Principles of external fixation

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How to use this handout?

This handout is part of the AO Trauma Course for ORP. The left column is the information as it may be given during the lecture. The column on the right gives you space to make personal notes.

Learning outcomes

- Outline indications for external fixation
- List different types of external fixators
- Discuss the modular technique
- Outline the technique considering corresponding instruments, implants, and aftercare

Indications

The external fixator can be used for many reasons and in many ways.

The two areas in which the fixator is used are traumatology and elective orthopedic surgery. In this presentation, we shall only discuss the use of the external fixator in traumatology.

- **Fractures with soft-tissue damage**

  Indications are fractures with severe soft-tissue damage:
  - Closed fractures with soft-tissue compromise
  - Open fractures with soft-tissue wounding

- **Polytrauma—damage control surgery**

  In a polytrauma case the external fixator must be applied as fast as possible to stabilize the patient and safe his life and limb. The stages of treatment are:
  1. First, application of (an) external fixator(s)
  2. Secondary, definitive treatment based on the paient's condition.

- **Skeletal infection**

  When the wound is infected,

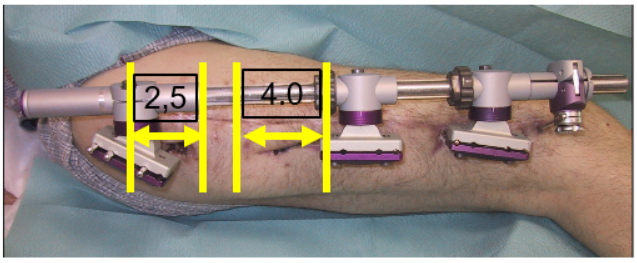
  1. Debridement will remove all dead and infected tissue—including bone.

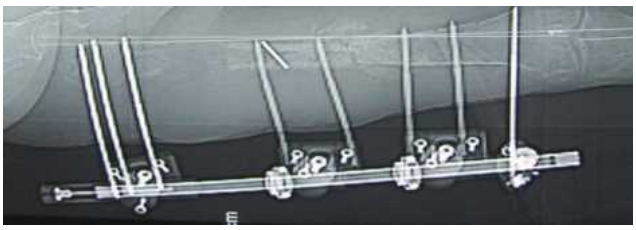
  2. The fracture will then be stabilized temporarily by external fixation.

  3. Final osteosynthesis is done later, once the infection is cured.

- **Corrective surgery**

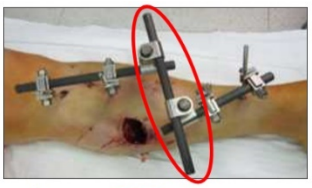
  Limb is lengthened with callus distraction. 6.5 cm can be achieved to restore the full length of the limb (2.5 plus 4.0 cm).

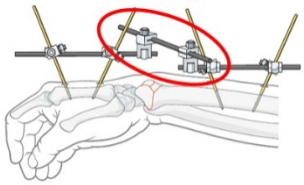




Types of external fixators

1. **Modular system**



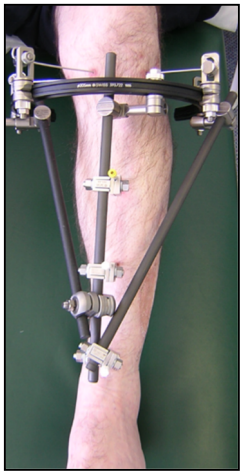


The modular system can be applied anywhere, for an individual bone fracture or for joint bridging fractures.

First, two pins are inserted in each segment of the fractured bone. Second, a rod will be fixed in parallel to the bone segment using clamps.

Third, this is repeated for the other segment. Finally, a third rod will be loosely fixed (once again with clamps) from rod to rod. Once the reduction is performed the clamps of the third rod will be tightened so that the fracture is fixed.

2. Hybrid system



Hybrid ring fixators refer to combinations of two types of fixator, such as a half-ring fixator plus unilateral external fixation system.

It is used to fix periarticular fractures.

3. Ring fixator

To achieve complex corrections in several planes, or just fracture stabilization.

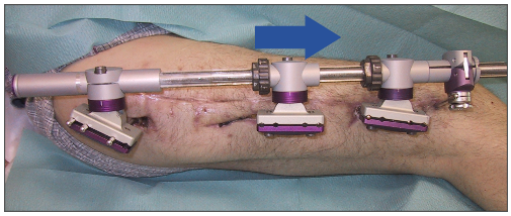
Corrective procedures:

- Lengthening of shortened limbs
- Correction of (rotational) deformities
- Segmental bone transport

4. Modular system

Corrective procedures can be performed in order to

- Lengthen of shorten limbs
- Correction rotational deformities
- Perform segmental bone transport (in this case as mentioned before 6 cm)



This presentation will further outline the modular technique.

Basic implants

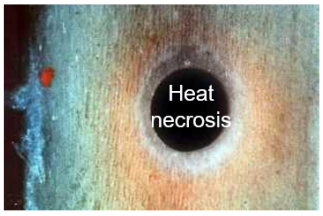
1. **Schanz screws**
   - Different lenghts
   - Different diameters
   - Self-tapping
   - Self-drilling

   The chosen diameter of the Schanz screws depends on the system that is selected for a particular fracture and on the bone size.
   For example, for a tibial fracture, Schanz screws with a diameter of 5mm are used (2.5mm Kirschner wires or threaded pins are used for the small fixator).
   Threads can be coated with hydroxyapatite to avoid loosening of Schanz screws. This is a mineral related to apatite which is the main inorganic constituent of tooth enamel and bone.

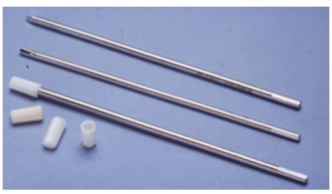

Self-tapping


Self-drilling

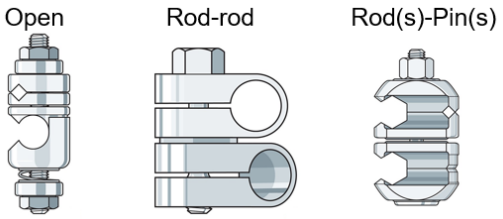
   When predrilling for a Schanz screw (drill bit 3.5mm), or inserting a self-drilling Schanz screw, continuous irrigation is required in order to decrease heat development. The heat produced can lead to necrosis of the bone (see picture on the right).



2. **Steinmann pins**
   - Unthreaded and threaded
   - With a sharp tip
   - Through body of bone, e.g. calcaneus, tibial head, etc.



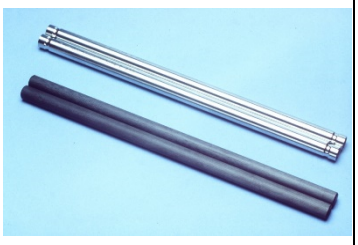
3. **Clamps**
   - Combining pin-to-rod
     - Closed
     - Open
   - Combining rod-to-rod
     - Only rod-to-rod
     - Rod-to-pin which can be combined with pin fixation



4. **Rods to link pins with clamps**

Rods come in steel, or carbon fiber, in different lengths and diameters, to stabilize the frame by linking pins, via clamps.

The advantages of carbon fiber rods are that they are radiolucent and are available in curved versions. They are, however, much more expensive.



Instruments

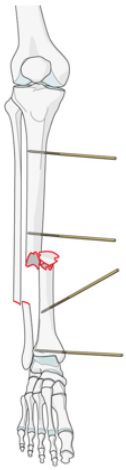
- Protection sleeves with handle
- Power adapter (optional) for Schanz screws
- Drill bit
- Universal chuck with T-handle
- Combination wrench (Assists final tightening of all nuts)
- Socket wrench

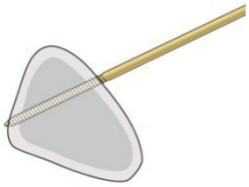
The drill bits are inserted with a power tool, using cold irrigation.
The protection sleeves can be used for 5.0mm and 6.0mm Schanz screws.
Power adapters for easy attachment are also available in different sizes matching the Schanz screw.
The universal chuck T-handle is used for fine adjustment of insertion respecting the correct depth.

Surgical technique—step-by-step

1. Pin insertion

Insert 2 pins on each side of the fracture in the safe zones.
Proximal pins should be inserted from anterior to posterior.
Distal pins should come from medial to lateral.

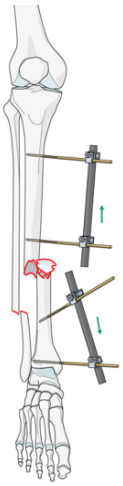




Schanz screws should ideally be inserted from anteromedially.
Penetration of fibula, ligaments and nerves must be avoided.

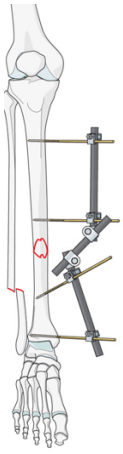
2. Fix rods/tubes to pins

With help of clamps, a rod is mounted on each side of the fracture. The rods will be used in a later stage as “handles” when the reduction is performed.



3. Apply third rod using two rod-to-rod clamps yet loosely

Mount the third short rod, using two tube-to-tube clamps: leave the two tube-to-tube clamps loose.
The fracture is then reduced and finally fixed by tightening the nuts.



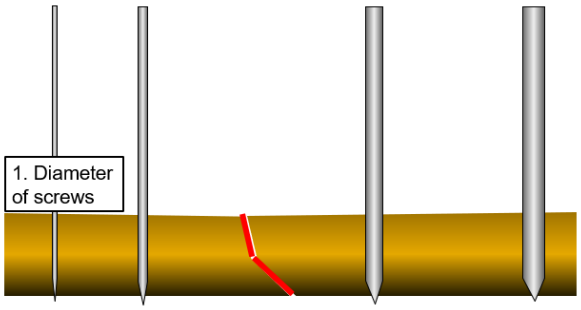
The modular technique using three rods allows the first two rods to be attached, one to each fragment. When the reduction has been achieved, the third rod locks the first two in that position. Gentle fracture reduction is performed in a second step. Only if one rod was used, reduction would have been performed first.

Once the final tightening is done, the modular frame can be strengthened by adding another rod.

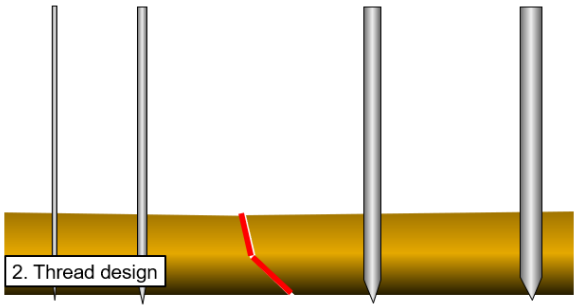
Strong frame constructions

There are six factors influencing stiffness of a frame.

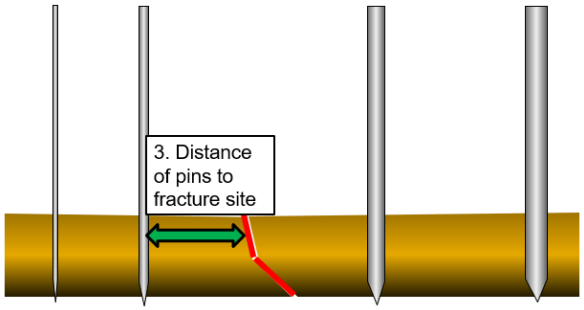
1. The stiffness of the frame increases with the **thickness of a screw**.



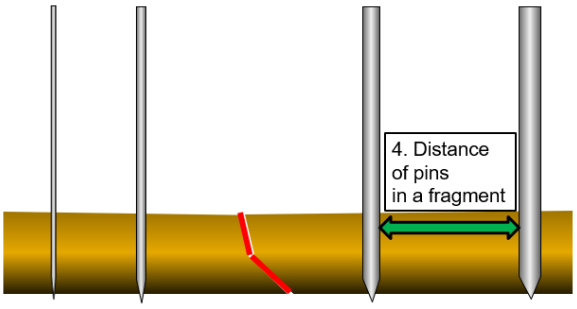
2. The **thread design** will define the holding strength in the bone.



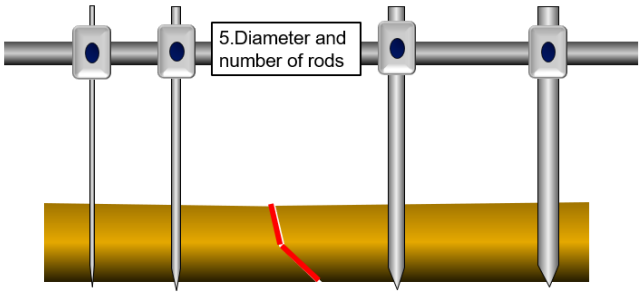
3. It is better to insert a pin as **close** as possible **to the fracture** site.



4. Through **larger distances between the pins** in a fragment, the holding strength increases.



5. Also, **a second rod** will additionally increase the stiffness.



Postoperative care

- Inserted pins may not irritate the skin. Free placement important. No mechanical stress should be applied on skin in order to prevent infection. If needed the incision is enlarged.

- The goal of post-operative care is to remove any debris, such as crusts or exudates. There is no evidence for a best-practice option. In cases in which definitive fracture treatment is foreseen using an external fixator, the patient is trained to clean the limb and the external fixator. The patient can shower or can even go for a swim in the ocean.

- In case of any color change of the skin or appearance of exudates around the pin, they are instructed to report to the surgeon as soon as possible.

Summary

You should now be able to

- Outline indications for use of external fixators
- List different types of external fixators
- Discuss criteria for stability of frame
- Outline technique with corresponding instruments, implants and aftercare

Questions

Bone healing with external fixator is

☐ Through primary bone healing

☐ Through indirect bone healing

☐ Only achieved with absolute stability

What are the basic implants for the application of a large external fixator? Select all what is possible

☐ Schanz screws and Steinmann pins, circular rods, clamps

☐ K-wires and Schanz screws, circular rods and clamps

☐ Schanz screws and Steinmann pins, rods and clamps

What is recommended post-operative care for external fixators?

☐ Shower before weekly dressing change, dry well and disinfect with alcoholic-chlorhexidine unless indicated

☐ Shower before daily dressing change, dry well and disinfect with alcoholic-chlorhexidine unless indicated

☐ Shower before daily dressing change, dry well and disinfect with alcoholic-betadine solution unless indicated

Reflect on your own practice:

Which content of this lecture will you transfer into your practice?