AO TRAUMA

Reduction techniques

Rodrigo Pesantez, Myriam Sanchez

Learning outcomes

- Define reduction and its types
- Understand the degrees of displacement of fractures
- Describe the reduction methods and the tools used

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

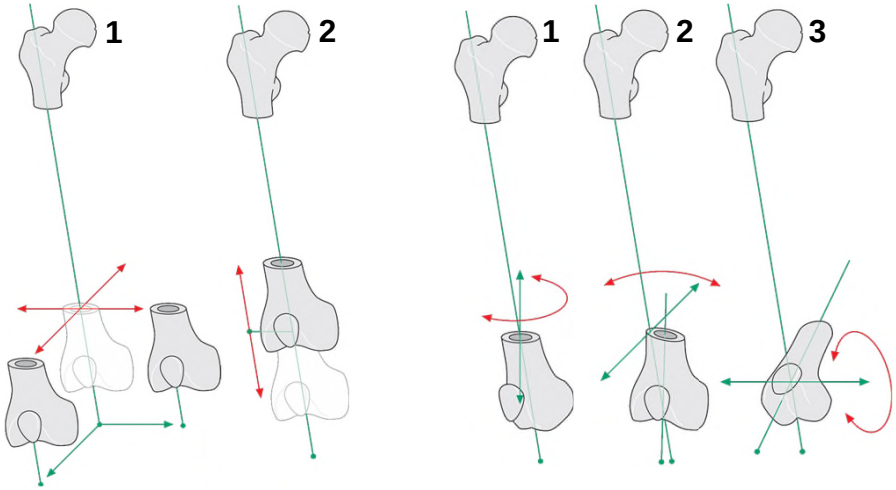
- Define reduction and its types.
- Understand the degrees of displacement of fractures.
- Describe the reduction methods and the tools used.

What is reduction?

- Realignment of a displaced fracture
- Returning the affected part of the body to its normal position

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

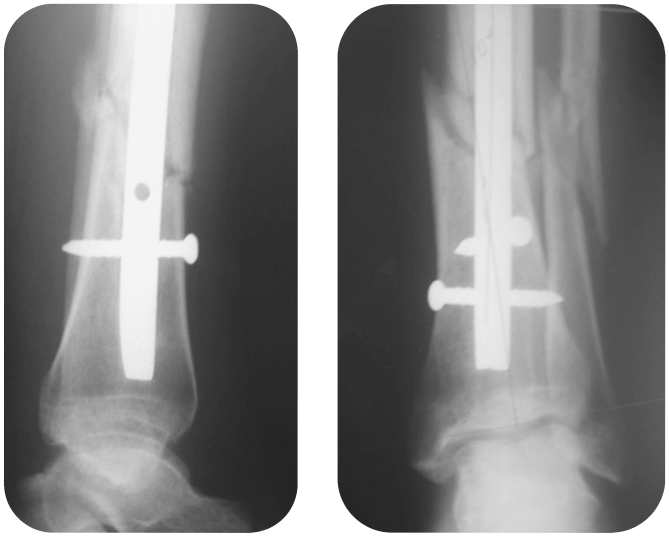
Types of displacement



There are two forms of displacement:

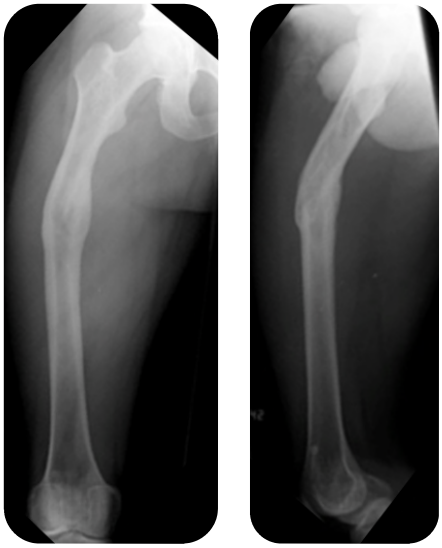
1. Translational displacement:
    - Medial or lateral and posterior or anterior
    - Shortening or lengthening
2. Rotational displacement:
    - Internal or external rotational malaligment
    - Valgus or varus malaligment
    - Flexion or extension malalignment

Why fracture reduction? Example 1



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



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

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

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

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 diaphyseal fractures

- Restore functional anatomy:
  - Length
  - Alignment
  - Rotation
- Restore axis of the extremity:
  - Eg, lower limb

- Exception: forearm, which works as a single articular unit

- An exception is the forearm. The forearm works as a joint (radiohumeral joint, and proximal and distal radio-ulnar joints for pronation and supination).

Image courtesy: Professor Christopher L Colton.

Reduction of articular fractures

- Anatomical reduction of the joint surfaces:
  - Avoid steps
  - Avoid gaps
- Restore axial alignment

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.

Methods

- Direct:
  - Restore every fragment under direct vision
- Indirect:
  - Blind (not under direct vision) reposition of fragments
  - Manipulation by traction

There are two reduction methods:

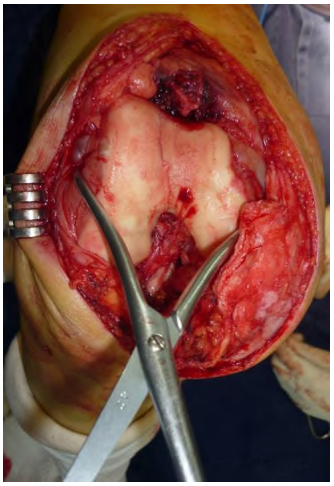
- Direct reduction where every fragment under direct vision is restored.
- Indirect reduction where the direction is done without direct view on the fracture.

Methods of direct reduction

- Direct clamp application:
  - Joint
  - Shaft
- Push-pull technique
- Direct application of an implant
- “Shoehorn technique”

There are different techniques of direct direction.

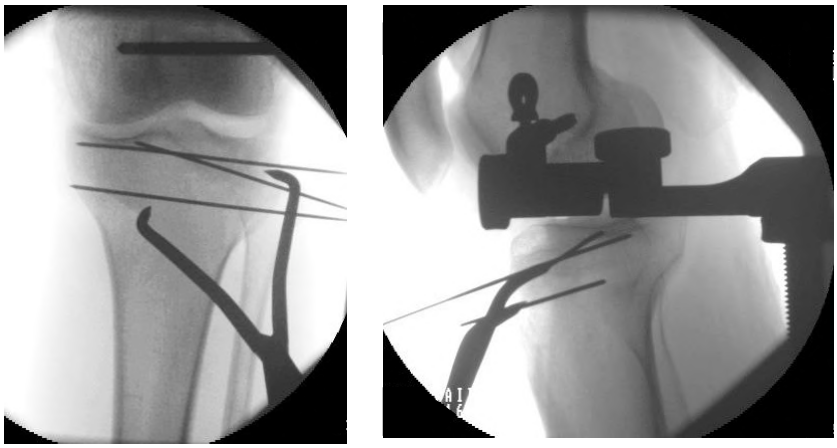
Direct clamp application: joint (example 1 and 2)



Knee Elbow

On this slide you can see how the distal femoral and distal humeral fractures are reduced with a pointed reduction clamp.

Direct clamp application: joint (example 3)



Reduction of proximal tibia/tibia plateau using a distractor in combination with a pointed reduction forceps.

Direct clamp application: shaft (example 4)

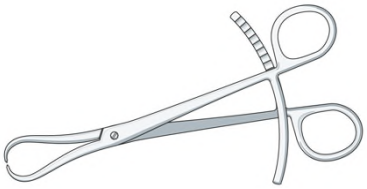
Also here the distractor is used to gain normal length. The forceps then reduces the main fragments.

Additional Material

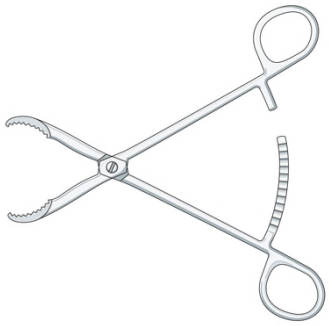
The next four slides (slides on reduction tools) are additional to the core knowledge but may be incorporated in any presentation, in which it is required.

Information for faculty: All slides on reduction tools can be used and explained. An possible alternative is a discussion of these instruments during hands-on exercises (eg, AO Skills Lab). In that case you may wish not to show these slides.

Direct clamp application: reduction tools



Pointed reduction forceps (Weber)
- or two-forceps techniques
- ReOne-duction in different planes



Toothed reduction forceps
- Used for alignment of plate on diaphyseal bone and reduction

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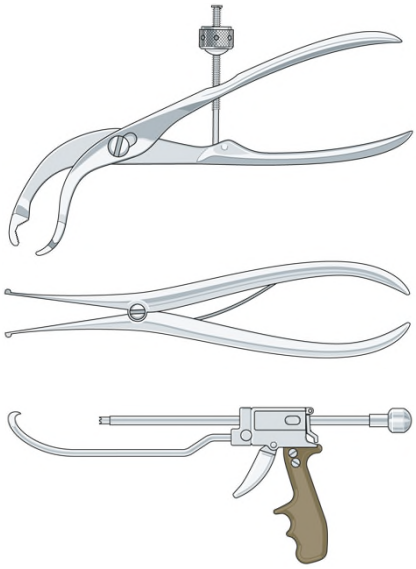
Commonly used reduction tools are:
- Pointed reduction forceps
- Toothed reduction forceps

Direct clamp application: reduction tools



Bone holding forceps, self-centering (Verbrugge)

Bone spreader
- Distraction

Colinear reduction clamp:
- With different attachments, hooks, etc
- Compression

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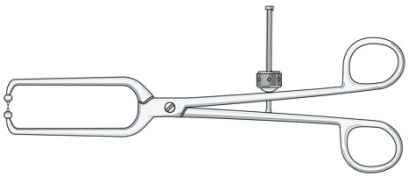
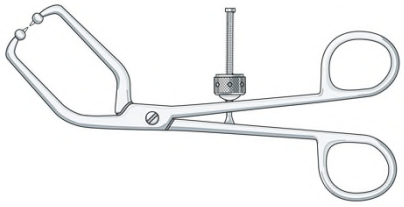
Commonly used reduction tools are:
- Bone-holding forceps, Verbrugge type
- Bone spreader
- Colinear reduction clamp

Direct clamp application: reduction tools



Pelvic reduction forceps (King/Queen Tong)
- With ballpoints



Angled pelvic reduction forceps (Matta forceps)

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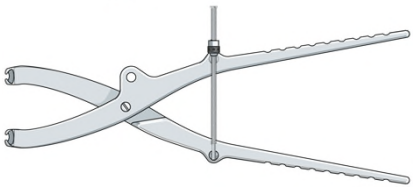
Reduction tools for oseosynthesis of the pelvis are:
- Pelvic reduction forceps
- Angled pelvic reduction forceps

Direct clamp application: reduction tools

Pelvic reduction forceps (Faraboeuf)
- Used with 3.5 mm and 4.5 mm screws

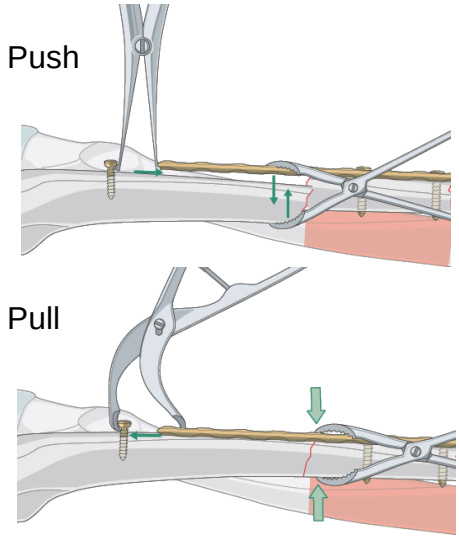


Pelvic reduction forceps (Yungbluth)
- Used with 3.5 mm and 4.5 mm screws

Information for faculty: All slides on reduction tools can be used and explained. An possible alternative is a discussion of these instruments during hands-on exercises (eg, AO Skills Lab). In that case you may wish not to show these slides.

Reduction tools for osteosynthesis of the pelvis are:
- Faraboeuf
- Yungbluth

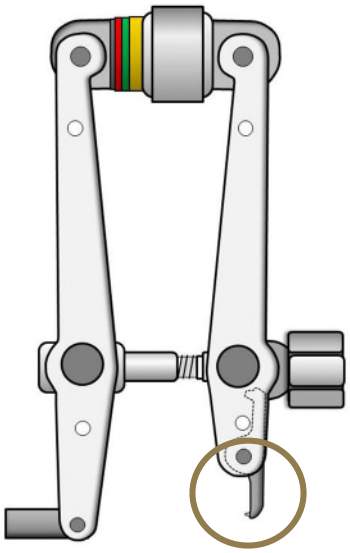
Push–pull technique



In diaphyseal fractures fixed with a plate, the plate is attached to one fragment: then a bone spreader, placed between the end of the plate and an independent screw in one main fragment, can be used to distract the fracture for reduction.
A loosely applied reduction forceps helps to maintain the alignment of the main fragment with the plate.
In a next step, in order to maintain the reduction using the same independent screw, preliminary axial compression can then be obtained by pulling the plate end towards the independent screw with a small Verbrugge clamp.

Direct application of an implant (plate)

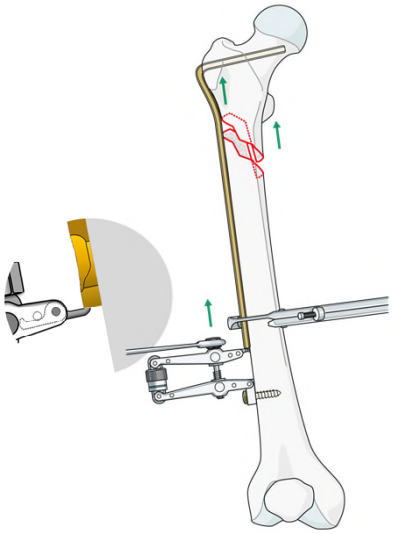
- The articulated tension device (ATD) may also be used for the push-pull technique

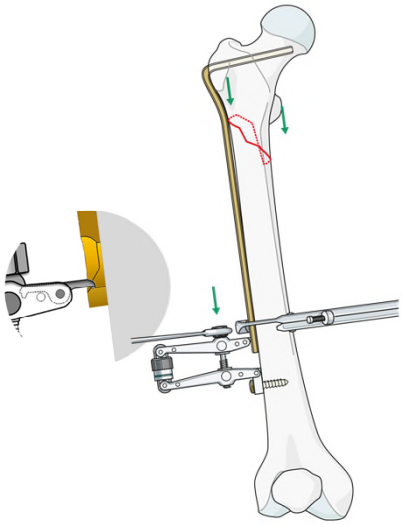


The articulated tension devide (ATD) can be used to serve the push-pull principle, as illustrated on the previous slide.
The push stage is achieved by reversing the hook on the articulated tension device (see circle and next slide).

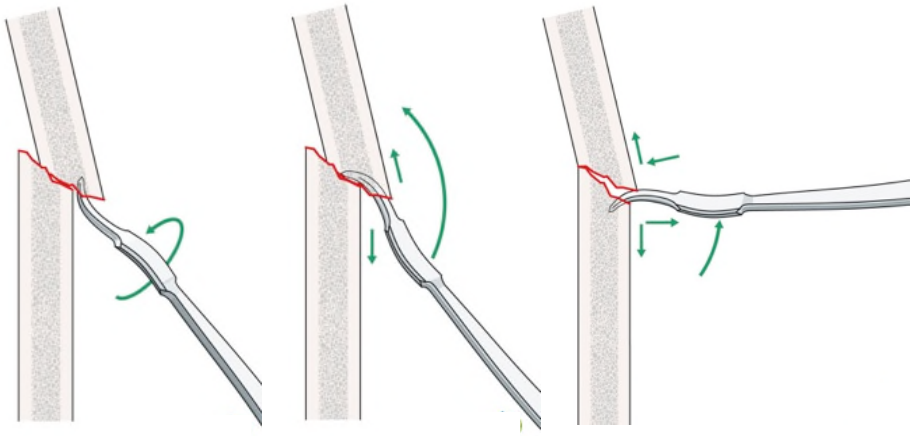
Image courtesy: Professor Christopher L Colton.

Direct application of an implant (plate)





Shoehorn technique

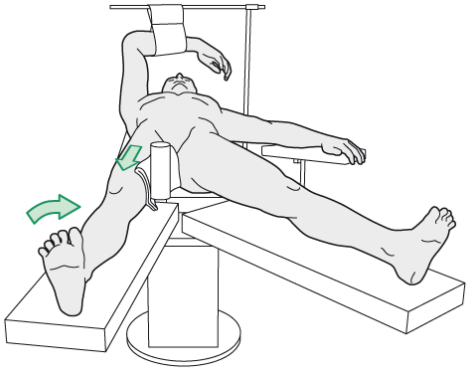


The tip of a Hohmann retractor can be used by placing it between the two bone ends of a fracture. By turning the instrument and levering the fragments into position the fracture can be reduced.

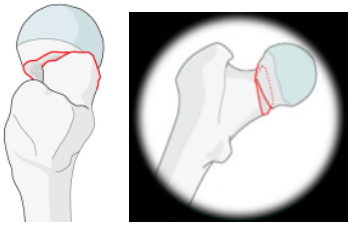
Methods of indirect reduction

- Traction table with image intensifier
- Distractor and joysticks
- Frames

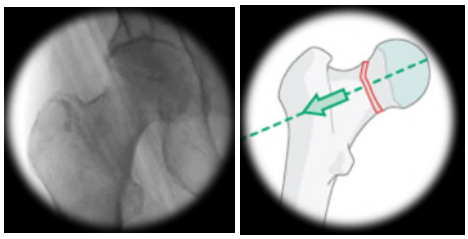
Traction table



Prereduction

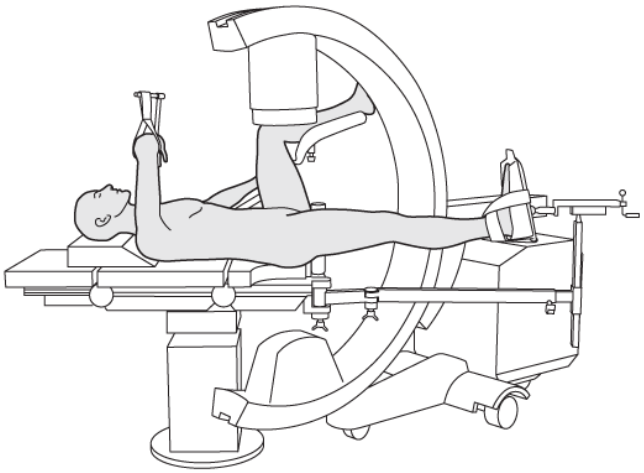


Postreduction



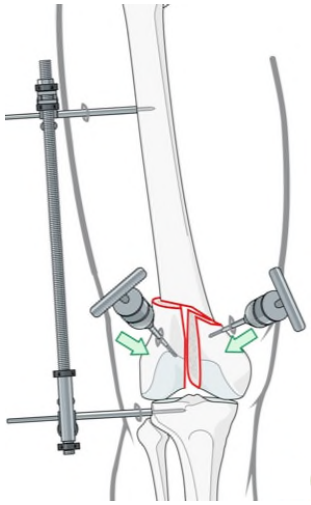
The fracture table is used to facilitate the reduction of certain fractures. It is commonly used for the reduction and fixation of proximal hip fractures.

Traction table (with image intensifier)



The use of the image intensifier is crucial when performing closed reduction and to guide fixation.
When using the extension table, good access with the image intensifier must be possible in both views, AP and lateral view.

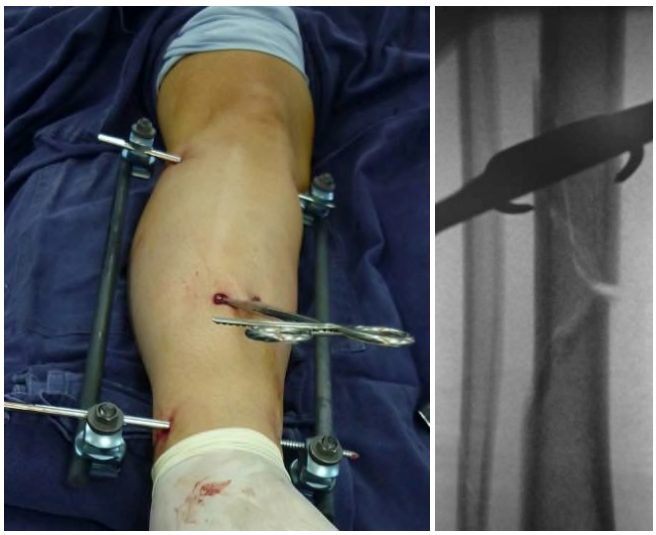
Distractor and joysticks



The large distractor is a tool used to distract the fracture. In a next step reduction can be carried out. The distractor can be used with any table, for any type of fracture, and with all kinds of implants, including the intramedullary nail. In combination with joysticks (Schanz screw with T-handle, placed in each fragment) reduction can more easily be obtained.

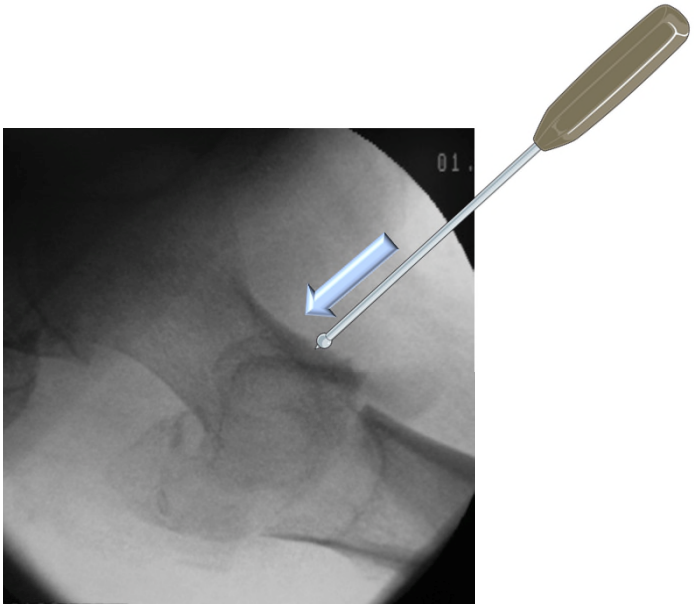
Distractor and joysticks: example

Frames with reduction forceps: example



Also the external fixator system with frame distraction can be used to obtain preliminary reduction, particularly in length.

Ball spike



Direct reduction

- Advantages:
  - Easy to see the fracture
  - Easier to reduce
- Disadvantages:
  - Increases the soft-tissue insult

The advantages of direct reduction (from point of view of the surgeon) are that the fracture can easily be seen, which makes it easier to reduce.
The disadvantage is that it is often associated with increased surgical insult to the soft tissue.

Indirect reduction

- Advantages:
  - Preserves soft tissues – biology
- Disadvantages:
  - More difficult to reduce
  - More difficult to keep it reduced
  - Increased ionizing radiation

The advantage of indirect reduction is that the soft tissues are preserved from additional insult.
Disadvantages are, firstly, the fact that many fractures are more difficult to reduce indirectly and to maintain reduced. Secondly, indirect reduction is also combined with an increased use of the image intensifier, and consequently, a higher exposure of the surgical team to ionizing radiation.

Questions?

Optional: Insert questions to check learning outcomes.

The aim of anatomical reduction is

1. Perfect restoration of bone morphology
2. Restoration of anatomical relationships of proximal and distal main fragments
3. Restoration of length, alignment, and rotation

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Methods of direct reduction

1. Ball spike

2. Push pull technique and traction table

3. Direct clamp application and shoe horn technique

Optional: Insert questions to check learning outcomes.

Methods of direct reduction

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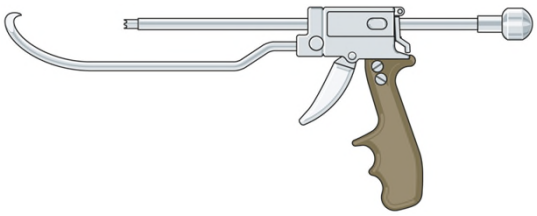
AO

Optional: Insert questions to check learning outcomes.

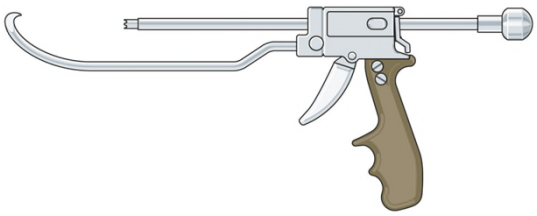
The colinear reduction clamp is used for



1. Distraction
2. Compression
3. Distraction and compression

Optional: Insert questions to check learning outcomes.

The colinear reduction clamp is used for



1. Distraction
2. Compression ✓
3. Distraction and compression

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Summary

You should now be able to:

- Define reduction and its types
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