

Four principles of fracture fixation

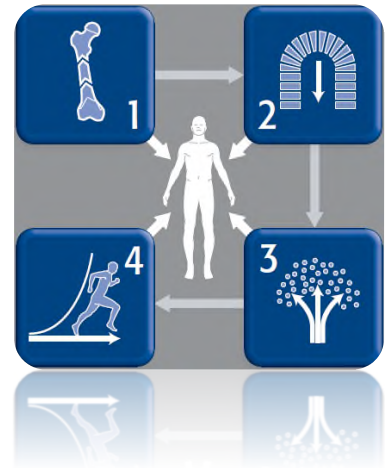
Josefa Bizzarro, Pietro Regazzoni



Learning outcomes

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

- Outline the four AO principles



AO

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

- Outline the four AO Principles of fracture fixation
 - Fracture reduction
 - Fracture fixation
 - Preserve blood supply
 - Early mobilization

The four AO Principles

1. Fracture reduction

- To restore anatomical relationships

2. Fracture fixation providing absolute or relative stability

- Depending on the “personality” of the fracture, the patient, and the injury

3. Preservation of blood supply

- Of soft tissues and bone

4. Early and safe mobilization

- Of the injured part and the patient

AO

1. **Fracture reduction to restore anatomical relationships.**
2. **Fracture fixation providing absolute or relative stability** as the “personality” of fracture, patient and injury requires.
3. **Preservation of blood supply** to soft tissues and bone.
4. **Early and safe mobilization** of the injured part and the patient as a whole.

1. Fracture reduction



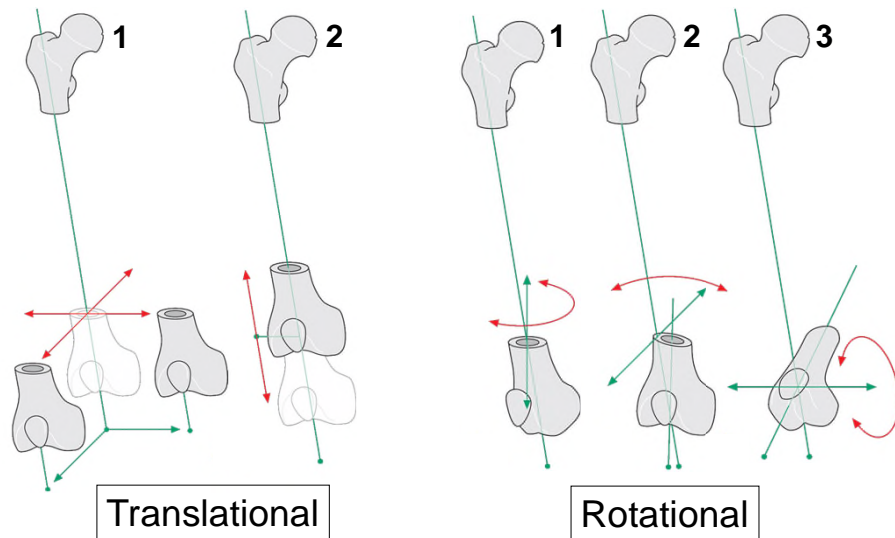
What does reduction mean?

- Restoring anatomical relationships
- Realignment of a displaced fracture

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Reduction is the action of restoring a dislocation or fracture by returning the affected part of the body to its normal position.

Types of displacement



There are two forms of displacement:

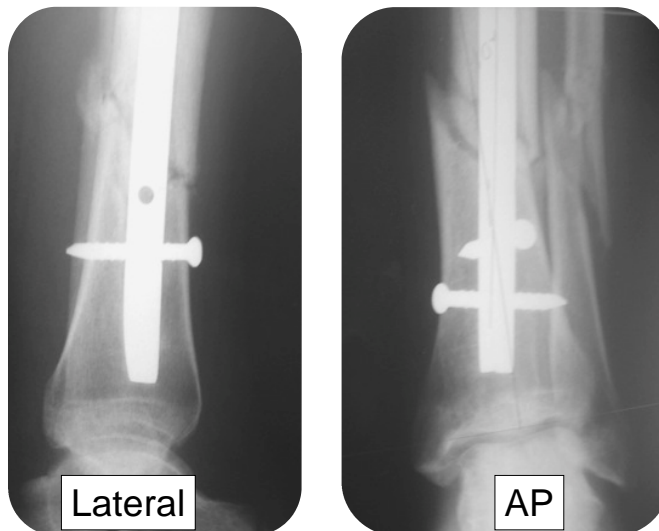
1. Translational displacement:

- Medial or lateral and posterior or anterior
- Shortening or lengthening

2. Rotational displacement:

- Internal or external rotational malalignment
- Valgus or varus malalignment
- Flexion or extension malalignment

Why fracture reduction? Example 1

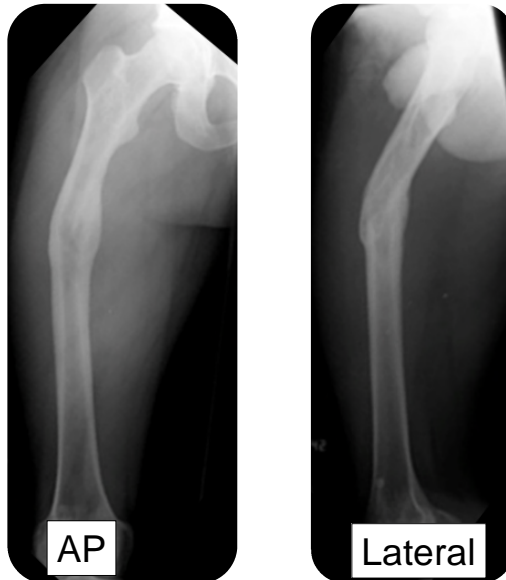


AO

Why fracture reduction?

Here we can see a fracture fixed with an intramedullary nail that looks reduced on the lateral view. On the AP view however we can see that there is some valgus angulation of the distal fragment.

Why fracture reduction? Example 2



AO

Why fracture reduction?

This fracture was not treated operatively and has healed with varus, antecurvatum, and shortening malunion.

Aim of reduction

- Anatomical reduction
 - Perfect restoration of bone morphology
- Functional reduction
 - Restoration of anatomical relationships of proximal and distal main fragments:
 - Length
 - Alignment
 - Rotation

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Some fractures are reduced perfectly to restore the bony anatomy and others to restore the relationship between the proximal and distal main fragments, setting the scene for recovery of the function of the limb.

Choice of reduction method

- Depends on location of the fracture
 - Metaphysis and diaphysis:
 - Functional reduction
 - Epiphysis (joint):
 - Anatomical reduction

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The decision, which reduction method should be used, depends on the location of the fracture:

1. Meta- and diaphyseal fractures usually need functional reduction.
2. Joint fractures need anatomical reduction.

Reduction of diaphyseal fractures

- Restore functional anatomy
 - Length
 - Alignment
 - Rotation
- Restore axis of the extremity
 - Eg, lower limb
- Exception: forearm
 - Functions as a single articular unit



AO

In diaphyseal fractures:

- The functional anatomy is restored (length, alignment, and rotational axis).
- The load-bearing axis of the extremity is restored (especially important in the lower limb).

Reduction of articular fractures

- Anatomical reduction of the joint surfaces:

- Avoid steps
- Avoid gaps



- Restore axial alignment

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In articular fractures:

- The joint surface is restored anatomically. Gaps and steps in the articular surface must be avoided.
 - “Steps” means that there is a difference between the levels of two main articular fragments.
 - “Gaps” means that there is some space between two adjacent main articular fragments.
- The axial alignment is restored.

2. Fracture fixation



What does fracture fixation mean?

- Providing absolute or relative stability depending on
 1. The “personality” of the fracture
 2. The patient
 3. The injury

AO

Goal of fracture fixation

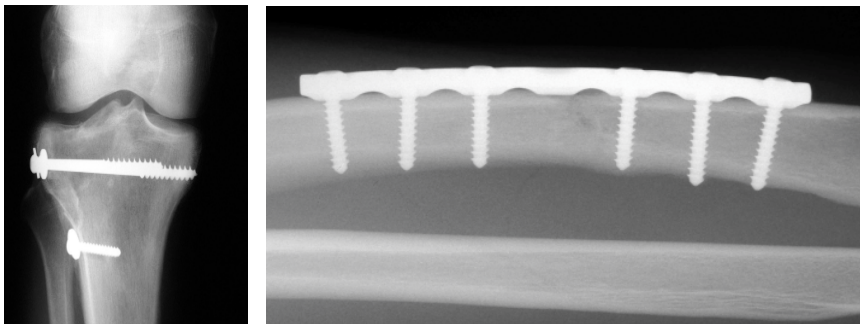
- To maintain the reduction
- To create adequate stability which:
 - Allows early and optimal function of the injured limb
 - Minimizes pain

AO

The main goal of internal fixation is to achieve prompt and, if possible, full function of the injured limb. Although reliable fracture healing is only one element in functional recovery, its mechanics, biomechanics, and biology are essential for a good outcome. Fracture fixation is always a compromise. For biological or biomechanical reasons it is often necessary to sacrifice some strength and stiffness of fixation and the optimal implant is not necessarily the strongest or the stiffest available.

Absolute stability

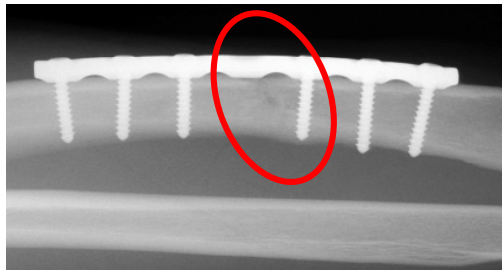
- No movement at fracture site
- Achieved by interfragmentary compression
 - Lag screw
 - Compression plate



AO

Absolute stability

- No movement at fracture site
- Achieved by interfragmentary compression
 - Lag screw
 - Compression plate
- No callus formation
 - Direct bone healing



AO

Absolute stability

- When is it required?
- How is it achieved?
- Which fixation techniques are used?

AO

Ask the participants

- *When absolute stability is required? (For which type of fractures, which anatomical regions)*
- *How absolute stability is achieved?*
- *Which fixation techniques are used. Ask for a few examples. Check briefly, if they know, which kind of instruments are needed.*

Do not go into detail. Detailed steps of procedure will be explained in other presentations.

Absolute stability

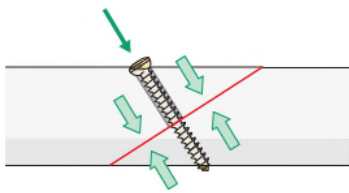
- When is it required?
 - Articular fractures
- How is it achieved?
 - By interfragmentary compression
- Which fixation techniques are used?
 - Lag screw, compression plate, tension band

AO

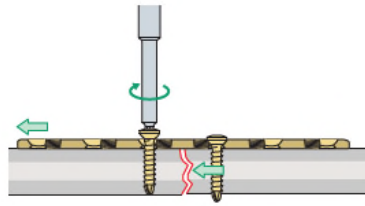
Fracture fixation with absolute stability does need anatomical reduction (refer to reduction, explained in previous slides).

Absolute stability

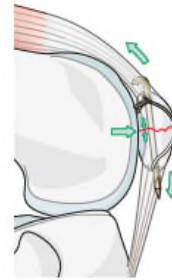
- Fixation techniques
 - Require perfect reduction



Lag screw



Compression
plating



Tension
band

AO

Relative stability

- Movement at fracture site
- No interfragmentary compression at fracture site

Elastic
nails



Fixation with relative stability aims to maintain the reduction and still keeps the mechanical stimulation for fracture repair by callus formation (see next slide). There is no interfragmentary compression such as shown in this image (fracture fixation with elastic nails).

Relative stability

- Movement at fracture site
- No interfragmentary compression at fracture site
- Callus formation
 - Indirect bone healing

Elastic
nails



AO

Relative stability

- When is it required?
- How is it achieved?
- Which fixation techniques are used?

AO

Ask the participants

- *When relative stability is required? (For which type of fractures, which regions)*
- *How relative stability is achieved?*
- *Which fixation techniques are used. Ask for a few examples. Check briefly, if they know, which kind of instruments are needed.*

Do not go into detail. Detailed steps of procedure will be explained in other presentations.

Relative stability

- When is it required?
 - Multifragmentary diaphyseal/metaphyseal
 - Extraarticular fractures
- How is it achieved?
 - By splinting or bridging the fracture
- Which fixation techniques are used?
 - Intramedullary nail, bridge plate, internal and external fixator ...

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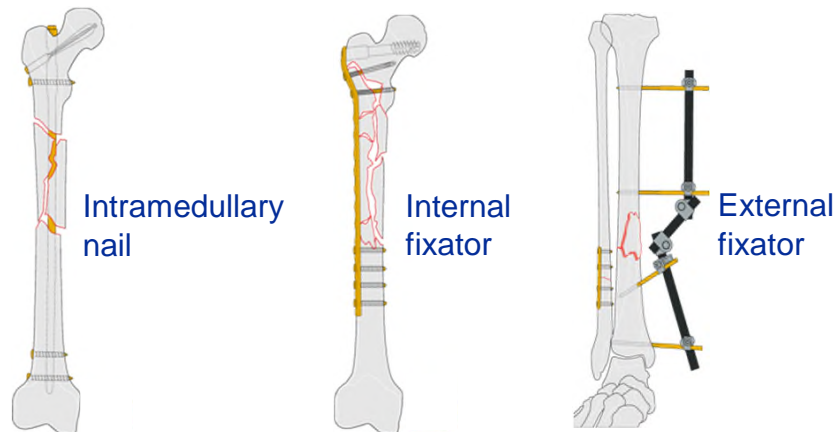
Fracture fixation with relative stability does not need anatomical reduction (refer to reduction, explained in previous slides). Axis, length, and rotation are restored.

The biology is also more important than the mechanics.

Devices such as external fixators, intramedullary nails, or internal fixators provide relative stability. The degree of flexibility varies. This is determined by how the surgeon applies the device and how it is loaded. All of these devices allow interfragmentary movement, which can stimulate callus formation. However, incorrect application of the device can result in excessive movement and inhibit bone union.

Relative stability

- Fixation techniques
 - Main fragments are connected



Splints reduce but do not abolish motion at fracture site, allowing active limb movement without pain.

3. Preservation of blood supply



What does it refer to?

- Handling and care of patient with fractured bone(s):
 - Decontamination of fracture site
 - Positioning of fractured limb
- Perioperative care of the soft tissues
 - Vessels, muscles



AO

Care for the soft tissues

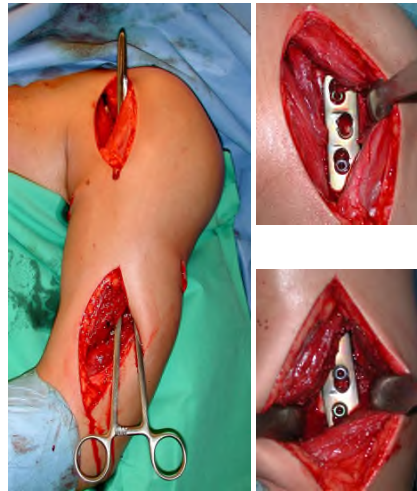
- Evaluation of limb swelling
- Consideration for staged procedure is important:
 - Primary stabilization → external fixation
 - Secondary stabilization → definitive fixation
- Careful reduction procedure:
 - Too intense efforts for perfect reduction are risky
 - Increases infection rate

AO

Care for the soft tissues



- Minimal invasive surgery
- 42-year-old humerus shaft (gun shot)



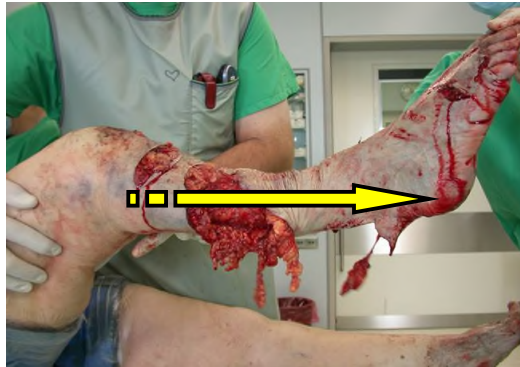
AO

Choice of technique in order to care for soft tissues.

Courtesy of: Christoph Sommer

Care for the soft tissues

- Nursing care of patient with fractures
 - Care during transfer and positioning
 - Traction of limb during disinfection/draping process



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Care for the soft tissues

- Nursing care of patient with fractures
 - Taking care of body temperature
 - In old and young patients
 - During long surgeries



AO

If the body temperature is below 35° Celsius a danger for coagulation problems exists.

Care for the soft tissues

- Intraoperative nursing care
 - Use of atraumatic soft-tissue forceps and retractors
 - Reduce pressure on bone elevators
 - Irrigate wound regularly
 - Cover wound with wet pads



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4. Early mobilization

What does this mean?

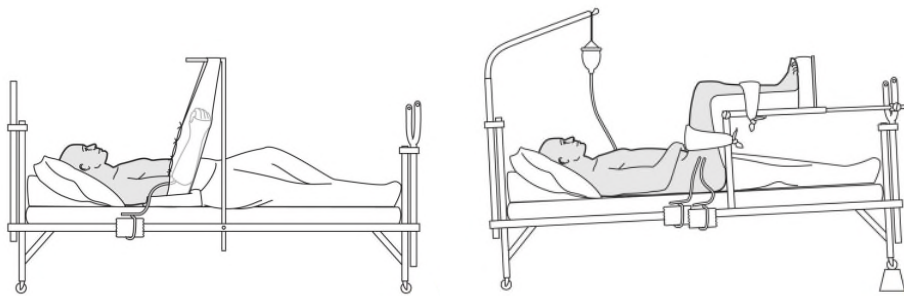


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This means mobilization of the injured part and the patient as a whole.

Postoperative care

- Immediately after surgery:
 - Elevation of the limb



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Immediately after the operation, the treated extremity is positioned above the level of the heart to minimize swelling.

Following osteosynthesis of the upper extremity, the limb is either placed on a cushion or elevated in a bag. When the latter is used, flexion of the elbow should not exceed 75° . After any procedure, pressure, malpositioning, and deformity must be prevented. In particular, the medial epicondyle of the elbow (ulnar nerve) and the head of the fibula (fibular nerve) must be well padded. During follow-up treatment, not only look at the x-rays but also at the injured limb. Pain, swelling, and tenderness are signs of either instability or infection.

Postoperative care

- Immediately after surgery:
 - Elevation of the limb
 - Early joint motion: Use of CPM machines



AO

CPM (continuous passive motion) machines are used to provide a continuous but passive (without force of the patient) motion for limbs where after surgery (knee or elbow) stiffness of the limb might be expected.

Postoperative care

- Immediately after surgery:
 - Elevation of the limb
 - Early joint motion
 - Partial weight bearing
 - Adequate pain control
 - Thrombosis prophylaxis
 - Early recognition of complications

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Postoperative management is not limited to the time spent in hospital, but must be carried on at home, at work and during leisure and sport. To achieve this three postoperative phases are recognized:

1. Immediately after surgery emphasis is on pain control, mobilization, thrombosis prophylaxis, and early recognition of complications.
2. When the patient leaves the hospital, attention is centered upon integration into the home and into the professional and social environment. Good mobilization is important.
3. Treatment is finished. The patient returns to his/her preoperative capabilities.

Questions

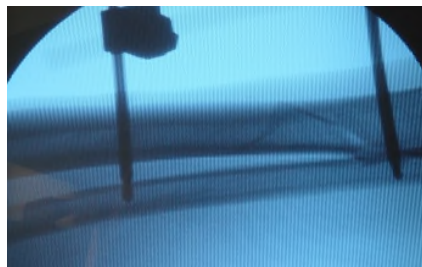
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What type of reduction was performed here?

1. Combined open & closed reduction

2. Open direct reduction

3. Closed indirect reduction



AO

Optional:

Insert these questions to check learning outcomes, if required.

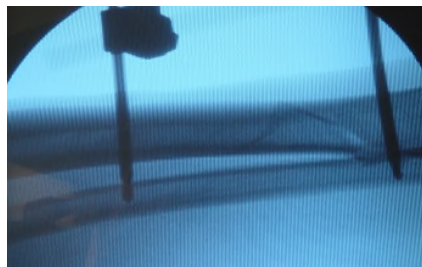
Courtesy R Frigg

What type of reduction was performed here?

1. Combined open & closed reduction

2. Open direct reduction

3. Closed indirect reduction ✓



AO

Optional:

Insert these questions to check learning outcomes, if required.

What type of stability is required here?

1. Absolute stability

2. Relative stability

3. Adequate treatment nonoperatively



Optional:

Insert these questions to check learning outcomes, if required.

Courtesy V Braunstein

What type of stability is required here?

1. Absolute stability



2. Relative stability

3. Adequate treatment nonoperatively



AO

Optional:

Insert these questions to check learning outcomes, if required.

Forearm fracture and blisters— What to do?

1. Delay surgery due to blisters

2. Immediate surgery and plating

3. Immediate surgery and
external fixation



AO

Optional:

Insert these questions to check learning outcomes, if required.

Forearm fracture and blisters— What to do?

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AO

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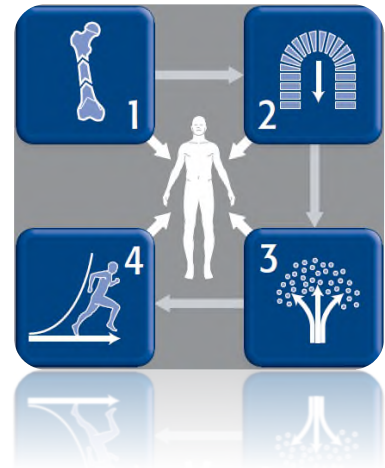
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Courtesy T Sawaguchi

Summary

You should now be able to:

- Outline the four AO principles



AO