
- Poor soft-tissue care
- Wrong timing

Most complications can be avoided with careful planning.

## Preoperative planning

- Assessment of fracture and soft tissue:
  - X-ray imaging, including CT
- Classify fracture
- Reduce fracture on paper
- Discuss:
  - Procedure
  - Approach/incision
  - Patient positioning
  - Position of implants
  - Choice of instruments
  - Need for bone graft



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Preoperative planning involves

- Correct assessment of fracture and soft-tissue parts
  - X-ray imaging, including CT: Traction views and CT scans (3D) are most instructive also in view of the planning of approaches.
- Classification of the fracture
- Reduction and drawing on paper
- Discussion of the:
  - Procedure step-by-step
  - Approach
  - Position of patient
  - Choice of implant(s) and the position of the implant(s)
  - Choice of instruments
  - Need for bone graft

## Timing of surgery

- Very crucial
- Vulnerable soft-tissue cover over the joints:
  - Thin subcutaneous fat
  - No muscles
- Skin tension results in:
  - Ischemia
  - Necrosis
  - Blisters



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The timing of surgery is always very crucial and important, certainly when the soft tissue is vulnerable. This is often the case when the layer of subcutaneous fat is thin and hardly no muscle structure is present.

Tension of the skin results in ischemia and later on in necrosis.

In case of doubt temporary stabilization of the fracture is chosen until the skin and soft tissue recovered. ORIF is done at a later stage.

## Timing of surgery

- History of the injury:
  - Energy involved
  - Time span since accident
- Swelling, skin tension, blisters, hematoma
- Open/closed injury:
  - Contamination
  - Neurovascular status
- Compartment pressure



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The timing of surgery depends on:

- The history of the injury. What kind of energy was involved (high or low)? How long was the interval since the accident?
- Swelling, skin tension, blisters, hematoma
- The fracture. Is it open or closed? Is it contaminated? What is the neurovascular status?
- Compartment pressure

Open and contaminated fractures, bad neurovascular status, and high compartment pressure are an indication for immediate surgery; temporary or definitive.

The longer the interval since the accident, the quicker the operation needs to be done, certainly in open and contaminated fractures.

Swelling, skin tension, and bad soft-tissue conditions are indications to delay definitive surgery and proceed to staged surgery (which will be explained later).

## Timing of surgery

- Based on soft-tissue conditions
  - Primary definitive surgery
  - Staged surgery
  - Delayed surgery



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There are three types of surgery: primary definitive surgery, secondary surgery, and staged surgery. Each one has advantages and draw backs. Most important in all cases are the soft tissues. This will define to which surgery the surgeon will proceed.



## Primary definitive surgery

- Unproblematic soft tissues
- Simple, open articular fracture (1° and 2°)
- Fractures with vascular injury



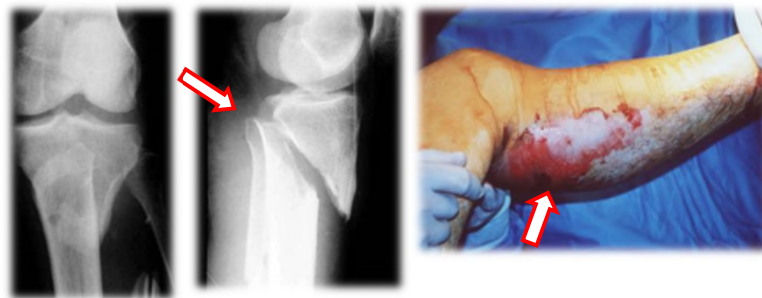
### Prerequisites

- Complete preoperative planning
- Access to OR
- Full equipment available
- Experienced team of surgeons and nurses

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## Motorbike accident—Case 1

- 30-year-old man
- III° open proximal tibia fracture (41-C1)
- Only a puncture wound
  - But poor pulses



A young man sustained an open proximal tibia fracture (III C) after a motorbike accident.

## Motorbike accident—Case 1

- 30-year-old man
- III° open proximal tibia fracture (41-C1)
- Only puncture wound
  - But poor pulses
  - “On-table” angiography in operating room

⇒ Injury of popliteal artery

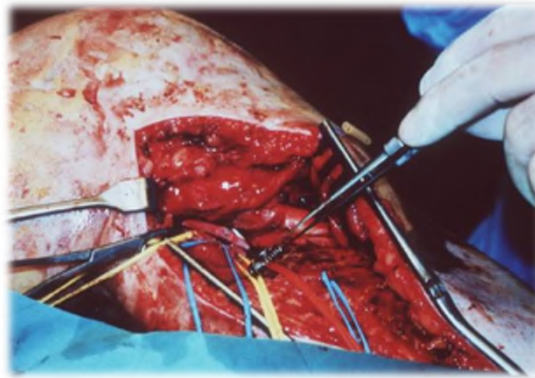


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An angiography in the operating room was done to detect the status of the popliteal artery.

## Motorbike accident—Case 1

- Surgery
  1. Medial approach to repair popliteal vessel



AO

The injury was approached through a medial incision. The popliteal vessels were repaired in a first step.

## Motorbike accident—Case 1

- Surgery
  1. Medial approach to repair popliteal vessel
  2. ORIF (**O**pen **R**eduction **I**nternal **F**ixation) with angled blade plate 3.5



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In a second step the fracture was reduced and fixed with a 3.5 mm angled blade plate.

Both interventions, the vascular repair and the osteosynthesis, were done by the same team. One and the same approach was used.

## Motorbike accident—Case 1

- Surgery
  1. Medial approach to repair popliteal vessel
  2. ORIF (Open Reduction Internal Fixation) with angled blade plate 3.5
  3. Prophylactic release of compartments



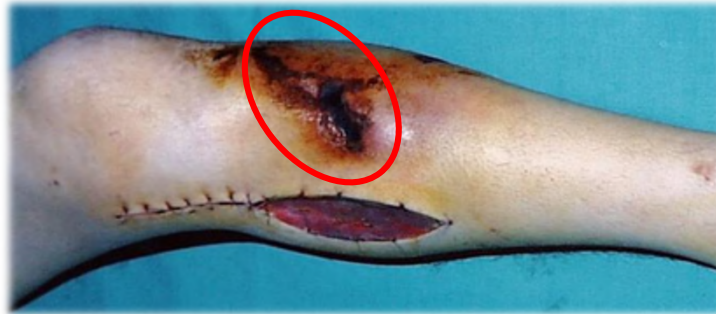
Open articular fractures  
are emergencies

AO

Because of the long duration of the ischemia the compartments were released prophylactically through several incisions.

## Motorbike accident—Case 1

- Second look:
  - Debridement of skin necrosis over tibial tuberosity

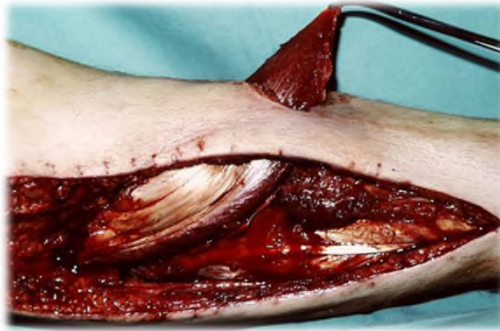


AO

After 5 days, necrosis of the skin had to be removed at level of the tibial tuberosity.

## Motorbike accident—Case 1

- Second look
  - Debridement of skin necrosis over tibial tuberosity
- Cover of defect with gastrocnemius flap



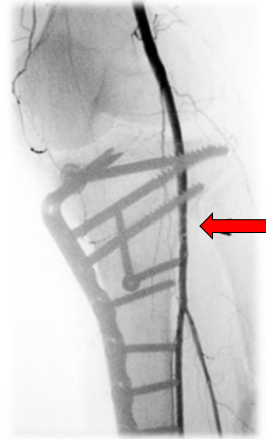
AO

After 5 days, necrosis of the skin had to be removed at level of the tibial tuberosity.



## Motorbike accident—Case 1

- Postoperative angiogram
  - To prove patency of popliteal artery



AO

A control angiogram was done to prove the patency of the popliteal artery.

## Motorbike accident—Case 1

- 13 weeks postoperative
  - No complications



AO

13 weeks later, there were no complications...

## Motorbike accident—Case 1

- 13 weeks postoperative
  - No complications
- Good function



AO

13 weeks later, there were no complications...

## Motorbike accident—Case 1

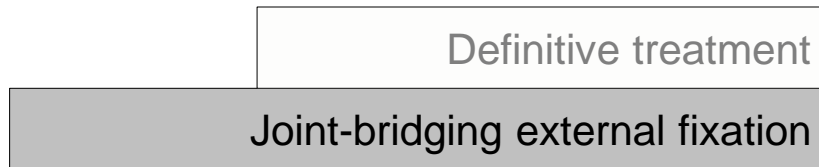
- 1-year follow up
  - Implant removal
  - Well-healed bone
  - Congruent articular surfaces



AO

This is the result after 1 year, showing a well healed bone with congruent articular surfaces.

## Staged surgery—advantages



- Advantages:
  - Minimally invasive preliminary fixation
  - Protects soft tissues for better recovery
  - Reduction aid for definitive surgery
  - Patient remains “mobile”
  - For the “less experienced surgeon” at night

AO

Staged surgery or minimally invasive preliminary fixation is the preferred technique for complex articular fractures today. An example is a joint bridging external fixator.

The advantages are:

- Protection of soft tissue
- Reduction aid for definitive surgery
- Patient remains “mobile”
- For “less experienced” at night

## Skiing accident—Case 2

- Anterior impaction of distal tibia (43-C fracture)

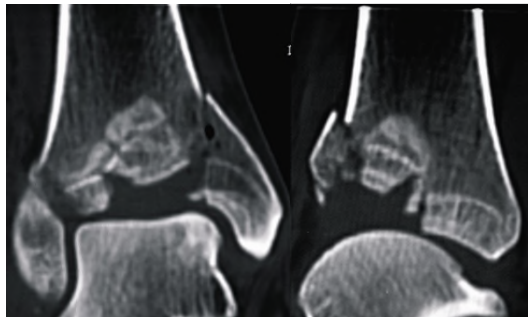


AO

This case from Dr Christoph Sommer (Switzerland) shows an anterior impaction of the distal tibia after a skiing accident.

## Skiing accident—Case 2

- Anterior impaction of distal tibia (43-C fracture)
- Absolute indication for surgery
  - Better evidenced by CT scan



AO

A CT scan shows that the case is an absolute indication for surgery.

Courtesy: C Sommer

## Skiing accident—Case 2

- Staged surgery (1)
  - Temporary, “joint bridging” external fixation
    - For soft-tissue recovery



AO

In the first stage an external fixation has been installed to fix the fracture temporarily allowing the soft tissue to recover before definitive surgery.

Courtesy: C Sommer



## Skiing accident—Case 2

- Staged surgery (2)
  - 14 days later
  - Reconstruction of anterior impaction
  - Standard approach under distraction



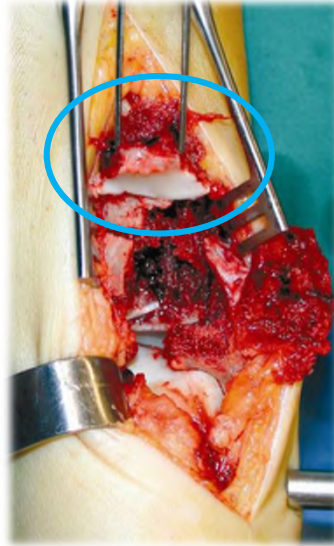
AO

14 days later definitive surgery took place. A standard approach and distraction at the fracture site created space...

Courtesy: C Sommer

## Skiing accident—Case 2

- Staged surgery (2)
  - 14 days later
  - Reconstruction of anterior impaction
  - Standard approach under distraction
  - Elevation of articular fragment with two K-wires



AO

...allowing to elevate the articular fragment with two K-wires.

Courtesy: C Sommer

## Skiing accident—Case 2

- Staged surgery (2)
  - 14 days later
  - Reconstruction of anterior impaction
  - Standard approach under distraction
  - Elevation of articular fragment with two K-wires
  - K-wire “cage”



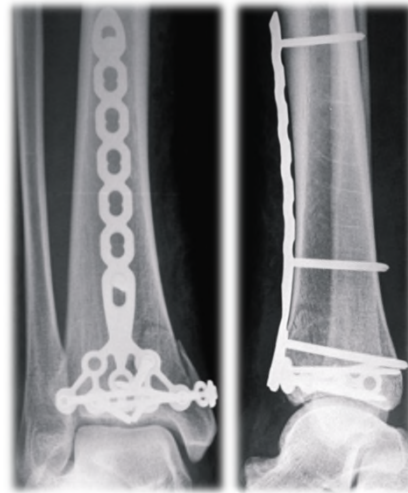
AO

A K-wire cage is build as temporary fixation.

Courtesy: C Sommer

## Skiing accident—Case 2

- Staged surgery (2)
  - 14 days later
  - Reconstruction of anterior impaction
  - Standard approach under distraction
  - Elevation of articular fragment with two K-wires
  - K-wire “cage”
  - Anterior buttress with LCP pilon plate



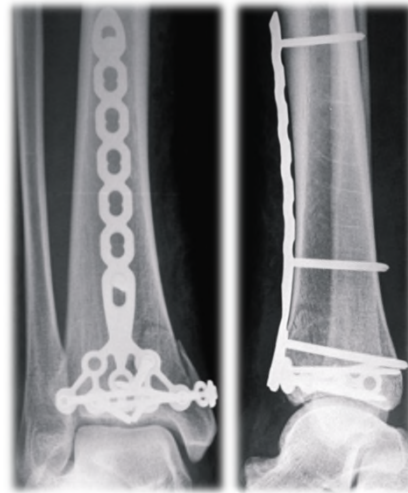
AO

A new pilon plate is used as anterior buttress.

Courtesy: C Sommer

## Skiing accident—Case 2

- 8-month follow up:
  - No
  - Complications
  - Gruent joint
  - Good function



AO

8 months later, the patient has good functionality of the ankle and no complications.

Courtesy: C Sommer

## Choice of implant for articular fractures

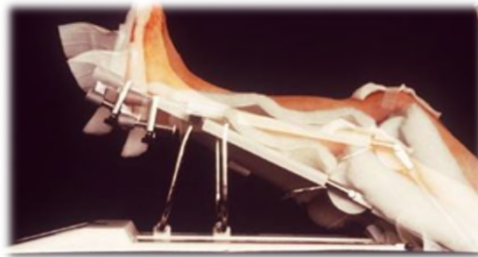
- Screws and plates are usually more adequate than intermedullary nails
  - 1/3 tubular, LC-DCP, LCP
  - Preshaped plates
- 3.5 mm implants are best dimension



In most cases 3.5 mm implants are used. Screws and plates are more adequate than IM-nails.

## Postoperative care

- CPM (Continuous Passive Motion) for 5–6 days
- No external splint
- Immediate toe-touch (15 kg) weight bearing
- 6–8 weeks 30–40 kg weight bearing



AO

### Postoperative care

If the patient is compliant, the postoperative care consists of:

- Continuous passive motion (CPM) for 5–6 days
- No external splint
- Immediate toe-touch (15 kg) weight bearing
- From 6–8 weeks partial weight bearing (30–40 kg)

## Results after ORIF in articular fractures

- Results:
  - 70–80% good or excellent
  - 10–15% moderate
  - 5–10% poor
- Decisive factors however are:
  - Anatomical reconstruction and rigid fixation
  - Experienced surgeon
  - Early rehabilitation

AO

The results after ORIF in articular fractures are in general good provided there is:

- Anatomical reduction and rigid fixation
- An experienced surgeon doing the surgery
- Early rehabilitation

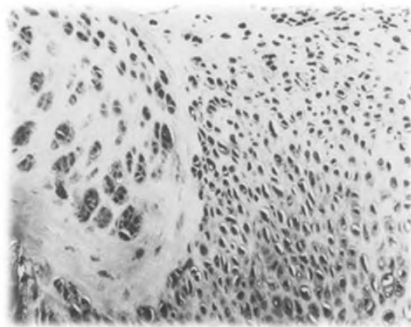
Results:

- 70–80% is good to excellent
- 10–15% is moderate
- 5% is bad



## Results

- Remember physiology of cartilage:
  - Damaged cartilage never „heals“ completely
  - Its repair „depends“ on early joint motion



AO

## Conclusion

- Displaced articular fractures are absolute indications for surgery
  - Staged surgery is advisable in complex fractures
- Correct timing and planning is crucial
- Experienced surgical team is important
  - New locking plates may have advantages, but a good surgeon is more important
- Early mobilization reduces cartilage damage
  - Injured cartilage never heals completely

AO

### Conclusion

- Displaced articular fractures are an absolute indication for surgery provided there is anatomical reconstruction and rigid fixation.
    - Staged surgery is advisable in complex fractures.
  - Correct timing and planning are crucial:
    - Good imaging and classification are important
    - Choice of approach(es)
    - Choice of reduction
    - Choice of implants and instruments
    - Choice of bone grafts or substitutes
  - New locking plates may have advantages but a good surgeon is more important
- Injured cartilage never heals completely, but early mobilization is mandatory to reduce cartilage damage.

## Questions

AO

*Optional*  
*Insert questions to check learning.*

## Displaced articular fractures are an indication for surgery providing...

1. Anatomical reconstruction and rigid fixation

2. Anatomical reconstruction and relative fixation

3. Reconstruction of length and axis and rigid fixation

AO

*Optional*

*Insert questions to check learning.*

## Displaced articular fractures are an indication for surgery providing...

1. Anatomical reconstruction and rigid fixation



2. Anatomical reconstruction and relative fixation

3. Reconstruction of length and axis and rigid fixation

AO

*Optional*

*Insert questions to check learning.*

## Advantages of staged surgery, eg, external fixator are...

1. Recovery of soft tissue

2. “Early” mobilization of patient

3. Use as reduction aid

AO

*Optional*

*Insert questions to check learning.*

## Advantages of staged surgery, eg, external fixator are...

1. Recovery of soft tissue



2. “Early” mobilization of patient



3. Use as reduction aid



AO

*Optional*

*Insert questions to check learning.*

## Cartilage

1. Can heal completely

2. Heals only partially

3. Does not heal

AO

*Optional*  
*Insert questions to check learning.*



## Cartilage

1. Can heal completely

2. Heals only partially



3. Does not heal

AO

*Optional*  
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## Summary

You should now be able to:

- Outline the pathophysiology of articular cartilage
- Describe the need for anatomical reduction and rigid fixation in articular fractures
- Discuss “staged surgery”

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