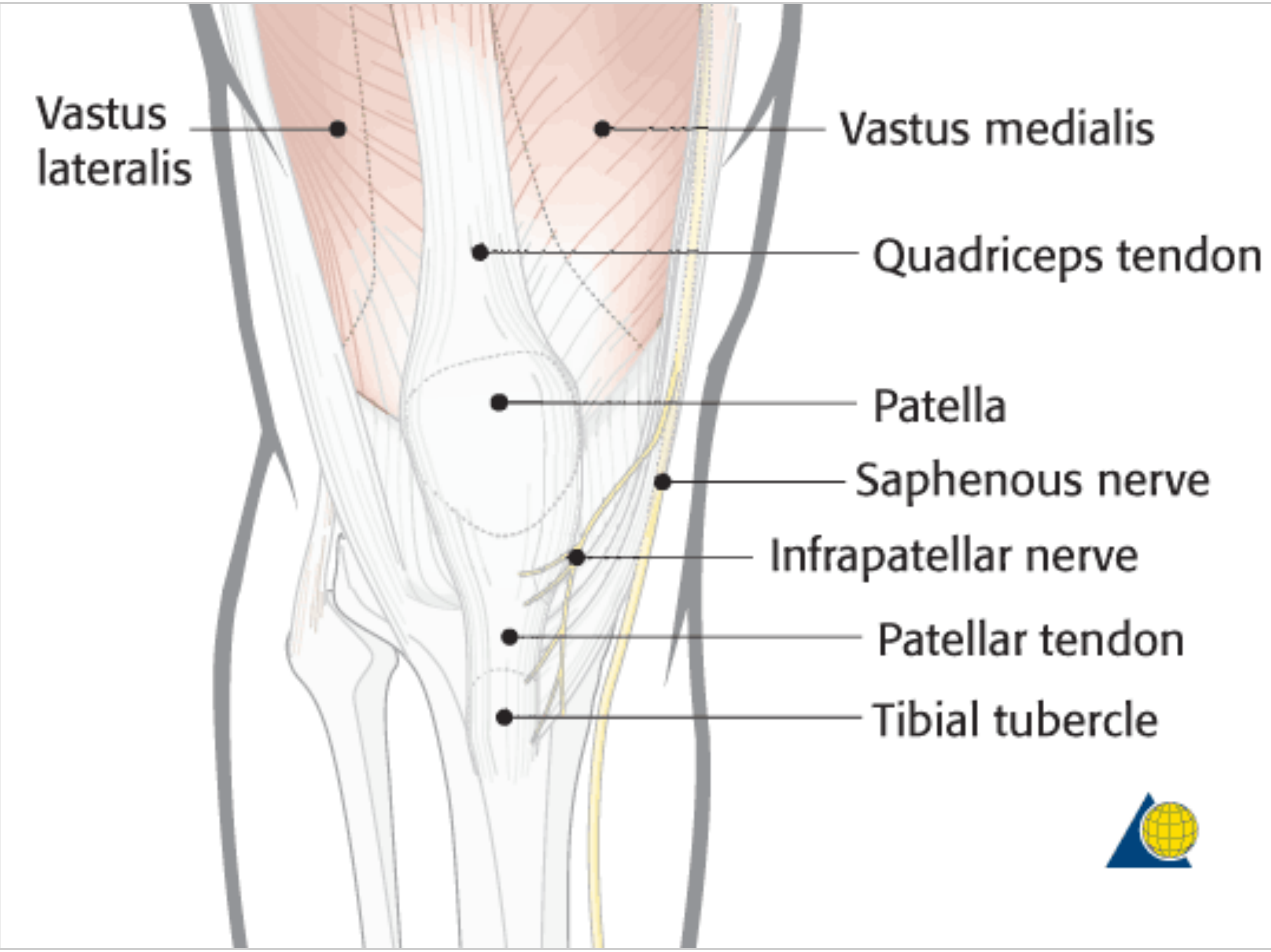
Patella 34-C1.3 ORIF

Authors

Tension band wiring

1. Principles

Surgical anatomy



The patella is the largest sesamoid bone in the human body. It is located within the extensor apparatus of the knee. Anatomical features include the proximal articular body, with an extraarticular anterior surface and a posterior articular surface, and the extraarticular distal pole. The rectus femoris and vastus intermedius muscles insert at the superior pole of the body and the vastus medialis and vastus lateralis muscles on either side. The patellar tendon originates from the inferior pole and inserts into the tibial tuberosity. The articular surface has the thickest layer of cartilage in the body, up to 5 mm, reflecting the very high resultant loads across the patello-femoral joint, rendering it susceptible to chondromalacia and degenerative joint disease.

History and examination

Patellar fractures comprise about 1% of all fractures and are mostly caused by direct trauma to the front of the knee, for example, a direct fall, or a blow onto the flexed knee.

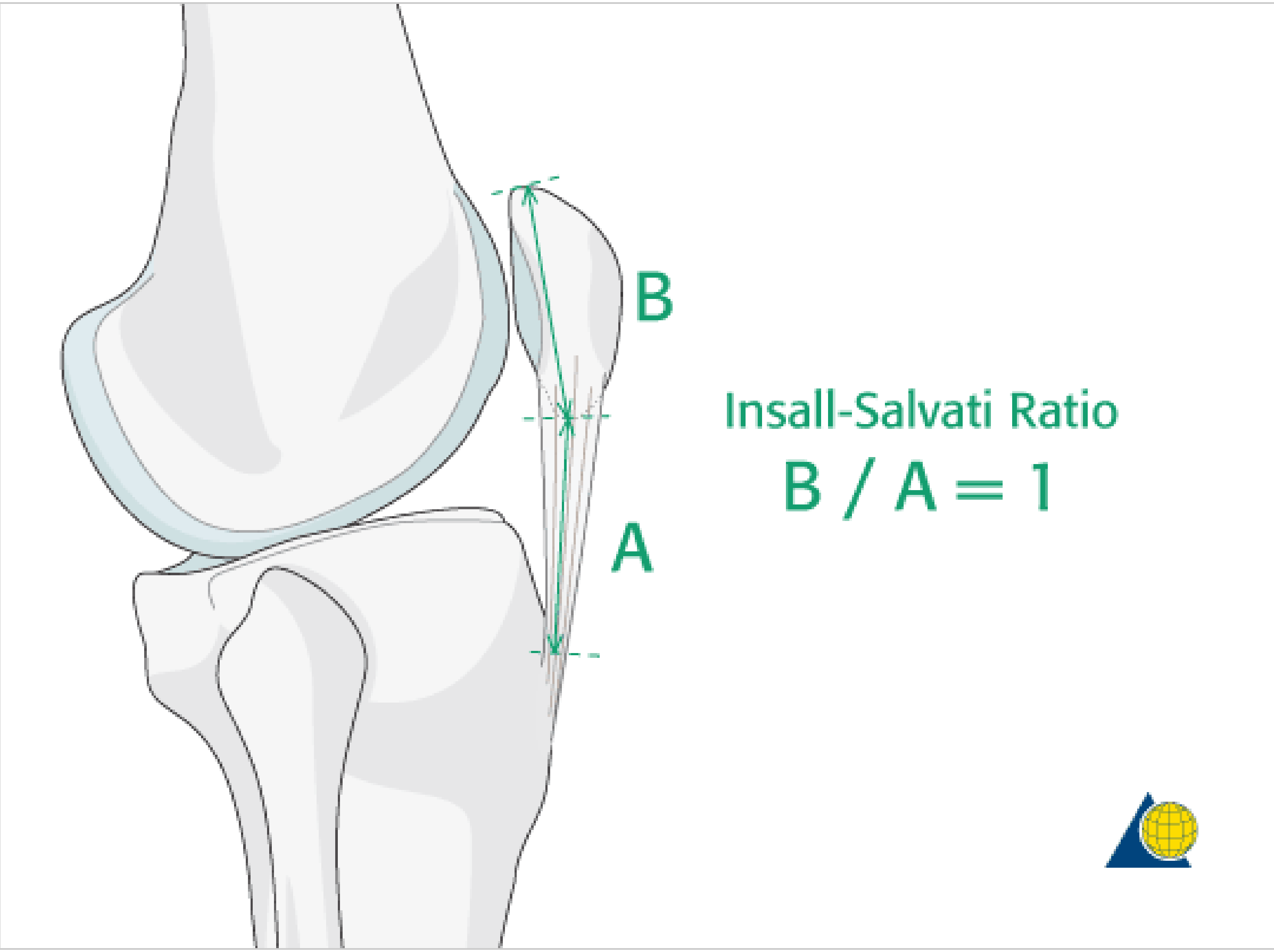
Bony avulsions of the adjacent tendons, or pure ruptures of the quadriceps and patellar tendons, are caused by indirect forces.

Typical signs are swelling, tenderness and limited, or lost, function of the extensor mechanism.

Preservation of active knee extension does not rule out a patellar fracture if the auxiliary extensors of the knee - the medial and lateral parapatellar retinacula - are intact.

If displacement is significant, it is possible to palpate a defect between the fragments, if present. The hemarthrosis is usually obvious. The examination must include assessment of the soft tissues, so as not to confuse with an injury to the prepatellar bursa, or to omit grading the injury if the fracture is open.

Imaging



In addition to the standard x-rays of the knee in two planes, a tangential ("skyline") view of the patella is useful. In the AP view, the patella normally projects into the midline of the femoral sulcus. Its lower pole is located just above a line drawn across the distal profile of the femoral condyles. In the lateral view the proximal tibia must be visible to exclude a bone avulsion of the patellar tendon from the tibial tuberosity. A rupture of the patellar tendon, or an abnormal position of the patella like patella alta (high-riding patella), or patella baja (shortening of the tendon), can be recognized with the help of the Insall-Salvati method. This is the relationship between the length of the patella (B) and of the patellar tendon (A) on the lateral x-ray, $r=B/A$. This ratio is normally $r = 1$. A ratio $r < 0.8$ suggests a high-riding patella (patella alta), or patellar tendon rupture.

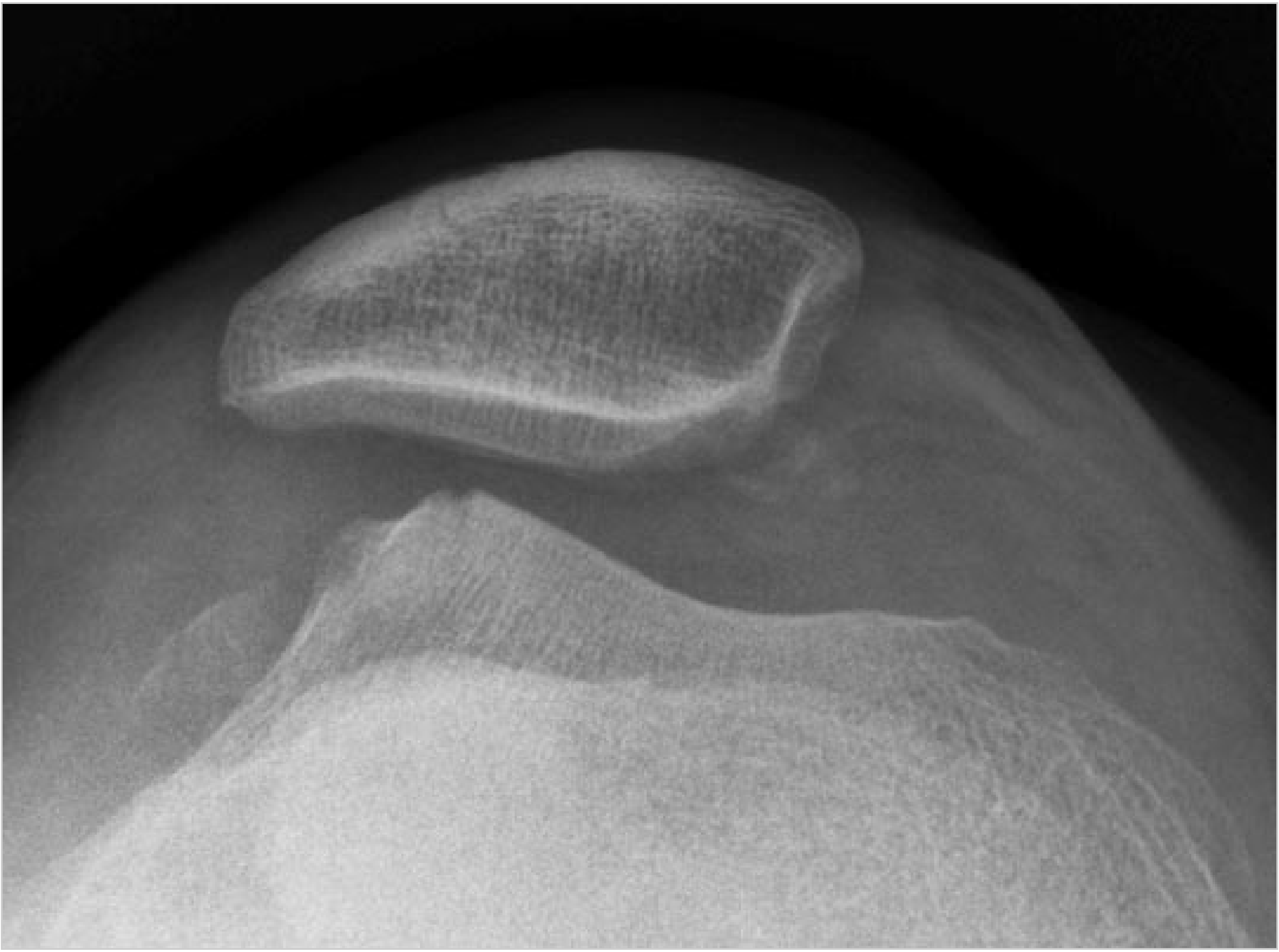
The third important x-ray projection is the 30° tangential view, which is obtainable in 45° knee flexion. If a longitudinal, or osteochondral fracture, is suspected, the 30° tangential view is a helpful diagnostic adjunct.

Special imaging is helpful in certain cases, such as stress fractures, in elderly patients with osteopenia and hemarthrosis, and also in cases of patellar nonunion, or malunion.

Computed tomography is recommended only for the evaluation of articular incongruity in cases of nonunion, malunion and patello-femoral alignment disorders.

Scintigraphic examination (or MRI) can be helpful in the diagnosis of stress fractures; a leukocyte scan can reveal signs of osteomyelitis.

MRI can be helpful to diagnose cartilage defects and lesions.



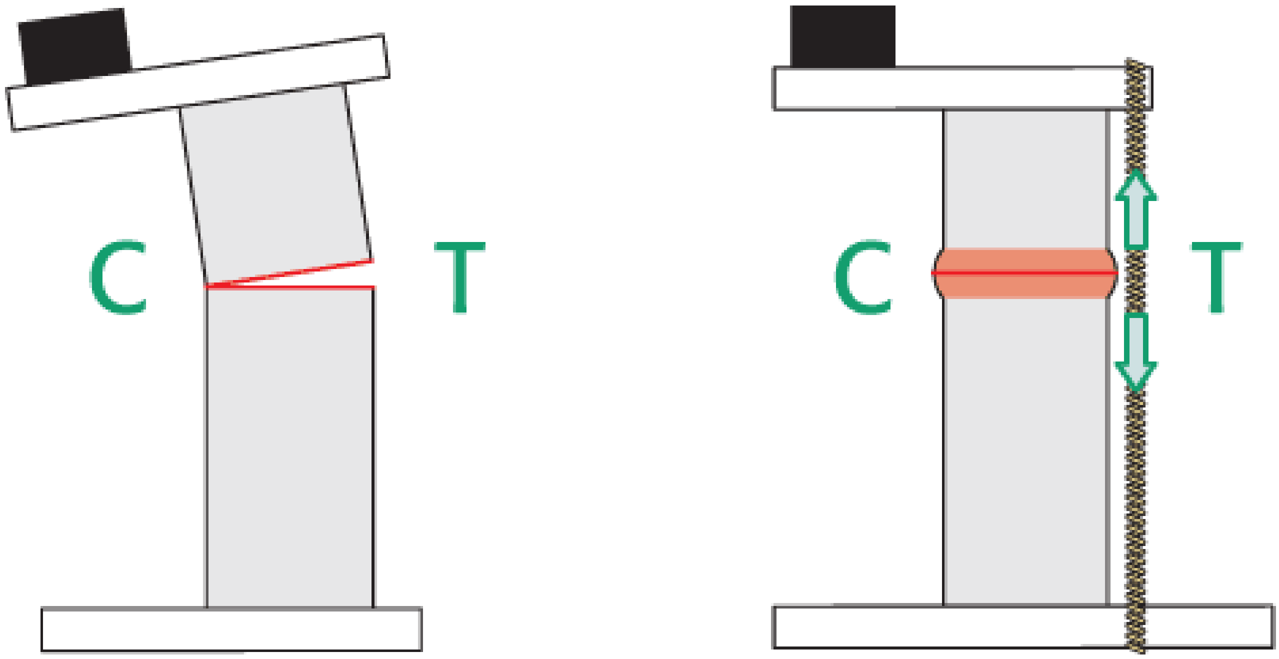
Tendon ruptures and patellar dislocation must be ruled out. Isolated rupture of the quadriceps, or patellar, tendon must be excluded by clinical evaluation (palpation) and ultrasound scan (or MRI). Dislocation, most commonly occurring to the lateral side, may result in osteochondral shear fractures with lesions of the medial margin of the patella, and occasionally impaction fractures of the lateral lip of the patellar groove of the femur.

X-ray by courtesy of Spital Davos, Switzerland, Dr C Ryf and Dr A Leumann.

Bipartite patella

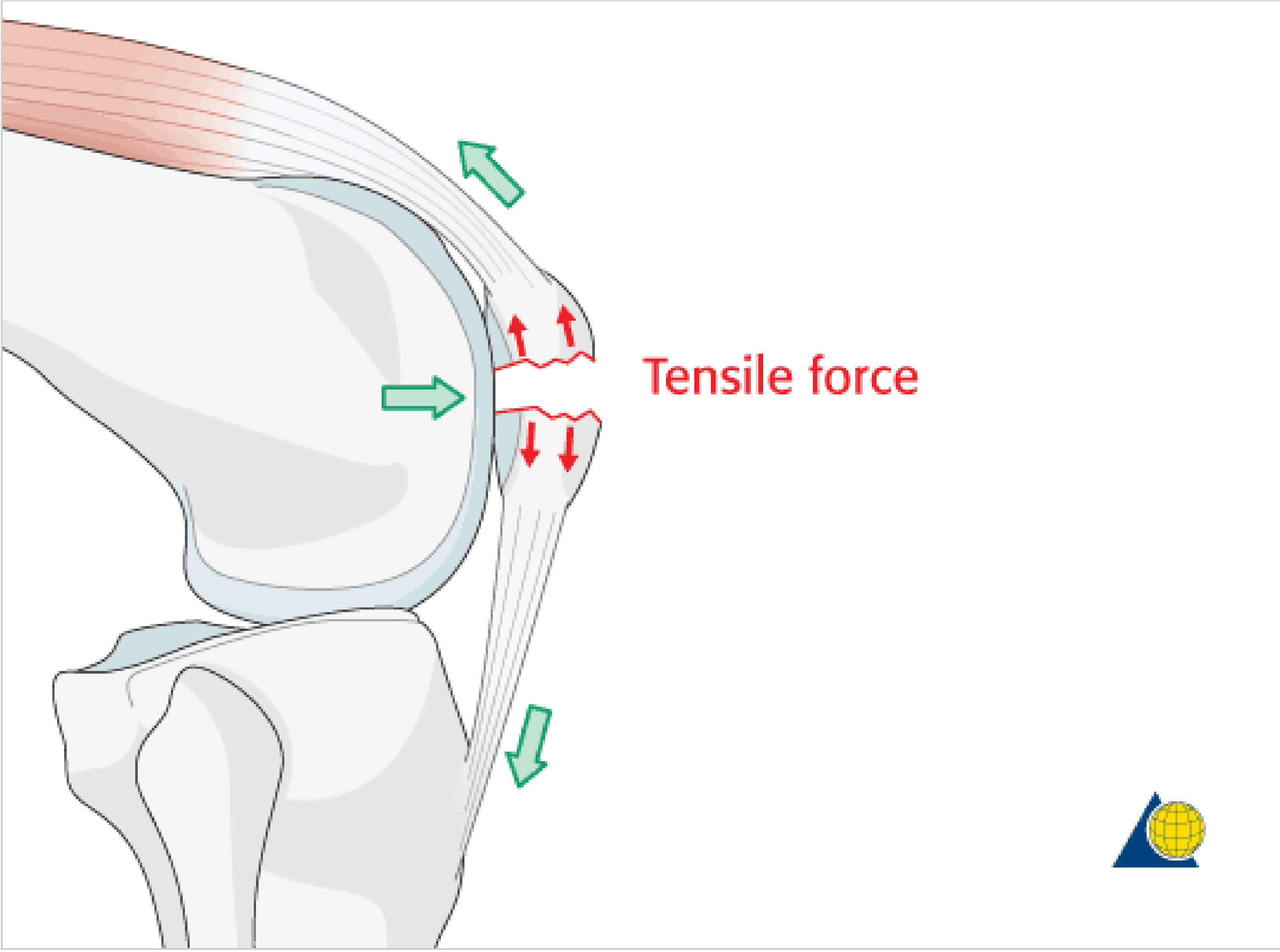
Bipartite patella is an anatomical variant that results from developmental lack of assimilation of the bone during growth. Located on the proximal lateral quadrant of the patella, the condition is without clinical relevance, is usually bilateral and has a characteristic x-ray feature with rounded, sclerotic lines rather than the sharp edges of a fracture.

Tension band principles

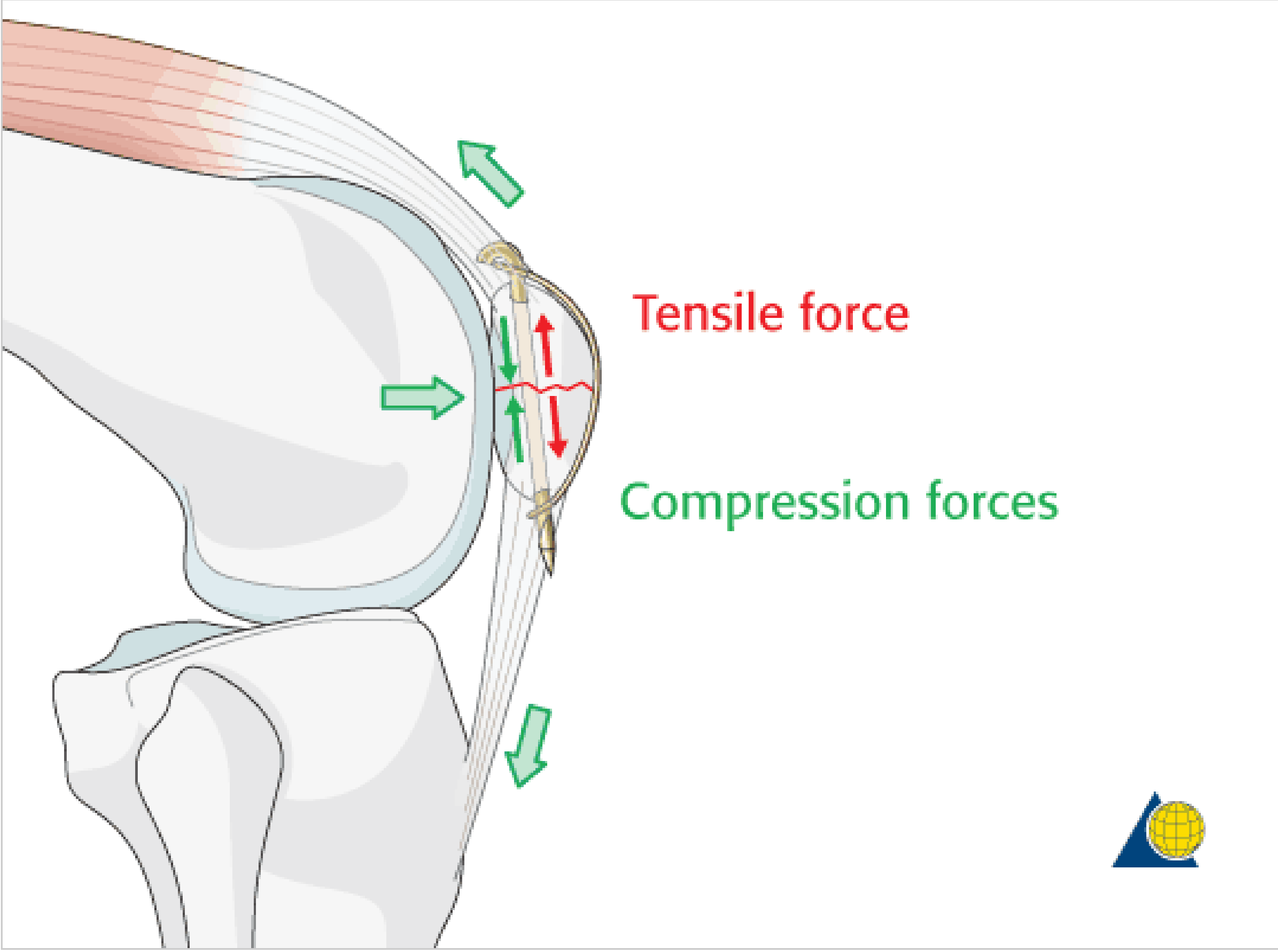


Tension (T) and compression (C) forces

The forces produced by the quadriceps on patellar fractures are significant and cause early fixation failure. For example, screw fixation alone would generally fail. Additionally, the goal of the fixation is to allow early range of motion of the knee. In most cases, the stability necessary to achieve this is obtained using the tension band fixation.



The anterior tension band converts tensile forces on the anterior aspect of the knee joint ...



... into compression forces at the joint line. In the patella, an anterior figure-of-eight wire loop acts as a tension band during flexion of the knee.

Multifragmentary patellar fractures cannot be fixed with a tension band. In order to be able to use a tension band, the posterior articular cortex cannot be comminuted as it must provide a buttress to allow compression.

The figure-of-eight wire loop lies on the anterior surface of the patella and acts as a tension band when tightened.
Choose a wire of sufficient strength to withstand the tensile forces generated in the figure-of-eight loop (1.0 – 1.25 mm diameter).

Combination of techniques

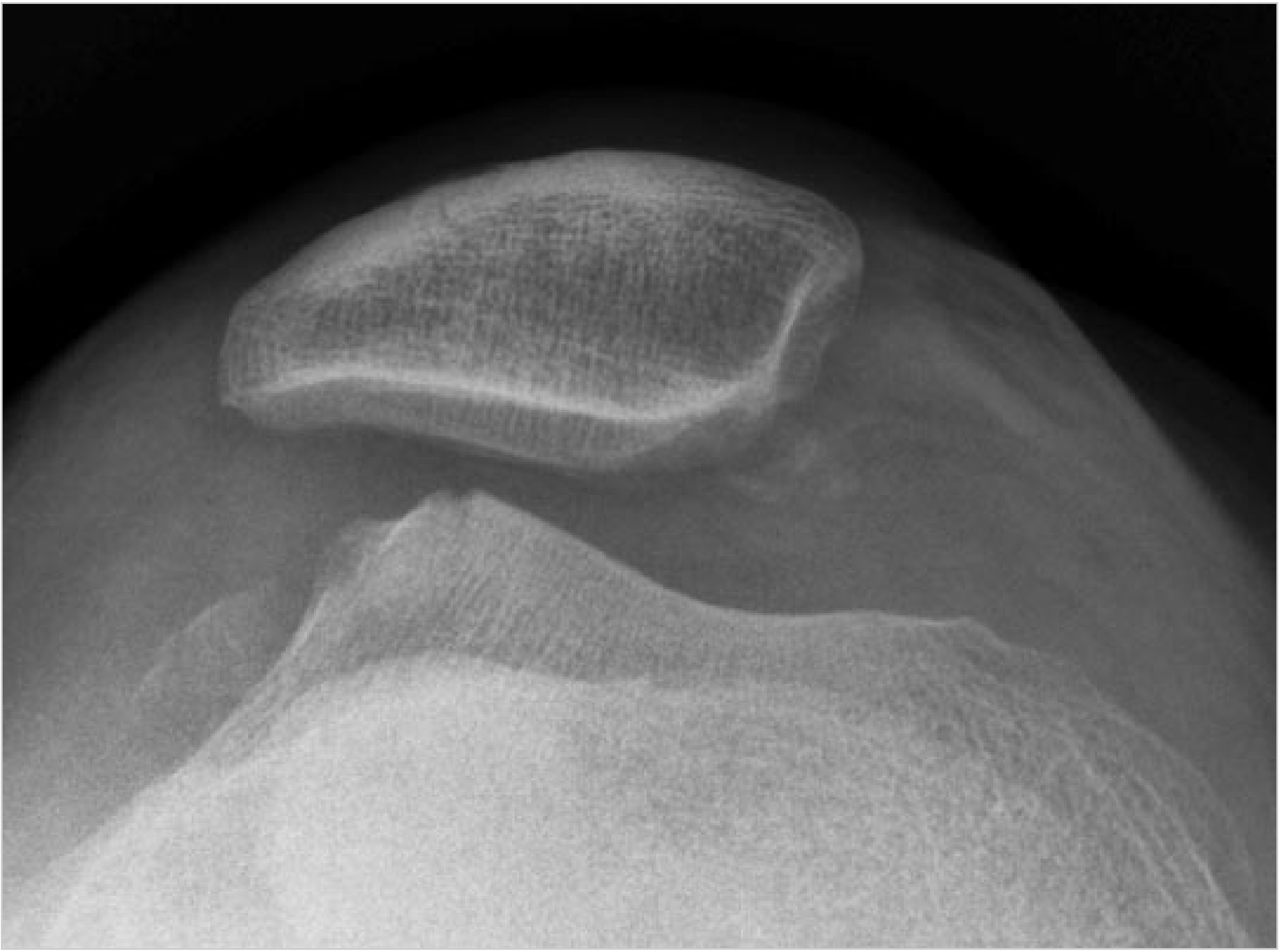
Tension band wiring may be used in combination with cerclage wiring and/or lag screws. Click here for details on the cerclage wiring and here for a description of the lag screw technique.

Alternatively, suture fixation may be helpful for inferior pole patellar fractures (A1-, and C1.3-type fractures), especially with comminution and/or osteoporosis. Click here to learn about the suture fixation.

Outside-in/Inside-out technique

The principle of tension band wiring is to convert the tension forces into compression, as the knee is flexed. Reduction and fixation can be achieved in two ways, either by first reducing the fracture and then drilling the K-wires through the reduced fragments (outside-in technique) or by first drilling the wires into the unreduced fragments followed by reduction and completion of the fixation (inside-out technique).

2. Preoperative considerations



In general, the complexity of a patellar fracture may be underestimated by a cursory review of the injury radiographs. Comminution and/or additional fracture lines may often be missed. Therefore, a careful scrutiny of good quality AP, lateral and axial radiographs can prepare the surgeon better for fixation of the fracture.

Occasionally, there are articular impaction, or osteochondral shear injuries, to the distal femur that are often irreparable. Knowledge of this preoperatively will allow an appropriate discussion with the patient of the expected clinical outcome.

If additional fracture lines are seen, preoperative planning will allow for additional instrumentation to be available. This may include small-fragment, or mini-fragment, screws.

X-ray by courtesy of Spital Davos, Switzerland, Dr C Ryf and Dr A Leumann.

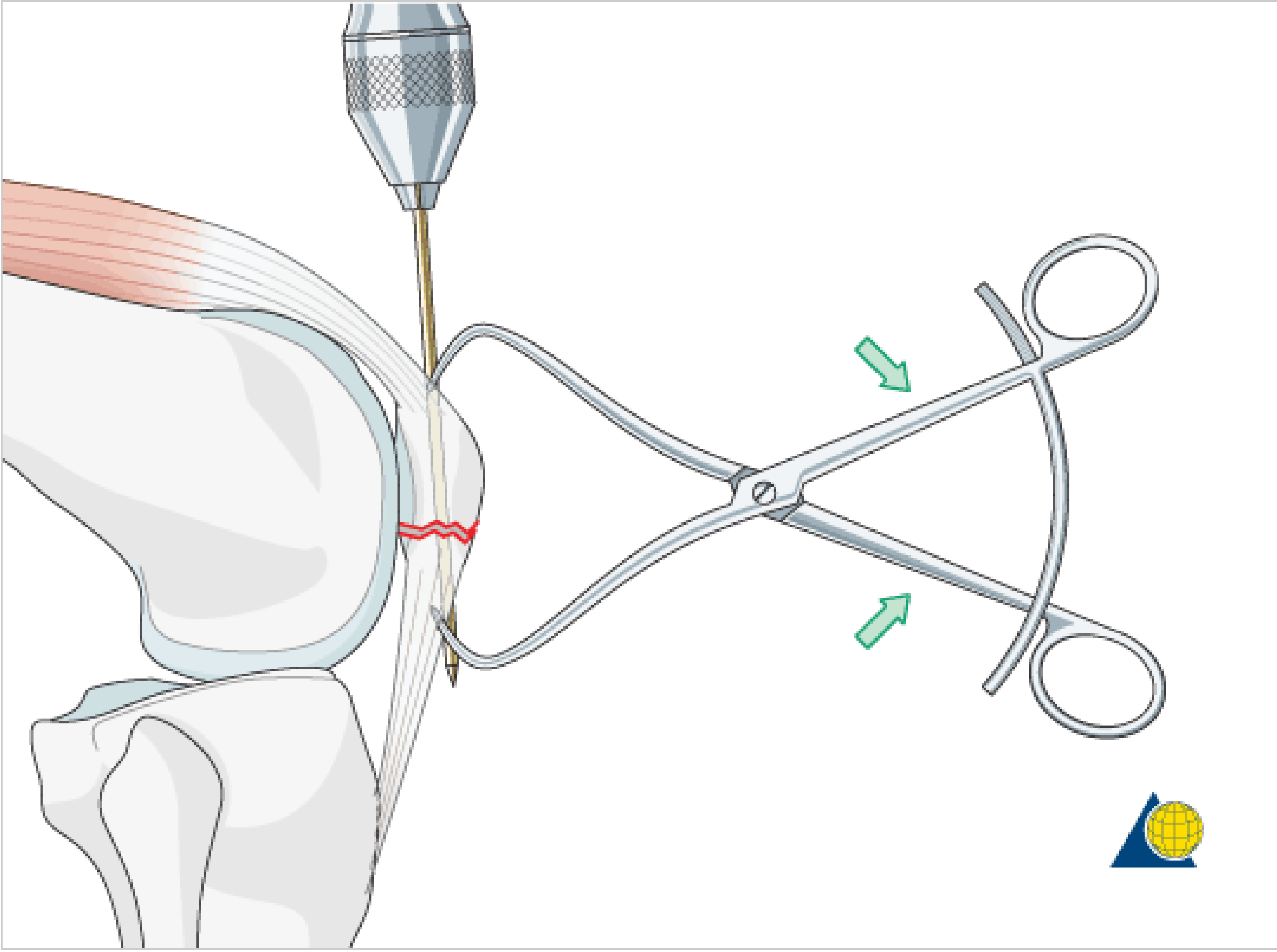
3. Reduction and fixation

Reduction techniques and tools

The knee joint and fracture lines must be irrigated and cleared of blood clot and small debris to allow exact reconstruction. The larger fragments are reduced using a pointed reduction forceps. In A- or C-type fractures, reduction is easier in a fully extended position of the knee. Longitudinal B-type fractures are more easily reduced with the knee flexed. Anatomical reduction of the articular surface is monitored by palpating the joint from inside, as neither inspection nor the x-ray will reveal a minor step off. If an inside-out technique is planned, K-wires are inserted in an open manner before the reduction is done. The wires can also be used as joysticks to help in reducing the fragments. Reduction is held by one or two reduction forceps.

An image intensifier should always be available so that the reduction can be checked in the AP and lateral planes.

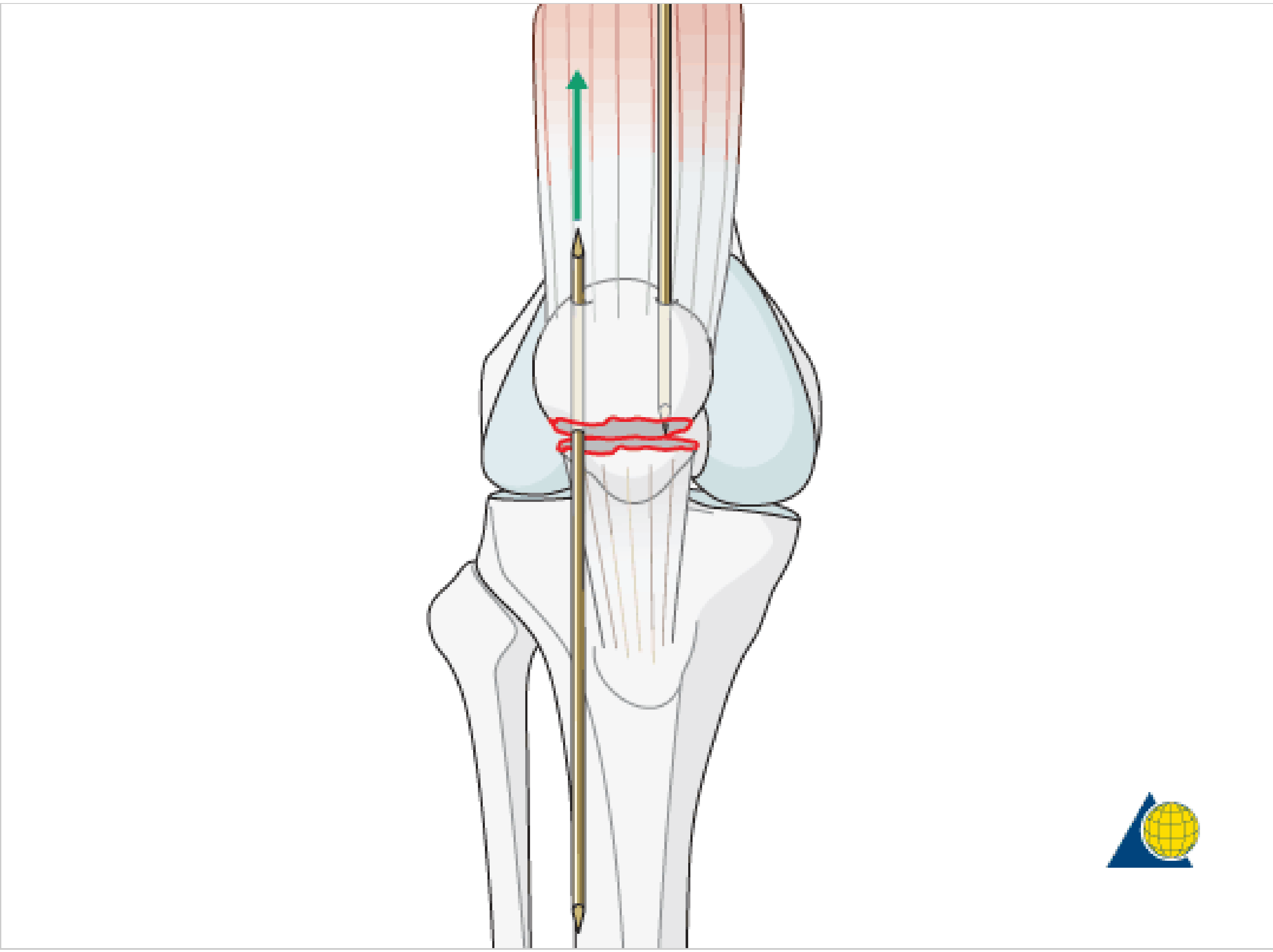
K-wire insertion outside in



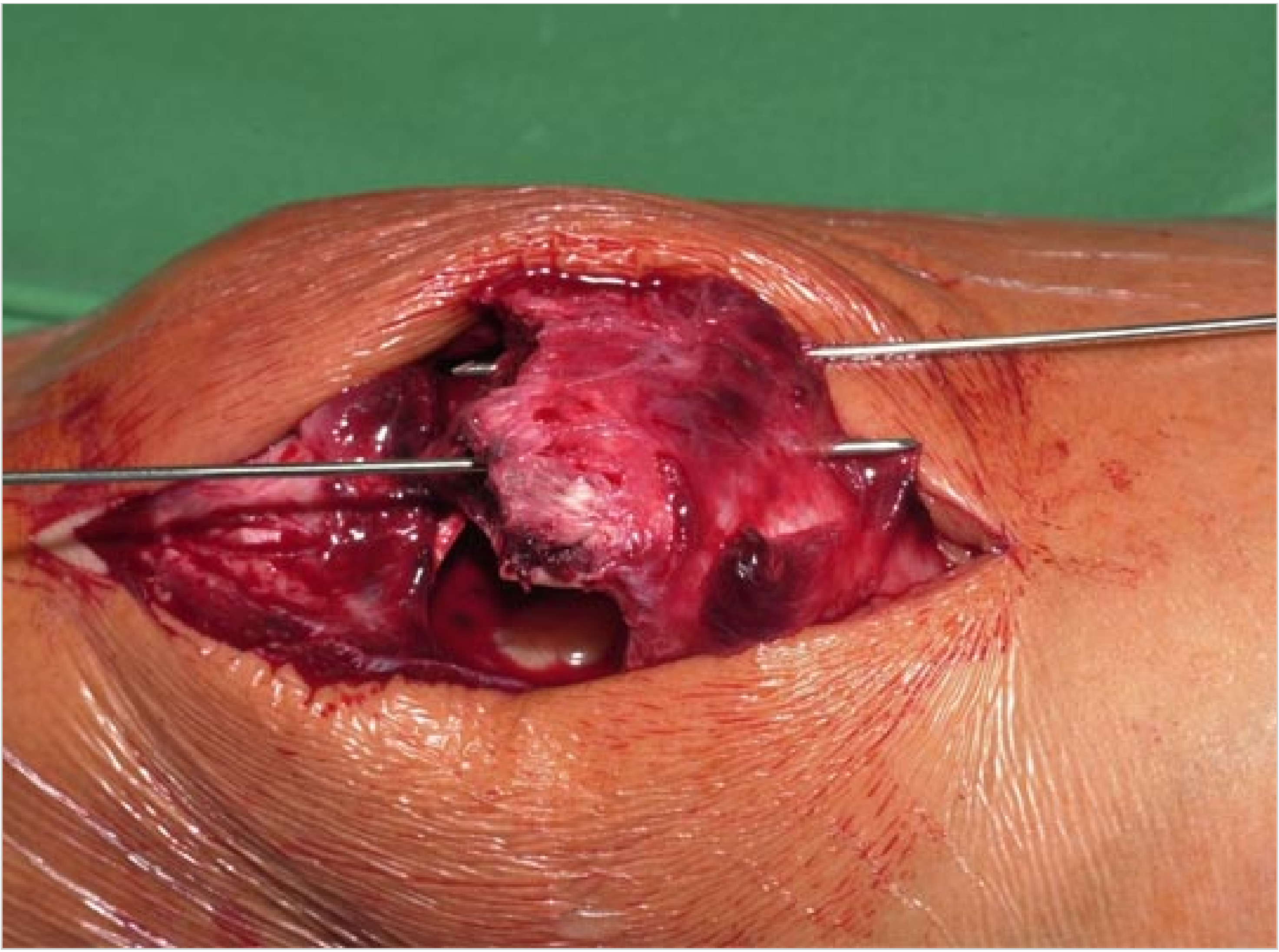
Using the outside-in technique, drill the first K-wire in an axial direction. The second K-wire is then drilled parallel to the first, through the reduced fragments. It may be difficult to find the right direction and position for the wires.

Two parallel K-wires should be inserted to give more stable fixation.

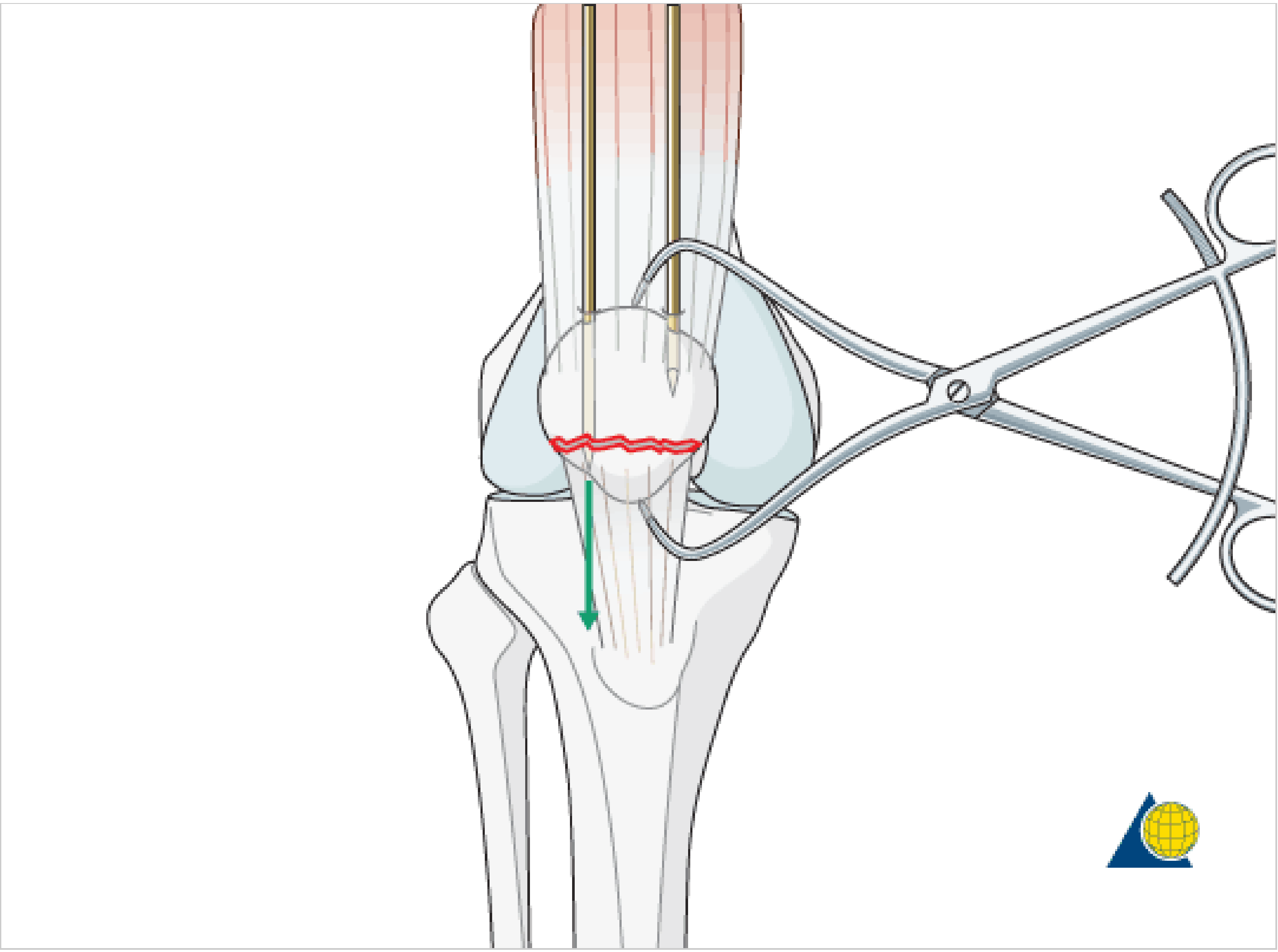
Alternative: K-wire insertion inside out



Exact positioning of the K-wires is challenging once the fracture is reduced. Therefore, some surgeons prefer to drill the K-wires in an inside out manner.



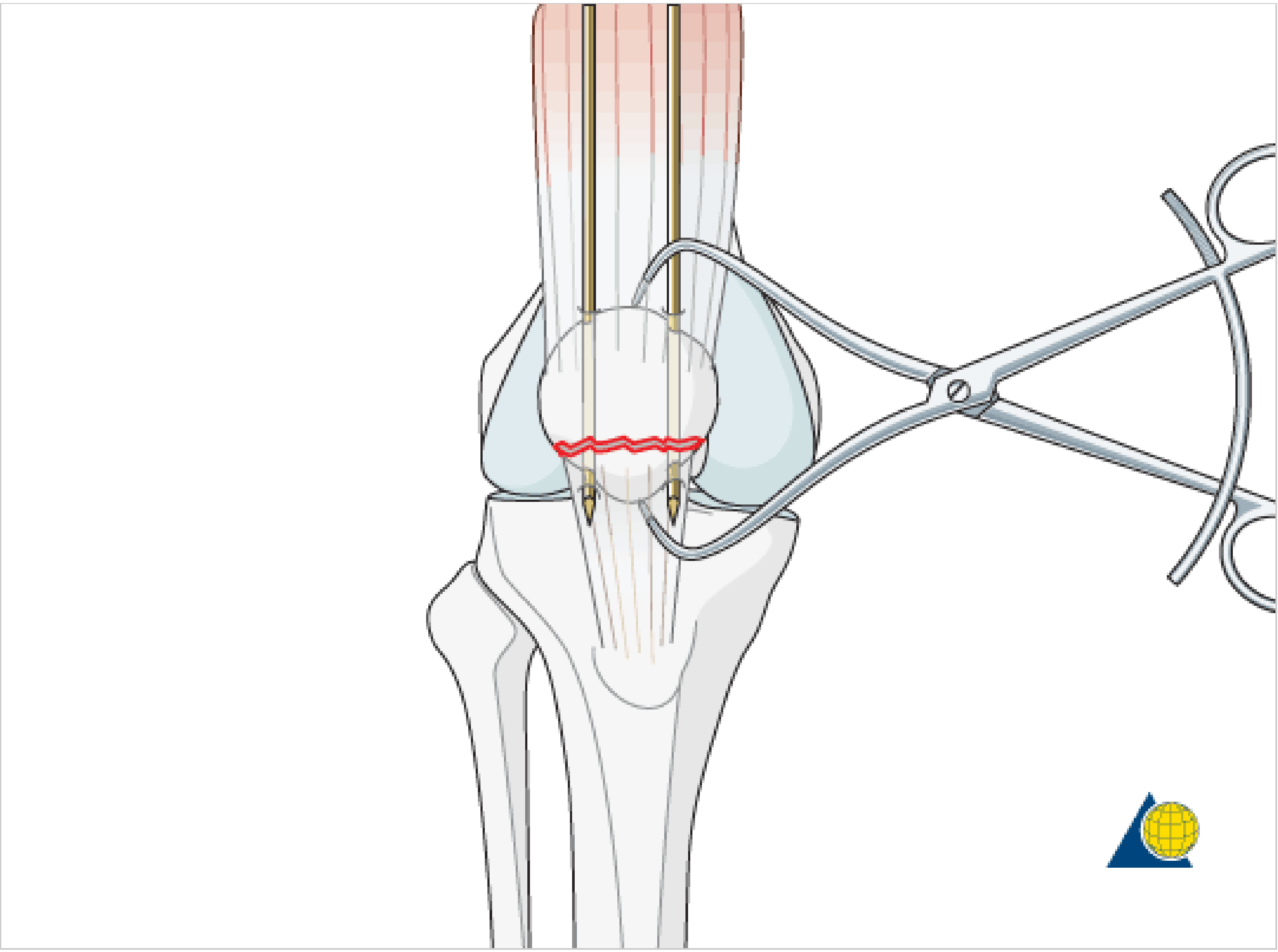
Drill two K-wires (pointed at both ends) from the fracture surface through the proximal fragment, exiting superiorly.



Manually reduce the main fragments and hold them with a pointed reduction forceps.

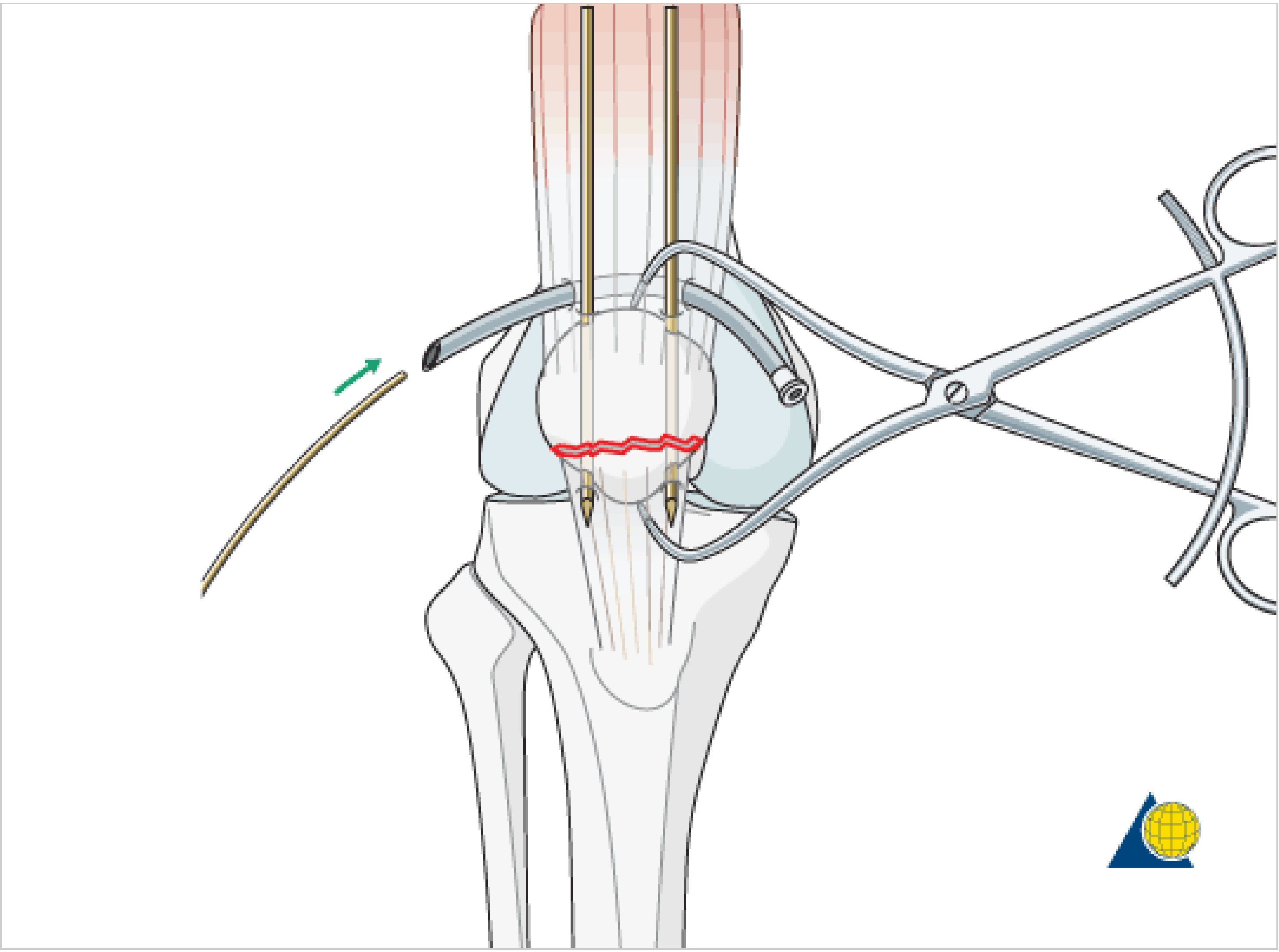
Pearl: creation of double ended K-wires
If the available K-wires are pointed only at one end, the opposite end can be sharpened by cutting it obliquely with a K-wire cutter.

Finalize K-wire insertion



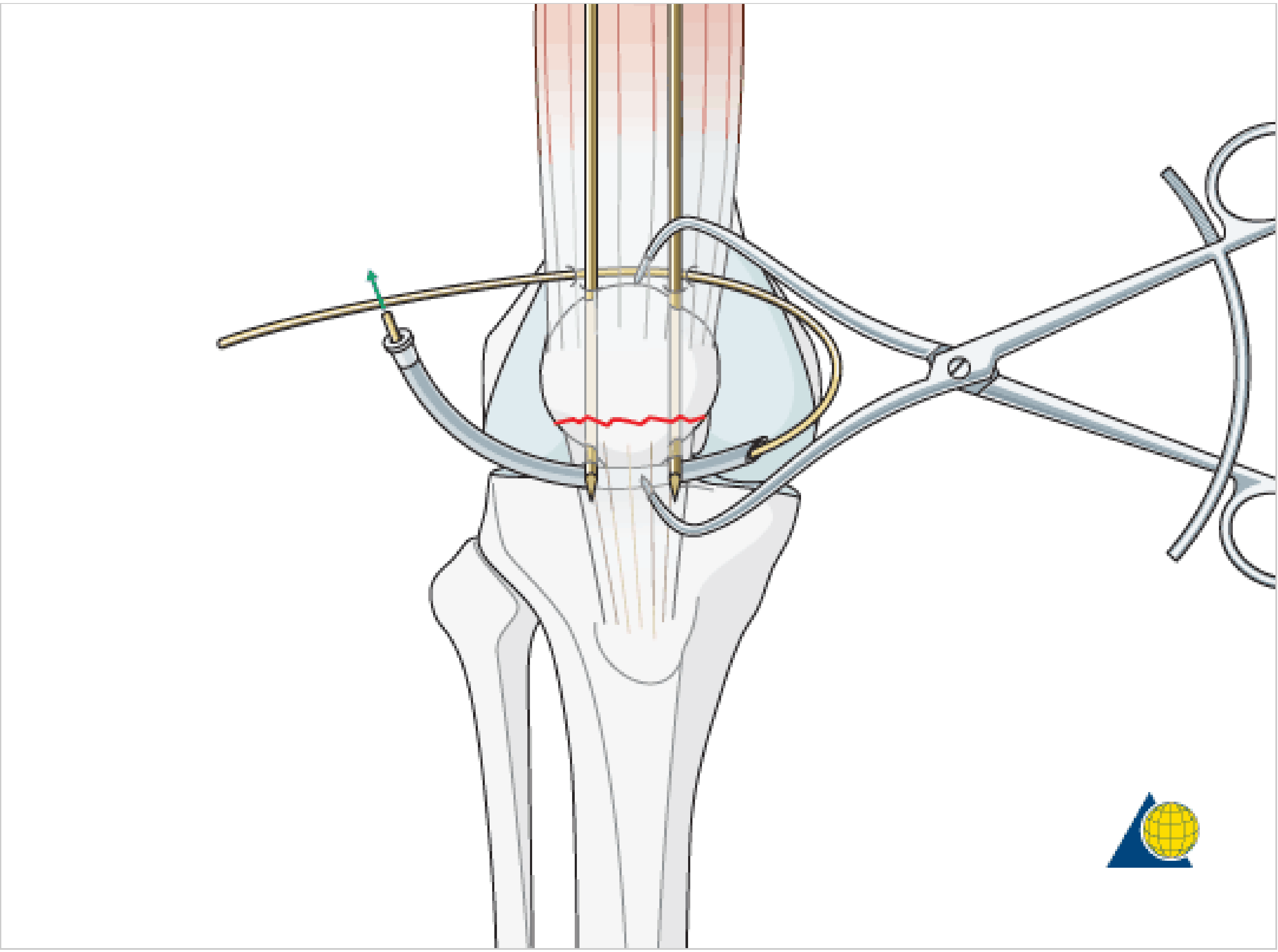
The ideal level for the K-wires lies approximately 5 mm below the anterior patellar surface. Often the K-wires are closer to the articular than to the anterior surface. Nevertheless, the principle of tension banding is not compromised. The position of the wires may be checked with image intensifier at this stage before proceeding to insert the tension band.

Tension band insertion



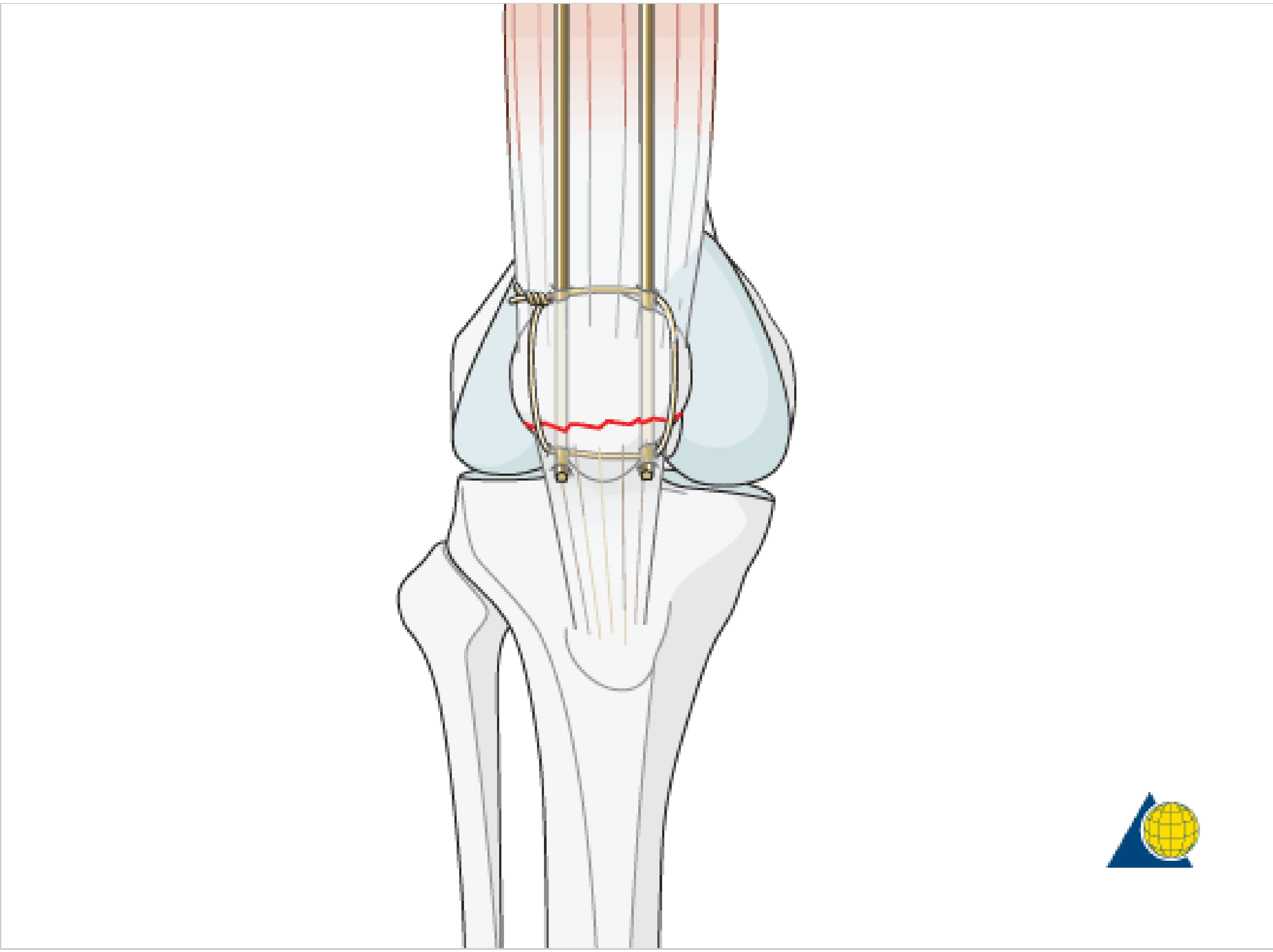
Push a sufficiently long (e.g., 30 cm), 1.25 mm, or 1.0 mm, wire manually as close as possible to the angle between the bone and the protruding K-wire tips.

The wire should be as close as possible to the bone throughout its whole course. The use of a curved large bore injection needle may be helpful.



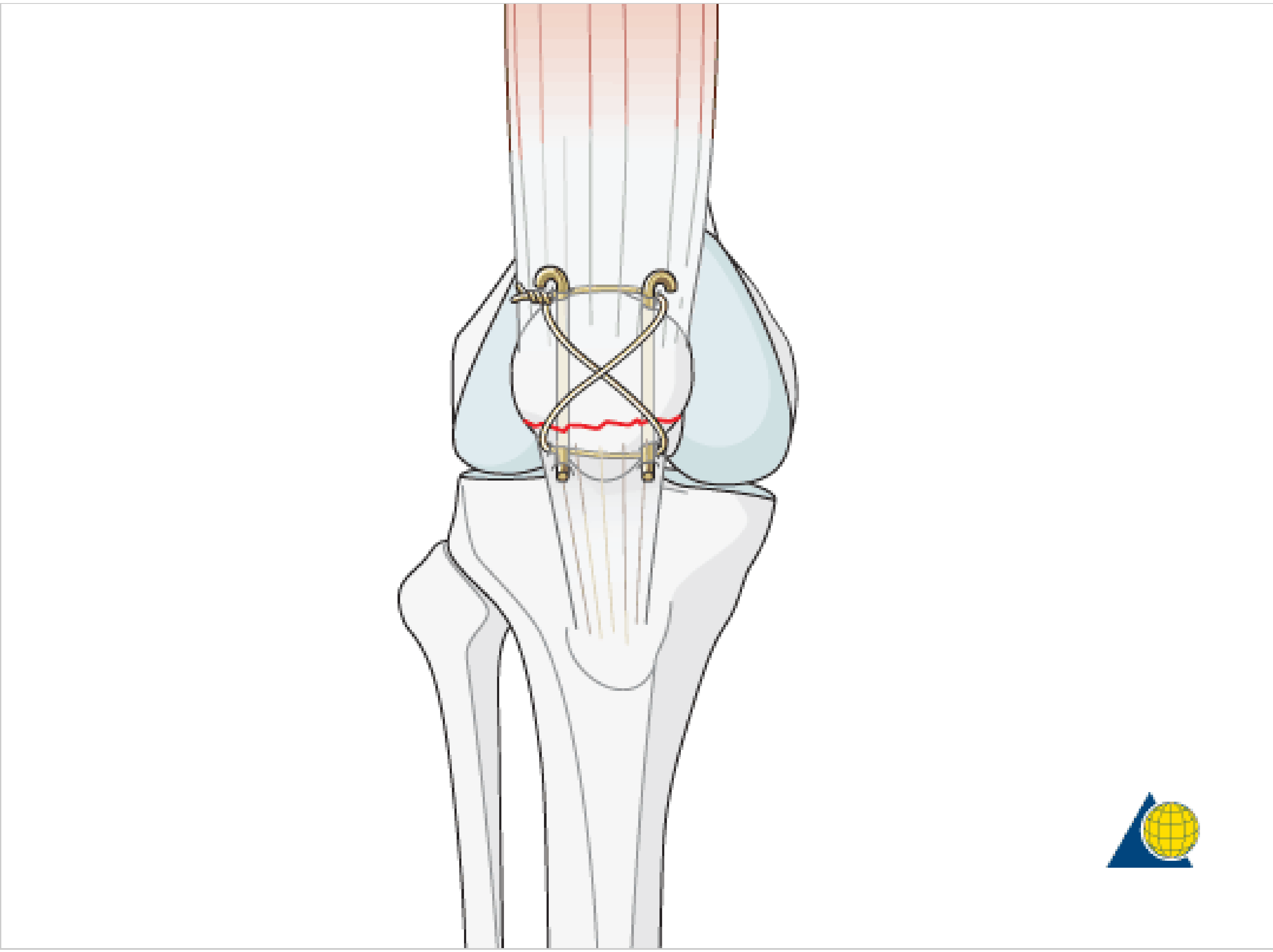
A cerclage (figure-of-zero) wire has more stability against torsion force. However, if the K-wires are located very near the lateral and medial borders of the bone, the cerclage can cut into the retinacula and the principle of tension banding is lost. A figure-of-eight is therefore preferred by many surgeons.

Applying the cerclage wire



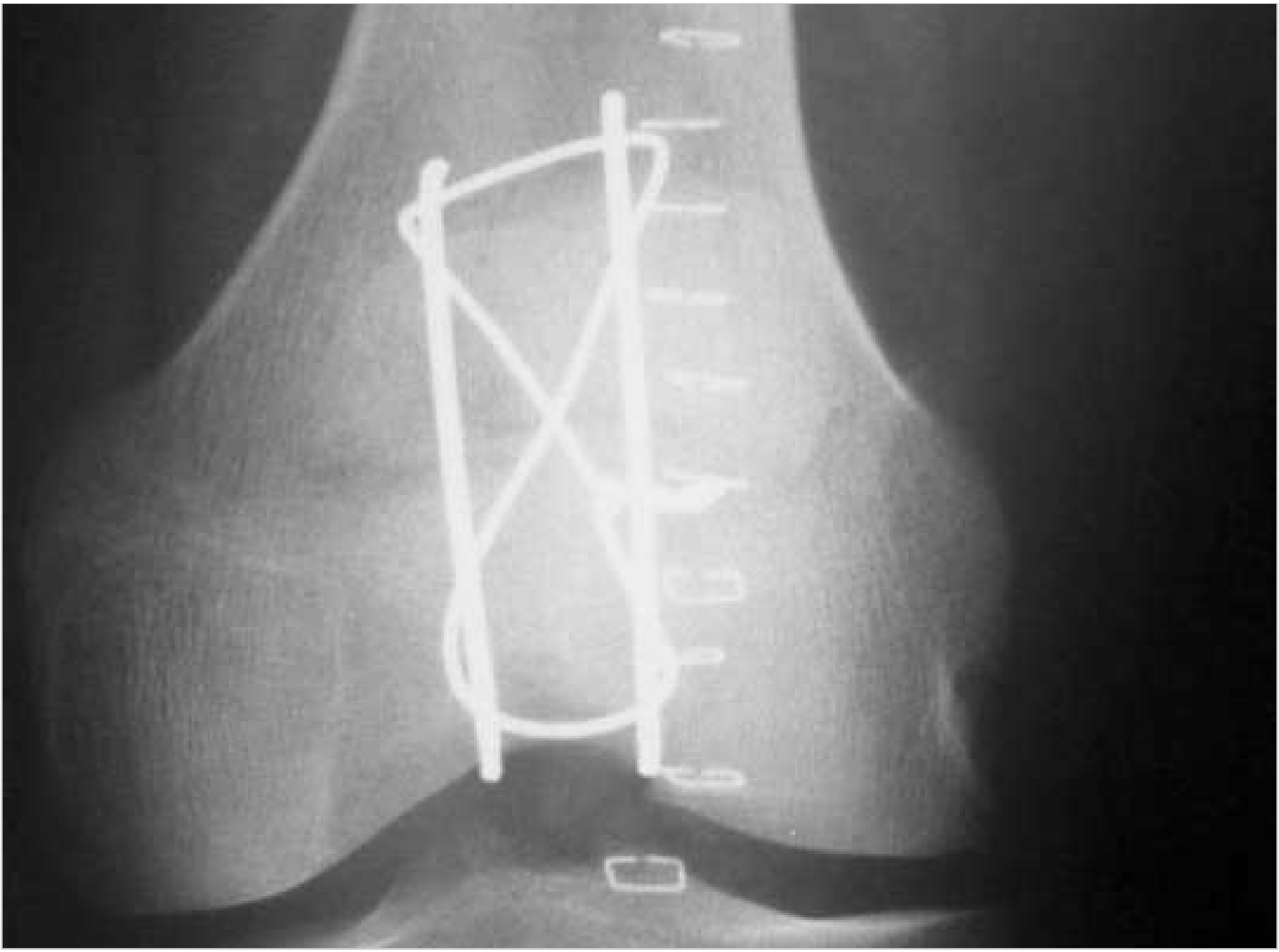
While tightening the cerclage with the knee in extension, check the reduction by palpating the retropatellar surface (this will require creation of a small arthrotomy). After tightening the cerclage, bend the proximal pin ends, shorten them, turn them towards the quadriceps tendon, and drive them into the patella to prevent skin irritation and loosening. The distal pin ends are trimmed to remove the sharp points, but not bent, for easier removal.

Some surgeons may prefer to make two twists to tighten the cerclage wire. If two twists are used care must be taken not to leave extra-prominent wires protruding.

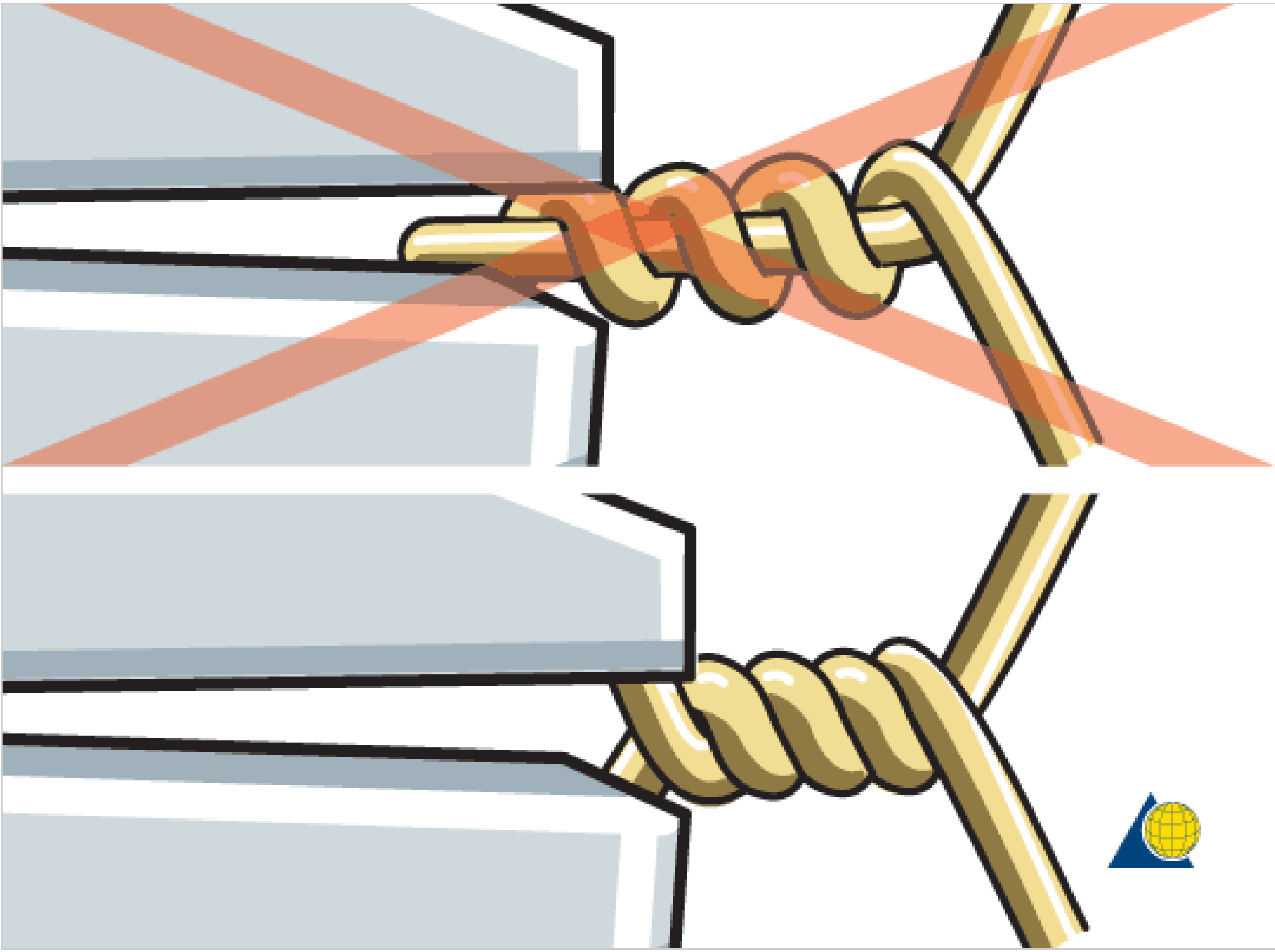


Alternative: figure-of-eight
Illustration showing the final osteosynthesis with the figure-of-eight configuration.

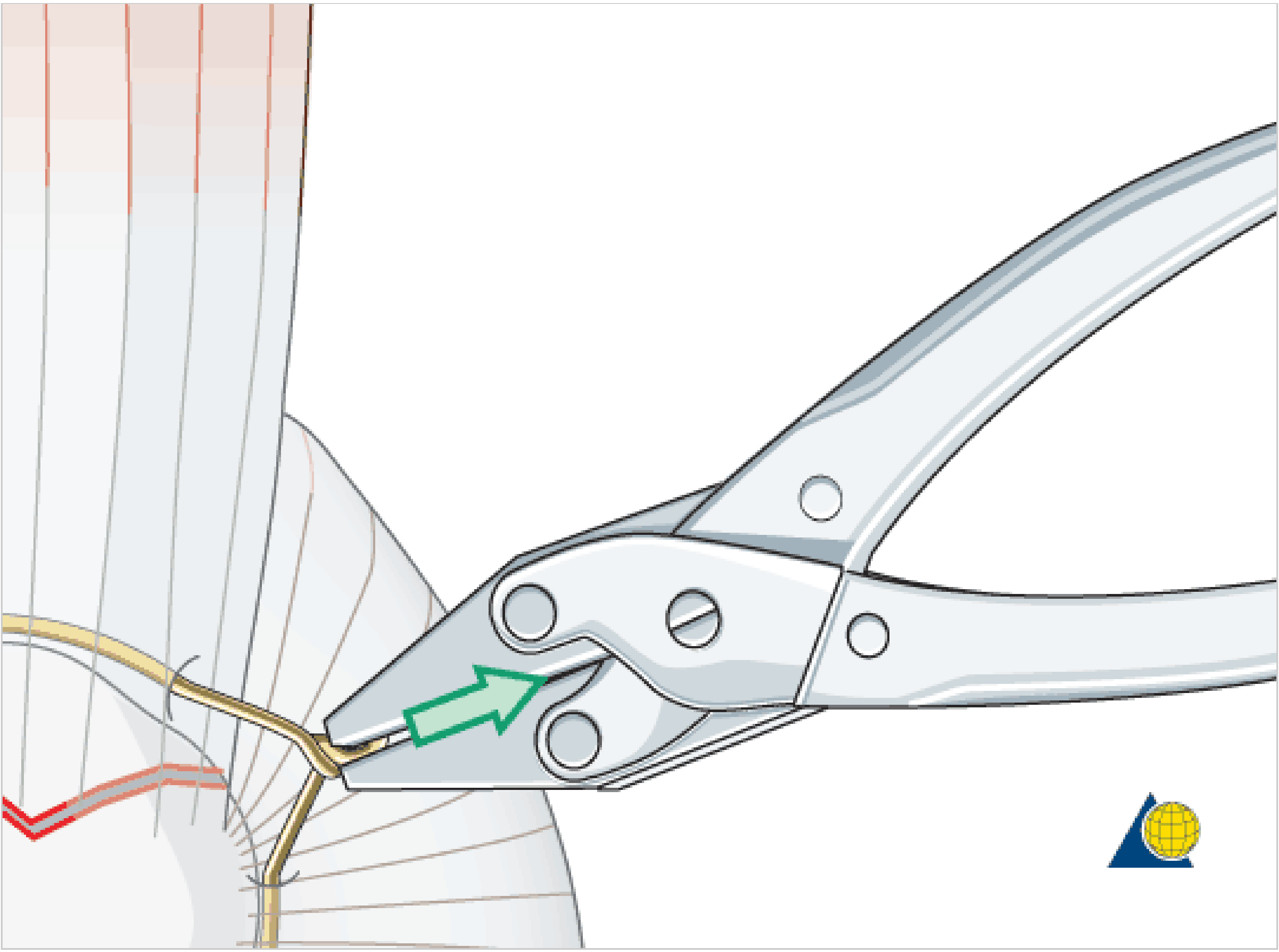
X-rays showing the completed osteosynthesis.



Pearl: correct wire-tightening technique



Loosely prepare the wire twist ensuring that each end of the wire spirals equally - the twist should not comprise one spiral around a straight wire.



To tighten the wires in this fashion, pull away from the patella as the wires are twisted.

The wires should be twisted at least 5 times so as to prevent fixation failure. When stainless steel wires tighten they will loose the surface sheen and if tightened further the wire may break.

Care should be taken finally to position the twisted wire into deeper soft-tissue muscle layers, if possible.

Appendix

Note

The physiological forces acting on the patella tend to distract the fragments, more on the anterior than at the posterior aspect. When the patella is fractured by hyperflexion and distraction, the use of an anterior tension band converts these physiological forces into compression forces across the reduced fracture plane(s).

Shortcuts

All Preparations

All Approaches

All Reductions & Fixations

Additional material

Animation of tension band application