Tension band fixation

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How to use this handout?

The left column is the information as given during the lecture. The column at the right gives you space to make personal notes.

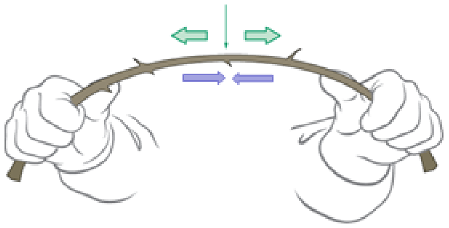
Learning outcomes

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

- Explain the principle of tension band wiring
- Sum up the indications for tension band wiring
- Describe step-by-step the two most commonly used techniques
- Discuss possible complications that might occur.

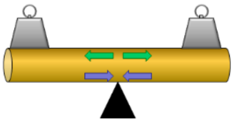
What does «tension band principle» mean?

A bending force applied eccentrically to a column (eg, bone, stick, etc.) causes tension and compression within that column.

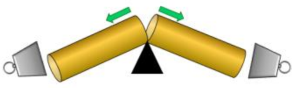


The tension can be absorbed/converted by a band (e.g. wire, plate, etc.) on the tension side. However the opposite side of the column (bone) must be able to resist the compression.

What happens when a beam, bone or column is overloaded eccentrically?



It will break!
One side is loaded in tension.
The opposite side is loaded in compression.

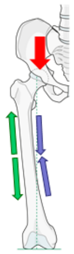


This example explains the borrowed principle of Pauwels, an engineer (1935) who stated what happens when a beam or bone is overloaded eccentrically.
The beam at level of the fulcrum (pivot) will break. The fracture will start at the upper tension surface (green arrows) of the beam. The fracture then completes across the bone until the compression side breaks.

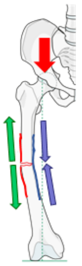
Eccentric loading of the femur

What happens when the femur is overloaded?

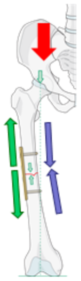
A fracture will occur. Because of the bowed shape of the femur, a vertical load passing down the load axis (from the centre of the femoral head to the intercondylar notch), will result in eccentric loading, with the lateral cortex under tension and the medial cortex in compression.



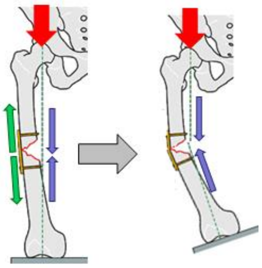
The femur will fracture on the tension side. The opposite side is loaded in compressoin. Overload will result in failure in tension of the lateral cortex and propogation of the fracture through to the medial cortex.



If a device (here a plate) is applied to the tension side of the bone, so that opening cannot occur, the load becomes a compressive one over the whole width of the bone. The lateral plate functions as "tension band". Tension is absorbed by the plate. The compression cortex becomes stable.



However if a tension band is applied to the tension cortex, but the opposite cortex is defective and cannot resist compression, then the fixation will fail under axial load.



Principle of «tension band»

To induce interfragmentary compression on a bending fracture a "tension band" is applied on the "tension side" of the bone. The “tension band” may be an implant (wire, plate).

The principle makes use of the functional movement of the limb. Tension forces are converted into compression forces, provided the compression cortex is not deficient.

Tension forces —„Tension band“→ Compression forces

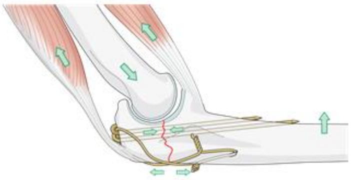
Indications for tension band wiring

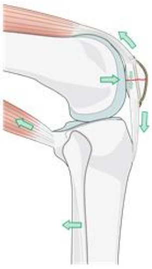
Indications are eccentrically loaded articular fractures.

Tension band wiring is a fixation technique which results in absolute stability. Interfragmentary compression and direct bone healing is obtained.

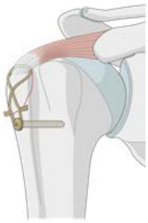
Other fixation methods leading where absolute stability is achieved are fixations with lag screw and fixation with plate and screws.

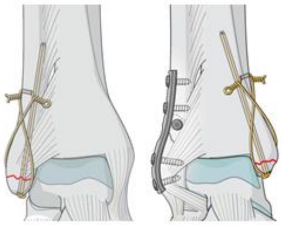
Wires are used as tension band most commonly in patella and olecranon fractures.





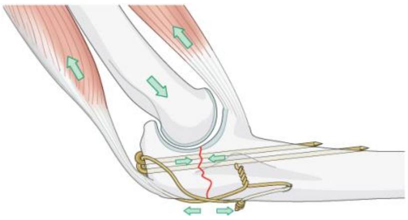
Other indications are tuberosity of the humerus, of the lateral and medial malleoli, and of the trochanter of the femur.





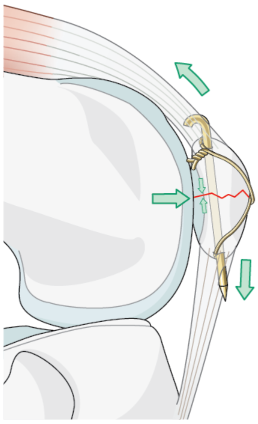
Olecranon

Biomechanically the olecranon is an inverted seesaw, with the distal humerus acting as the pivot while triceps and brachialis muscles pull on each side of the proximal ulna. The dorsal surface of the olecranon is therefore under tension and the ventral surface under compression.



The figure of eight wire prevents opening of the posterior (tension) cortex and the forces of the triceps and brachialis then result in compression across the whole fracture plane.

Patella



Cerclage wire and the compression of condyles as well as the tension of quadriceps and patellar tendon induce resistance and compression on fracture site. The insertion of the quadriceps and patellar tendons onto the superficial surface of the patella which provides the load and the femoral condyles which act as pivot, setting up tension at the superficial and compression at the deep surface of the patella. Failure usually occurs in tension, usually caused by a fall on the front of the knee.

Technique of tension band wiring

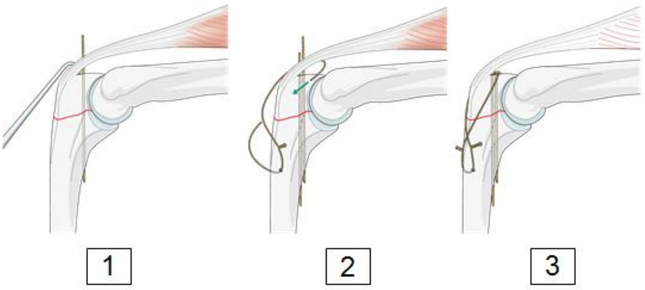
Olecranon fracture

Technique

A simple transverse fracture can be held accurately by:

1) Inserting a K-wire through the fracture line.
2) Inserting a second K-wire parallel to the first one to prevent fragment rotation.
3) The tension band is provided by a figure-of-eight looped wire over the tension surface, anchored around the K-wire ends proximally, and a transverse hole through the ulna distally. The wire is tightened equally on both sides by twisting to apply compression.

Once fixed, any pull on the triceps muscle increases the dynamic compression across the fracture site.



Clinical example

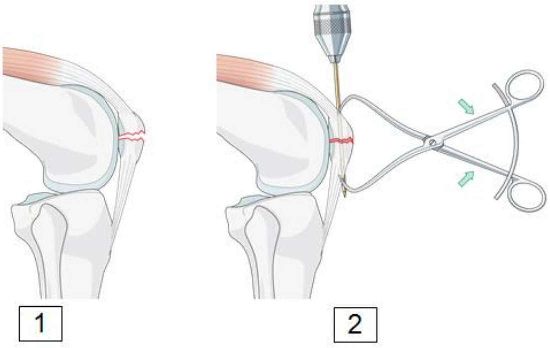
This olecranon fracture has been widely separated by the pull of the triceps.
The tension band wire holds the reduction and prevents the posterior cortex from opening.
The pull of the triceps and brachialis muscles is thereby converted into a compression force.

The fracture healed perfectly (the implants have been removed).

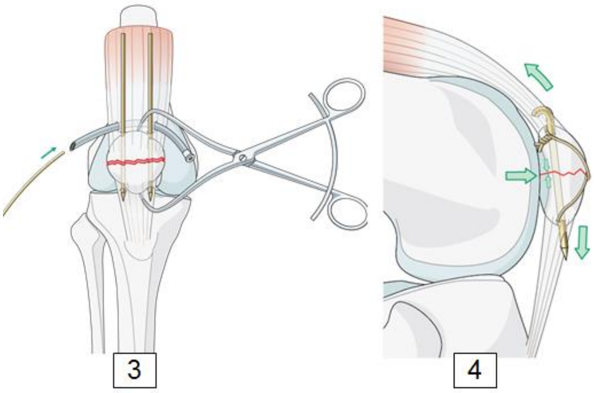
Patella fracture

Technique

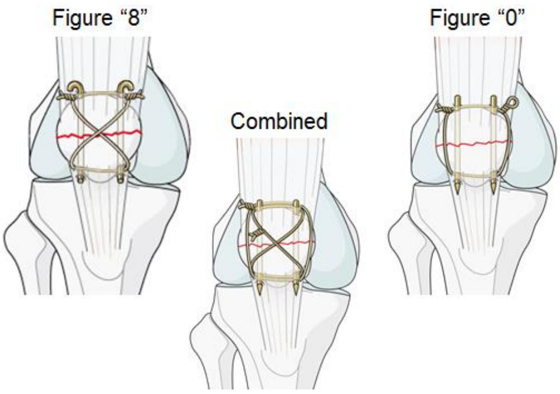
1) Provided the fracture is a simple transverse fracture and there is no fragmentation of the deep articularcortex.
2) It can be reduced with pointed forceps and held with two parallel K-wires.



3) A wire, inserted around the ends of these wires (deep to the quadriceps tendon), crossed over the front of the patella, and then around the lower ends of the K-wires is tightened to provide compression. This achieved by tightening a loop on each limb of the wire.
4) The pull of the quadriceps then increases dynamic compression across the fracture as the knee flexes and extends.



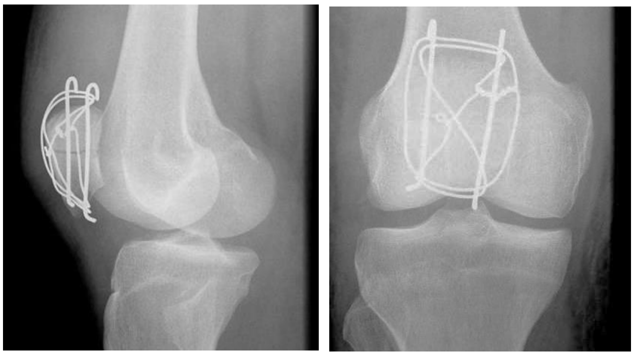
There are two options of cerclage wire technique: figure of 8 or 0. Or they may be combined (8 and 0).



Clinical example

Here you can see a transverse patellar fracture, distracted by pull of quadriceps muscle.

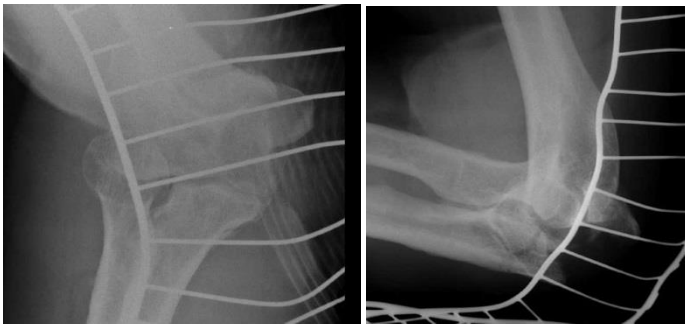
This has been reduced and stabilized with a combination figure-of-8 and 0-wiring.



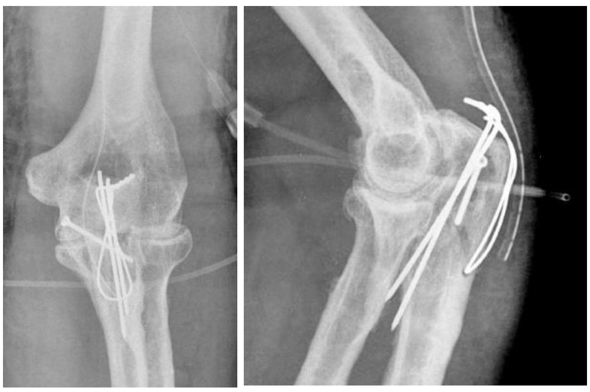
Complications

Complications can be
1) Implant failure
   - Due to wrong indication
   - Osteoporosis
   - Implant loosening relatively common, early removal required
2) Joint stiffness
   - Deficit in flexion and extension
   - Strong capsule and ligaments, due to the injury

In course case questions



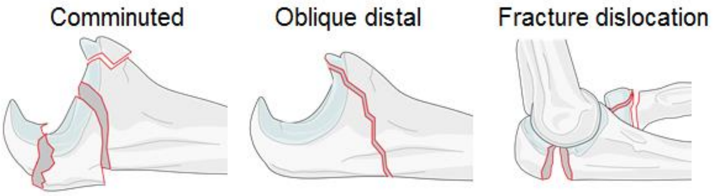
1. What about the image quality?
2. How would you classify or describe this fracture?
3. What is your suggestion for treatment?



4. What about this surgical treatment?

Displaced olecranon and complex fractures

- Require tension band plate
  - Options are
    - One-third tubular plate
    - Reconstruction plate
    - Locking plate



Case

Alternative fixation with cannulated screws and associated tension band applied through screws.

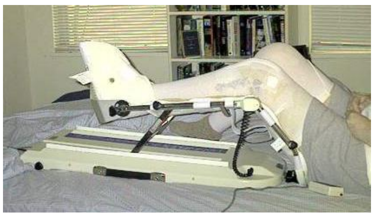
Aftercare

Tension band wiring is an optimal mechanical principle for early functional motion.

- Depending on fracture stability

Motion will increase the interfragmentary compression.

- Active
- Passive



Summary

You should now be able to:

- Explain the principle of tension band wiring
- Sum up the indications for tension band wiring
- Describe step-by-step the two most commonly used techniques
- Discuss possible complications that might occur.

Questions

What is the correct answer? More answers can be possible.

1. Tension band wire technique is…

☐ … always applied on the tension side of a bone

☐ …always applied on the compression side of a bone

☐ …always refers to 2 K wires and 1 cerclage wire

2. Tension band wiring is a technique of…

☐ …relative stability with indirect bone healing

☐ …relative stability with direct bone healing

☐ …absolute stability with direct bone healing

3. For which anatomical regions is tension band mostly used?

☐ Femoral shaft, tibial shaft, and patella

☐ Patella, olecranon, and malleolus

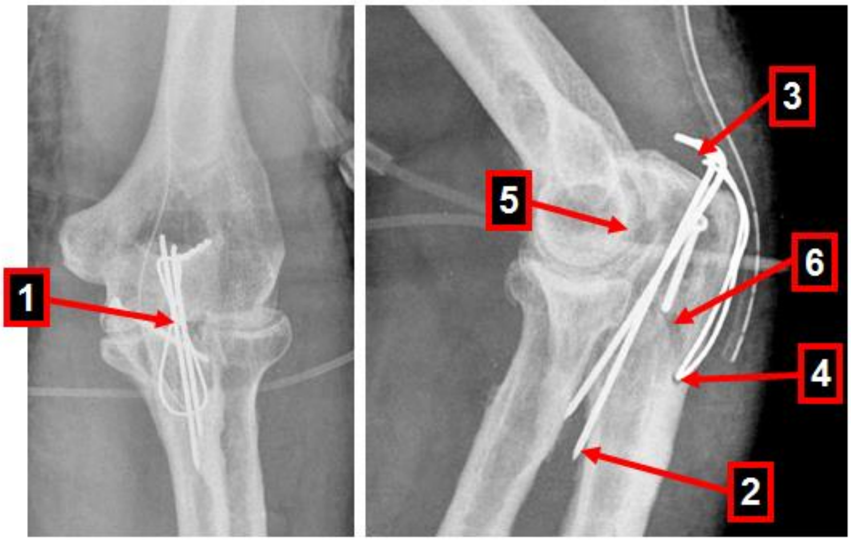
☐ Patella, olecranon, and clavicula

Reflect on your own experience

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

Answers on in course case questions

1. Unacceptable quality, no straight projection, no projection in a 90° angle.
2. Therefore classification and description of the fracture is not possible.
3. Because of lack of information, a suggestion for treatment is not possible. New images are necessary. If this is not possible a CT scan should be ordered.
4. Treatment



- The K-wires are too narrow. There is no rotation stability.
- The K-wires are too long.
- The K-wires are not fully inserted therefore the fracture is unstable.
- The hole for the cerclage wire is too close to the fracture gap. Danger of dislocation exists.
- There is insufficient reduction of intraarticular fracture. A fracture gap is still visible.
- Also here there is insufficient reduction. The main fracture gap is too big.