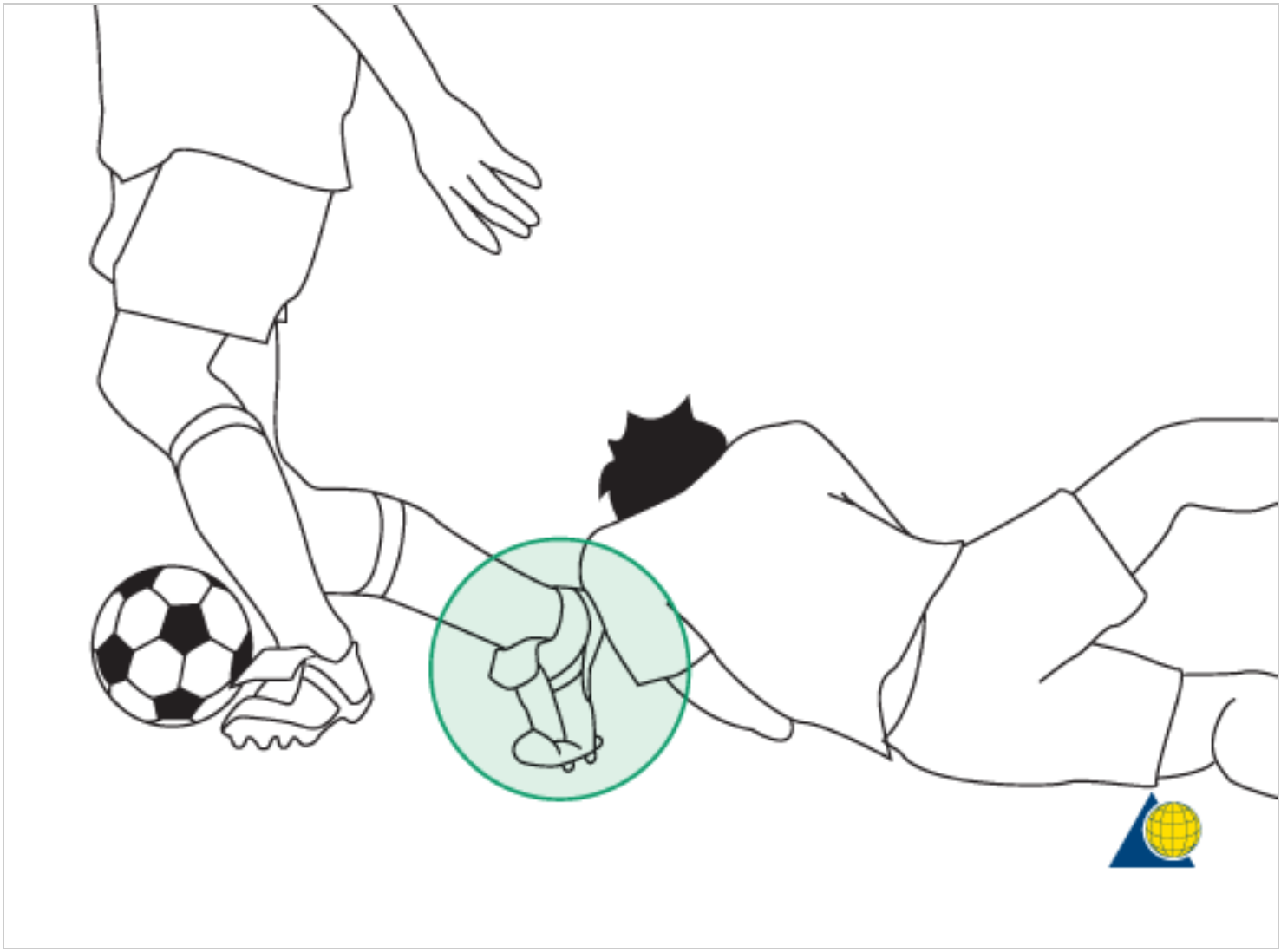
1. Diagnosis

Mechanism of the injury



Tarso-metatarsal (Lisfranc) injuries may be caused by direct or indirect forces.
Direct forces include a crush injury (MVA or industrial) or a direct blow. These may be combined with soft-tissue injury and present as open fractures.
Indirect injuries are more common. They result from an axial load to a plantarflexed foot. They may occur during sports, or stepping down from a stair or sidewalk.

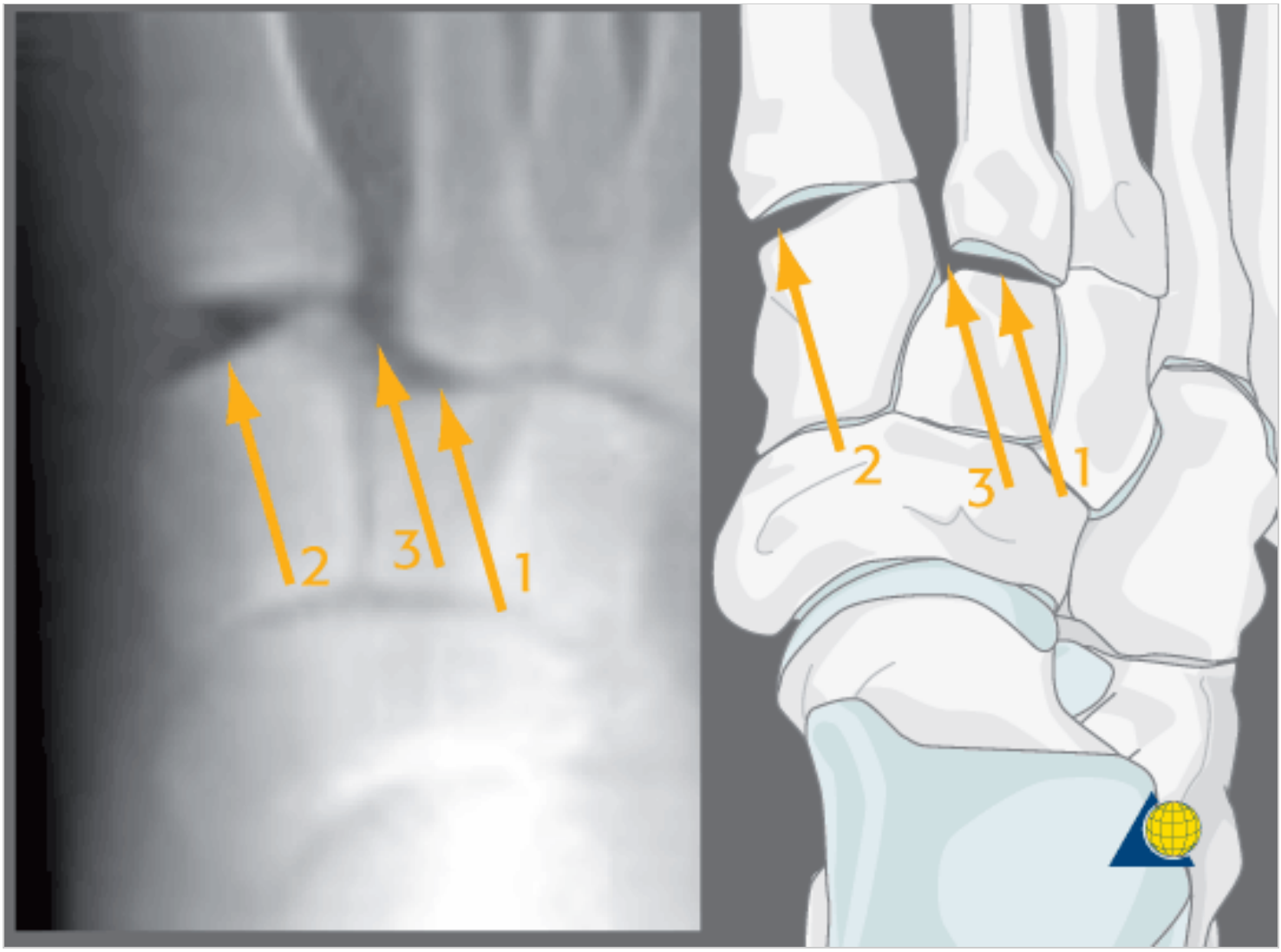
Physical exam

There is midfoot swelling, usually dorsal. There is pain on palpation of the TMT area. A provocative test may show instability. This is painful, so it should be done carefully (under regional or general anesthesia, if possible).
There is often an area of plantar medial ecchymosis.
There is pain seemingly out of proportion to the injury. Unlike a routine ankle sprain, these injuries elicit patients' comments of a visceral nature like "I almost passed out", "I almost threw up".

Pitfalls

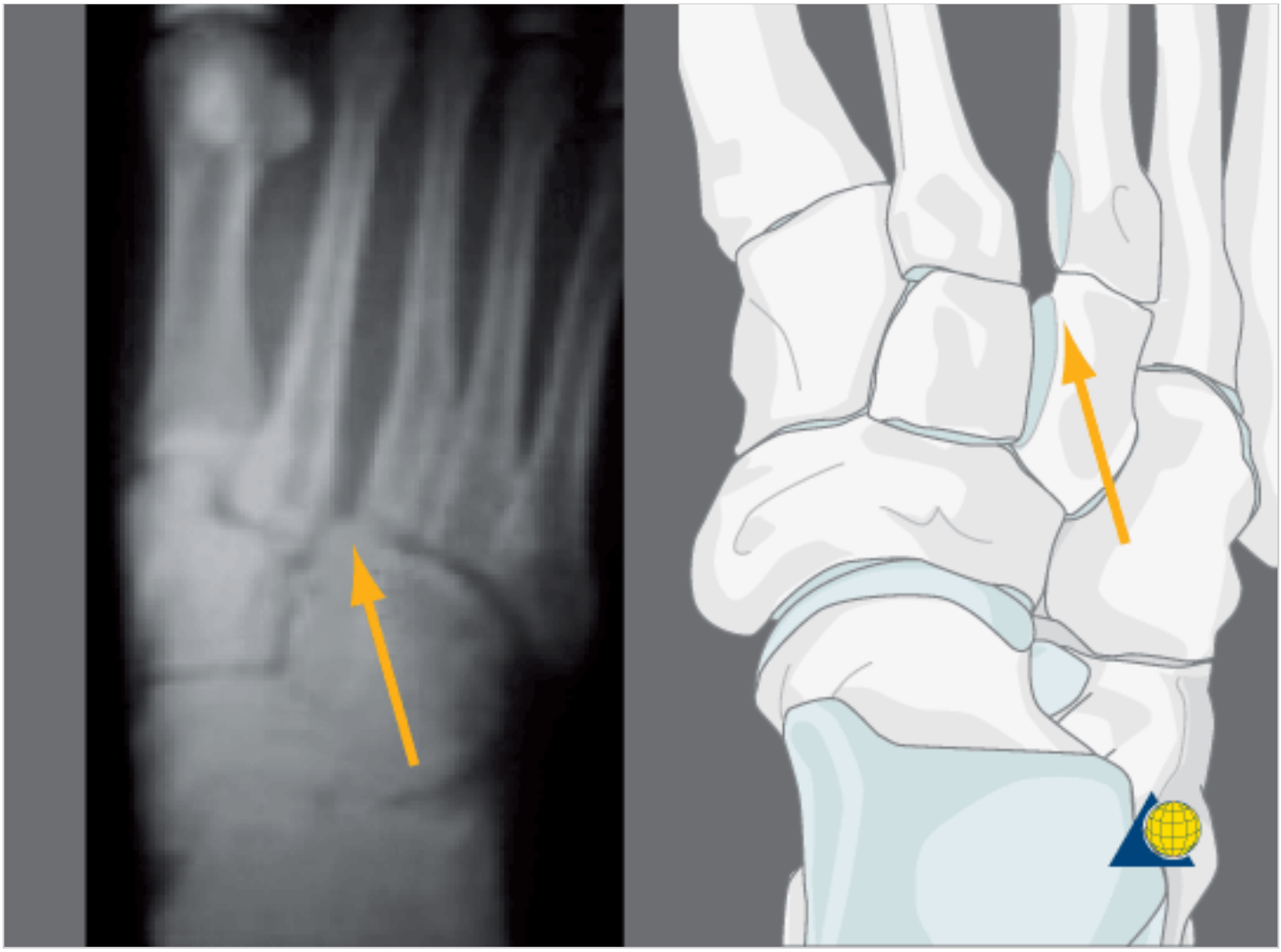
Beware of a patient who was told in the Emergency Room that they had a "sprained foot". Since Lisfranc injuries may represent instability without frank displacement, ER x-rays (which are often non-weight bearing) may not show the extent of the injury.
Subsequent weight-bearing x-rays in the office or clinic may show displacement/instability.
Remember, that Lisfranc injuries involve frequently high energy, which dissipates through the soft tissues and therefore they may be associated with a compartment syndrome.

X-ray – AP view



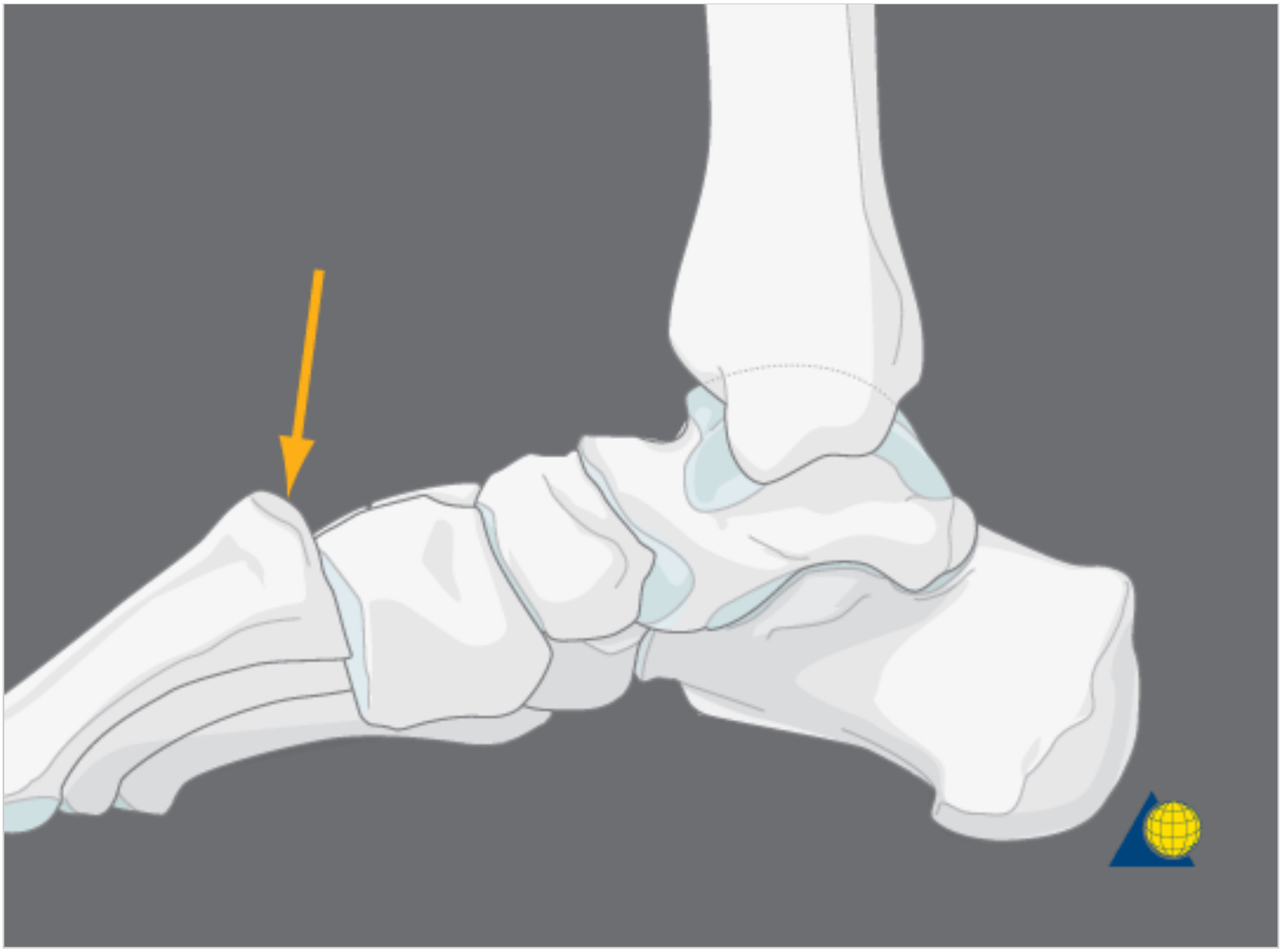
1. Lateral displacement of 2nd metatarsal on intermediate cuneiform
2. TMT 1 disruption
3. Gap between 1st and 2nd metatarsal

X-ray – 30 degree oblique view



Lateral displacement of 3rd metatarsal on lateral cuneiform

X-rays – lateral view



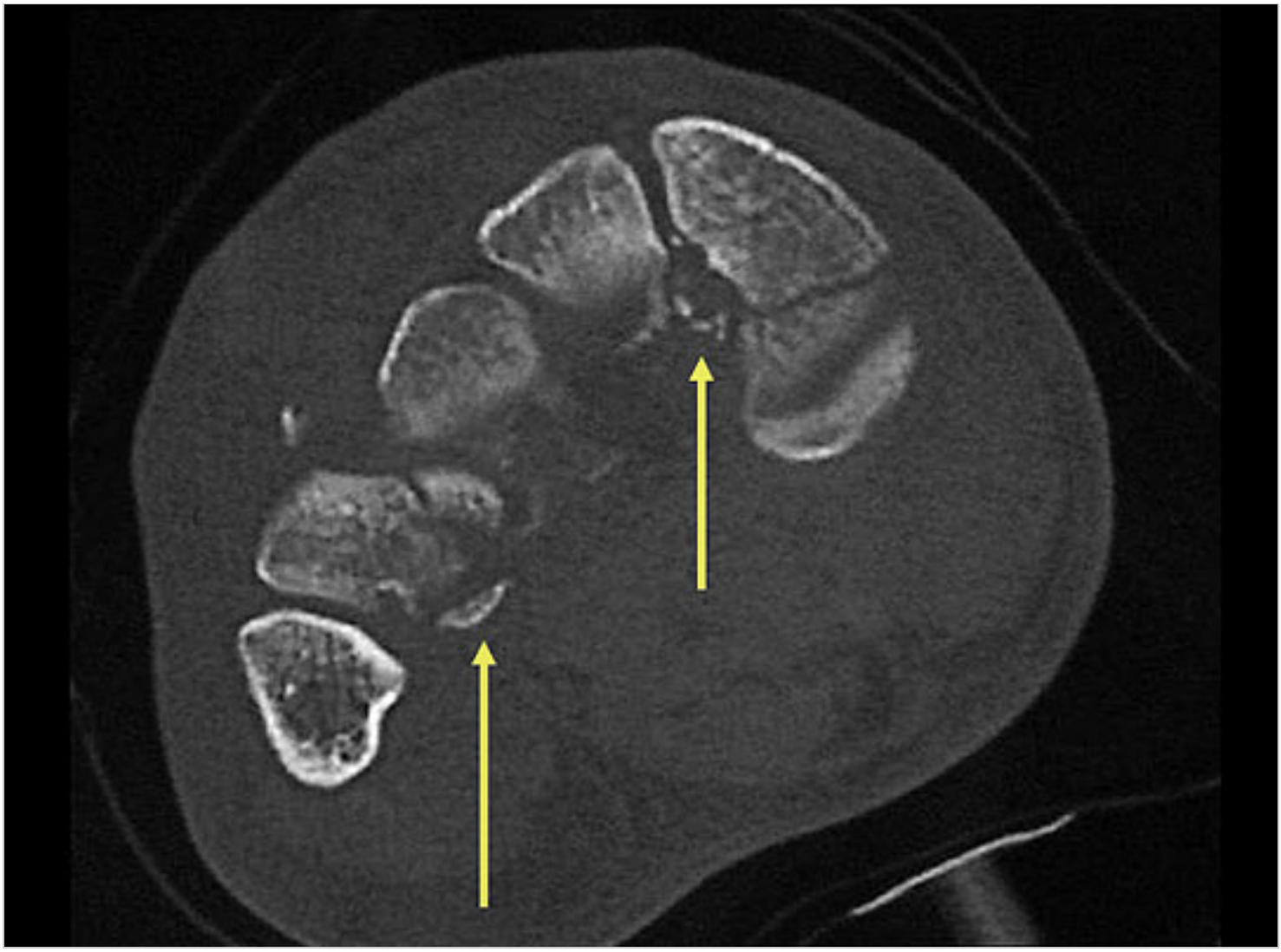
The dorsal cortex of the metatarsals should be even with the dorsal cortex of the cuneiforms. Dorsal displacement of the metatarsal bases above the level of the cuneiforms is abnormal and indicates a Lisfranc injury.

Stress x-ray

The stress test can uncover instability that may not be apparent in a static x-ray. This, however, can be painful for the patient. It could be done under anesthesia. Routine x-ray film or image intensification can be used.

Weight-bearing films
If you suspect a serious injury insist on a weight-bearing film within the patients tolerance.

CT scan



There is often plantar comminution.
CT can be useful to further define the injury.

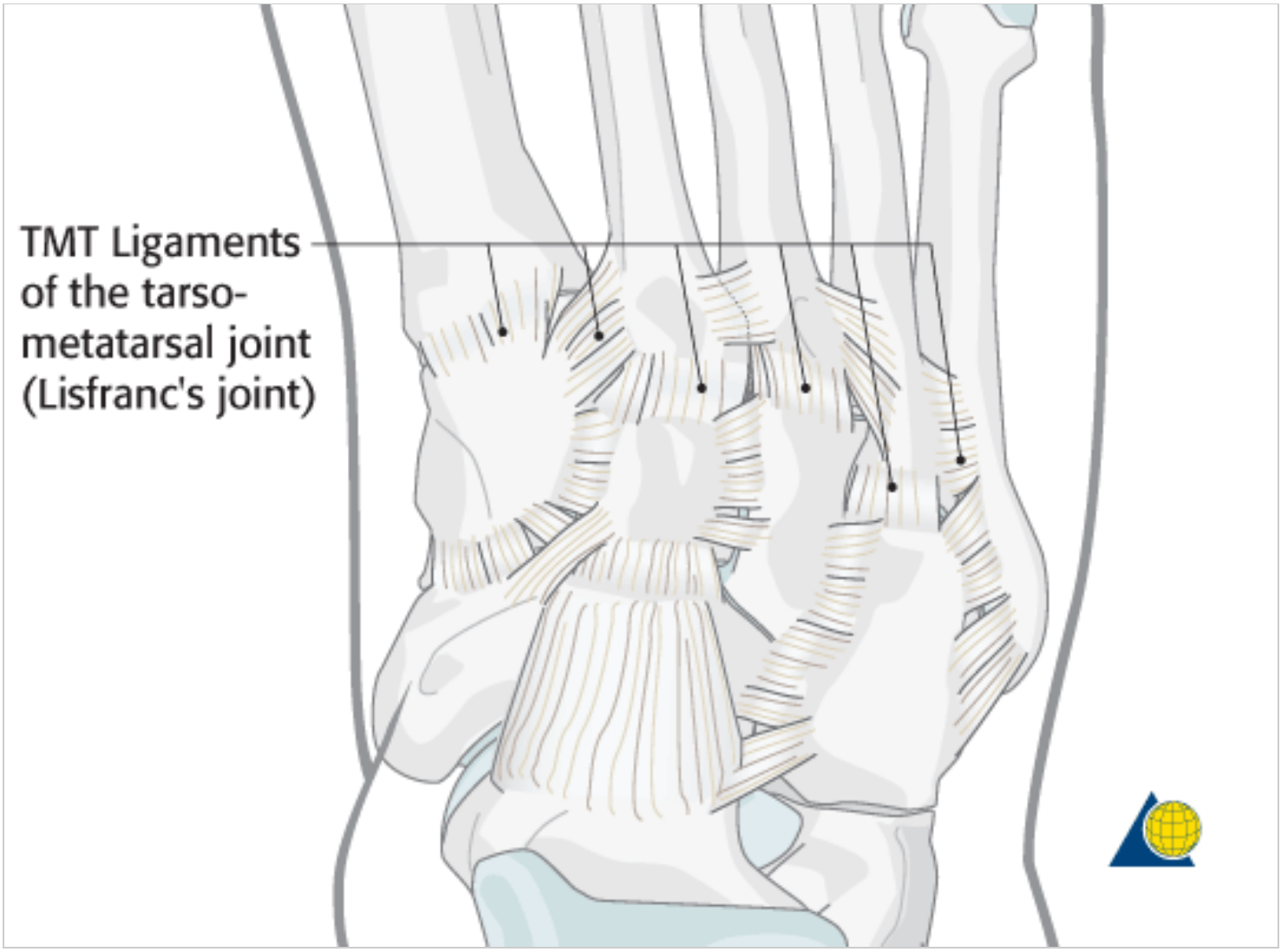
2. Principles

General considerations

ORIF is preferred to closed reduction and percutaneous fixation.

Screw fixation is preferred to K-wire fixation.

Anatomy and mechanics



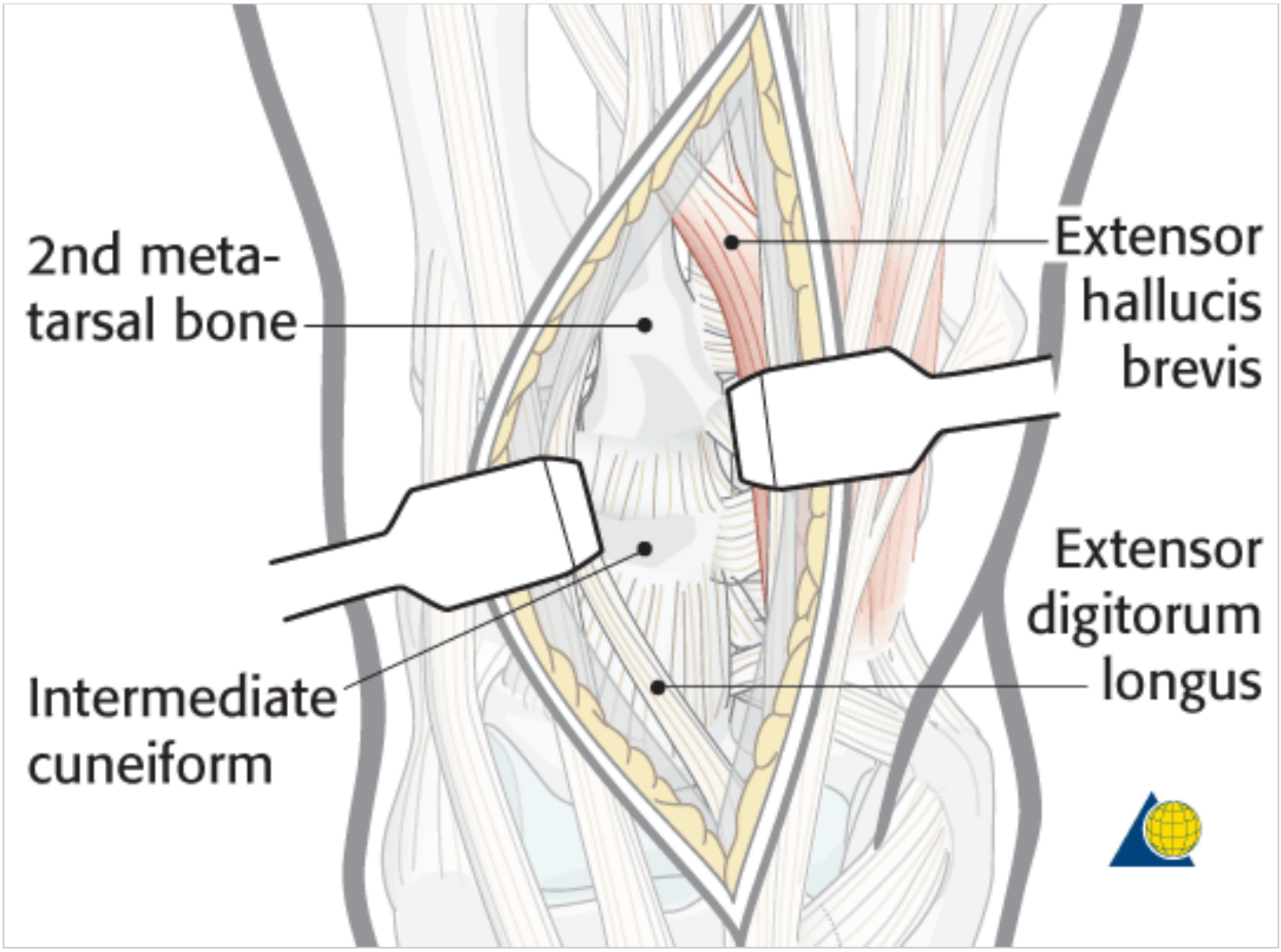
The Lisfranc / tarsometatarsal (TMT) articulation is very strong. The base of the second metatarsal is held in place by the plantar TMT ligaments.
The significance is that motion at the base of the second metatarsal is restricted. This leads to fractures at the base of the second metatarsal. Unlike other areas with their “essential” joints, the midfoot area joints are not “essential” and therefore motion can be sacrificed to obtain stability and function. The 1, 2 and 3 TMT joints can in fact be fused for acute purely ligamentous injuries. The 4 and 5 TMT joints should be stabilized with K-wires as some retained motion in this area is helpful for better function, because normally there is motion between the 4th and 5th metatarsal and the cuboid.
As a result, when treating fractures in the Lisfranc / midfoot area, joint surface reconstruction may not be as critical as in other joints.

3. Approaches

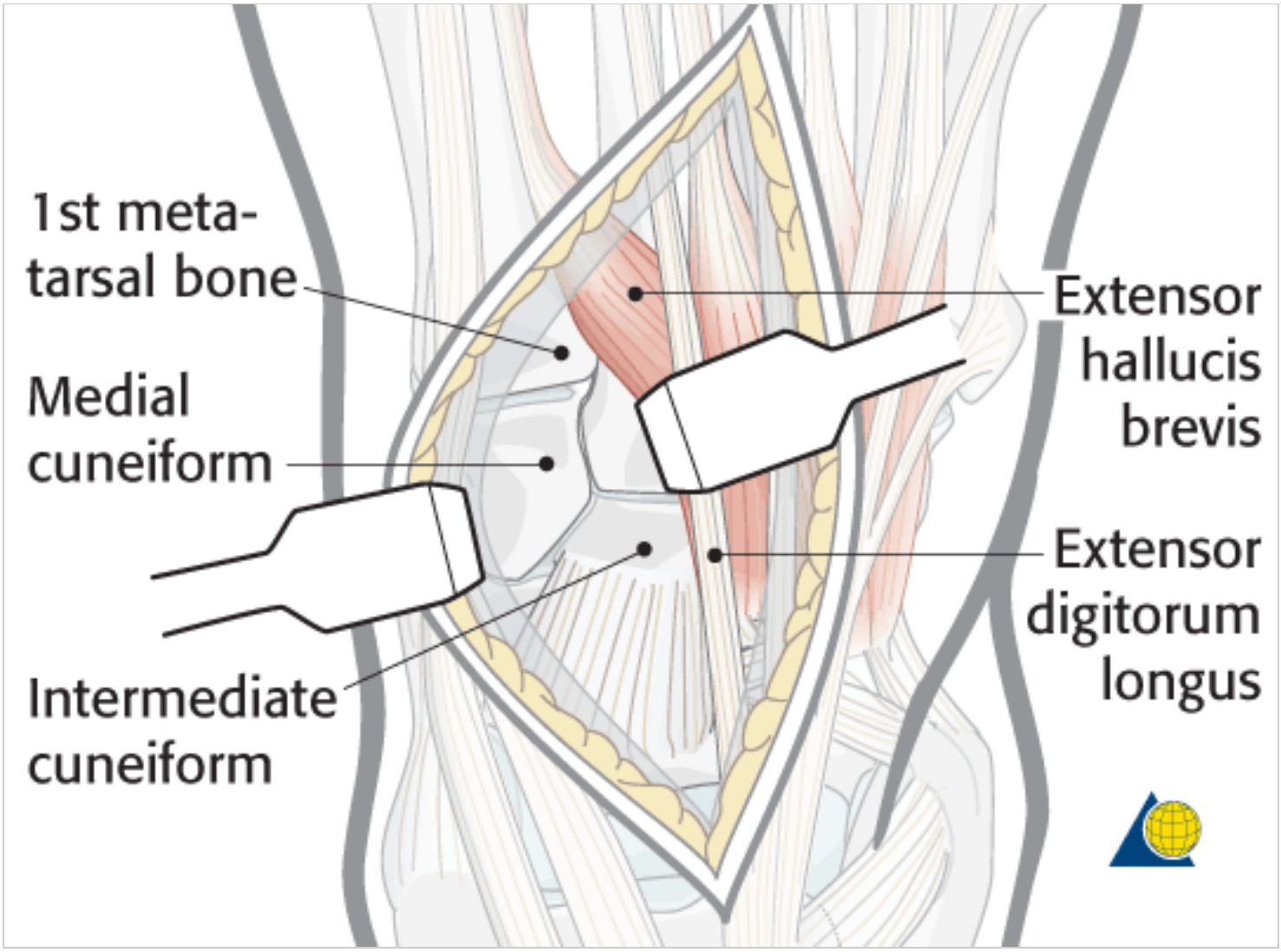
Dorsal double parallel and medial mini approach

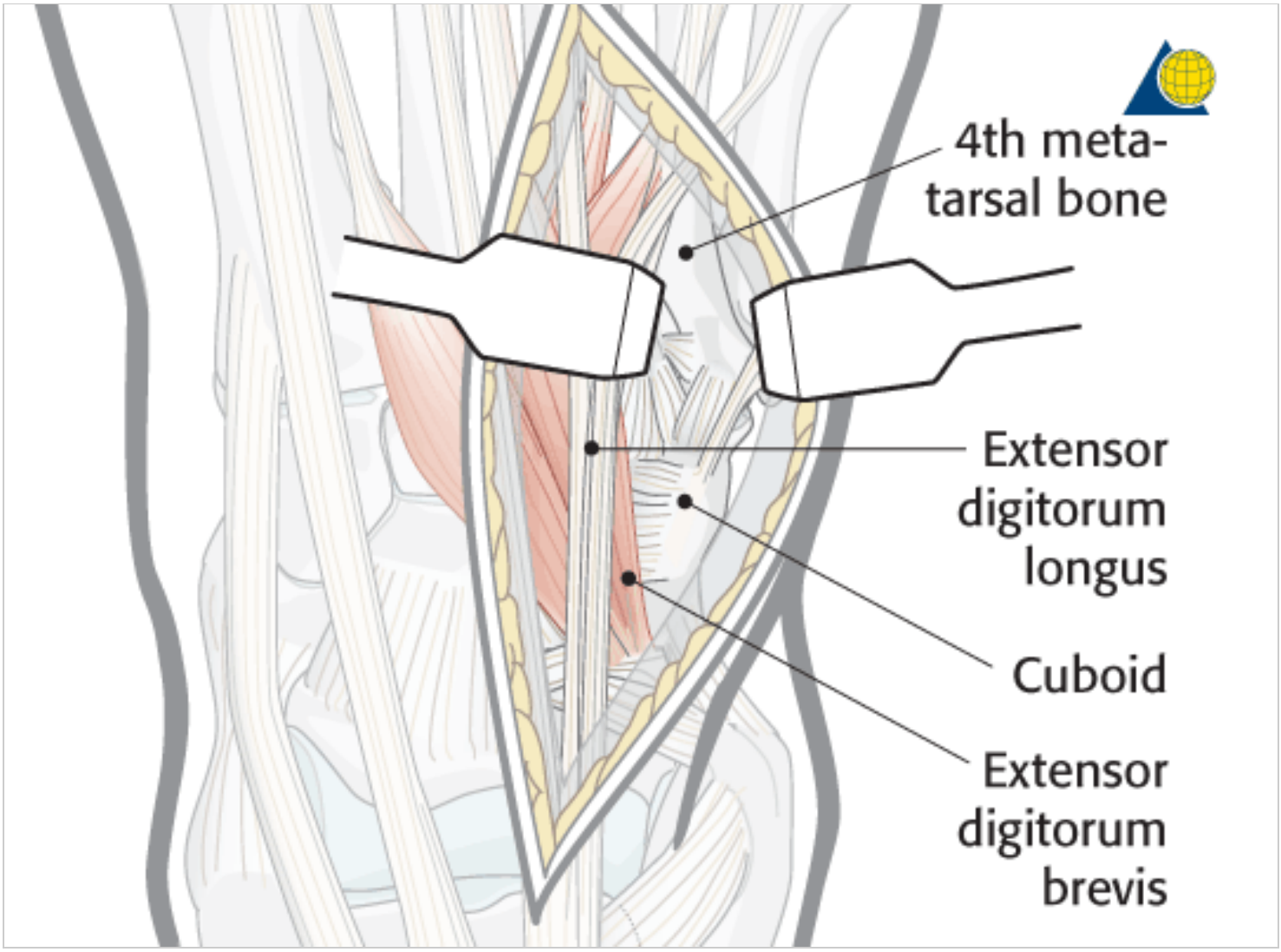
In the forefoot, incisions should be straight, in the axis of the foot and should never be undermined.
The dorsomedial incision is centered over the TMT area, between the extensor hallucis longus tendon (EHL) and extensor hallucis brevis (EHB). This incision allows access to the first TMT and the medial base of the 2nd TMT.
The dorsolateral incision is centered over the TMT area, roughly in line with the fourth metatarsal.
A skin bridge as wide as possible should be maintained. But, as long as the area between the incisions is not undermined, the skin bridge is not compromised.
A third small medial incision (along the medial utility line) is used for screw placement and pointed reduction clamps.

Alternative incision



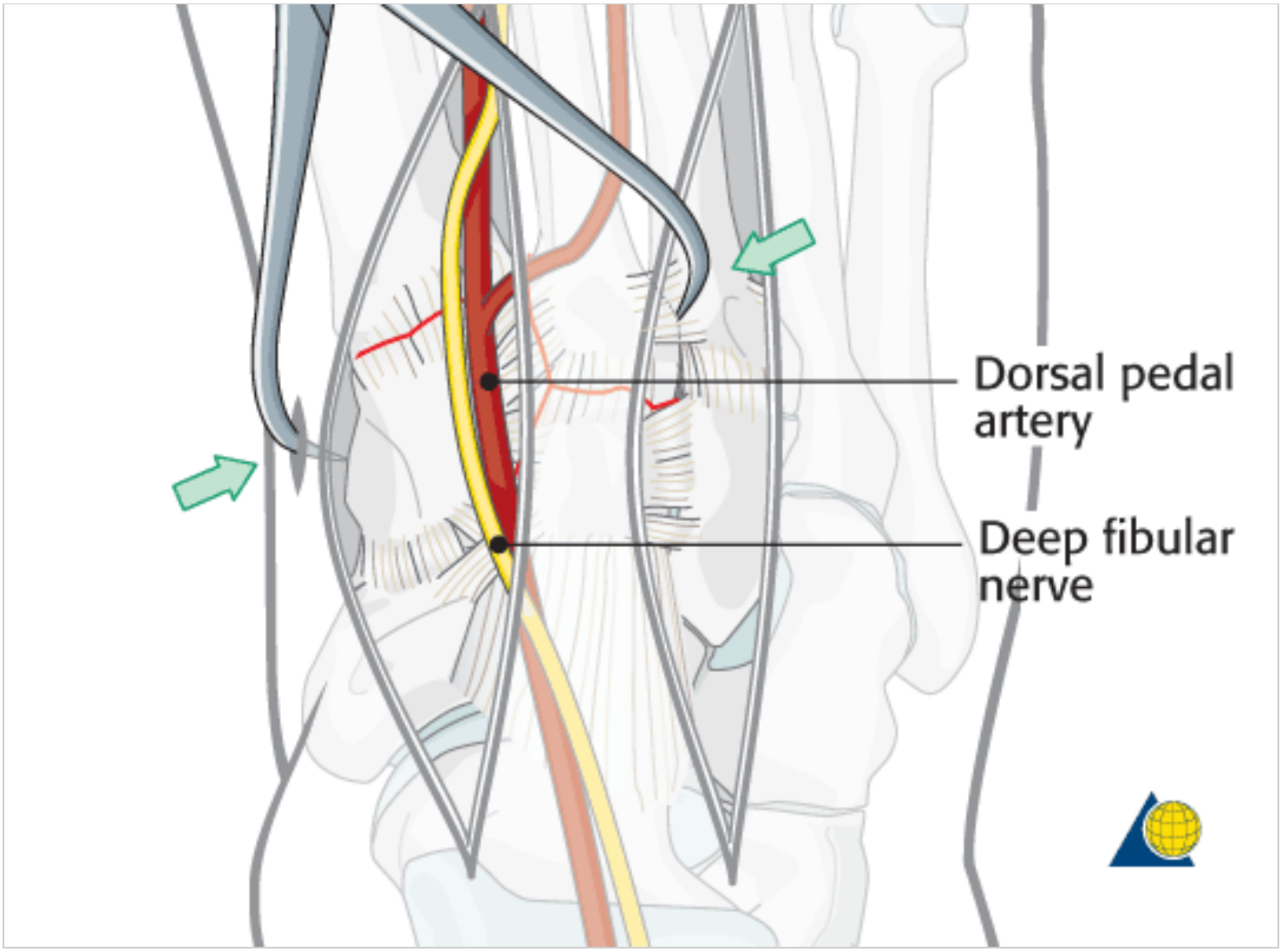
An alternative approach is the extensile dorsal salvage incision (EDSI/Zwipp).
The EDSI is useful in extreme injuries. It can be used for combined foot and leg injuries. It starts at the base of the second toe and runs straight up the foot to the ankle, and if needed it can be extended proximally along the anterior compartment of the leg. In the foot, it can be used for decompression as well as approach for ORIF. However, much tissue dissection is required when this is used for ORIF and this can lead to soft-tissue complications.


1st meta-
tarsal bone
Medial
cuneiform
Intermediate
cuneiform
Extensor
hallucis
brevis
Extensor
digitorum
longus



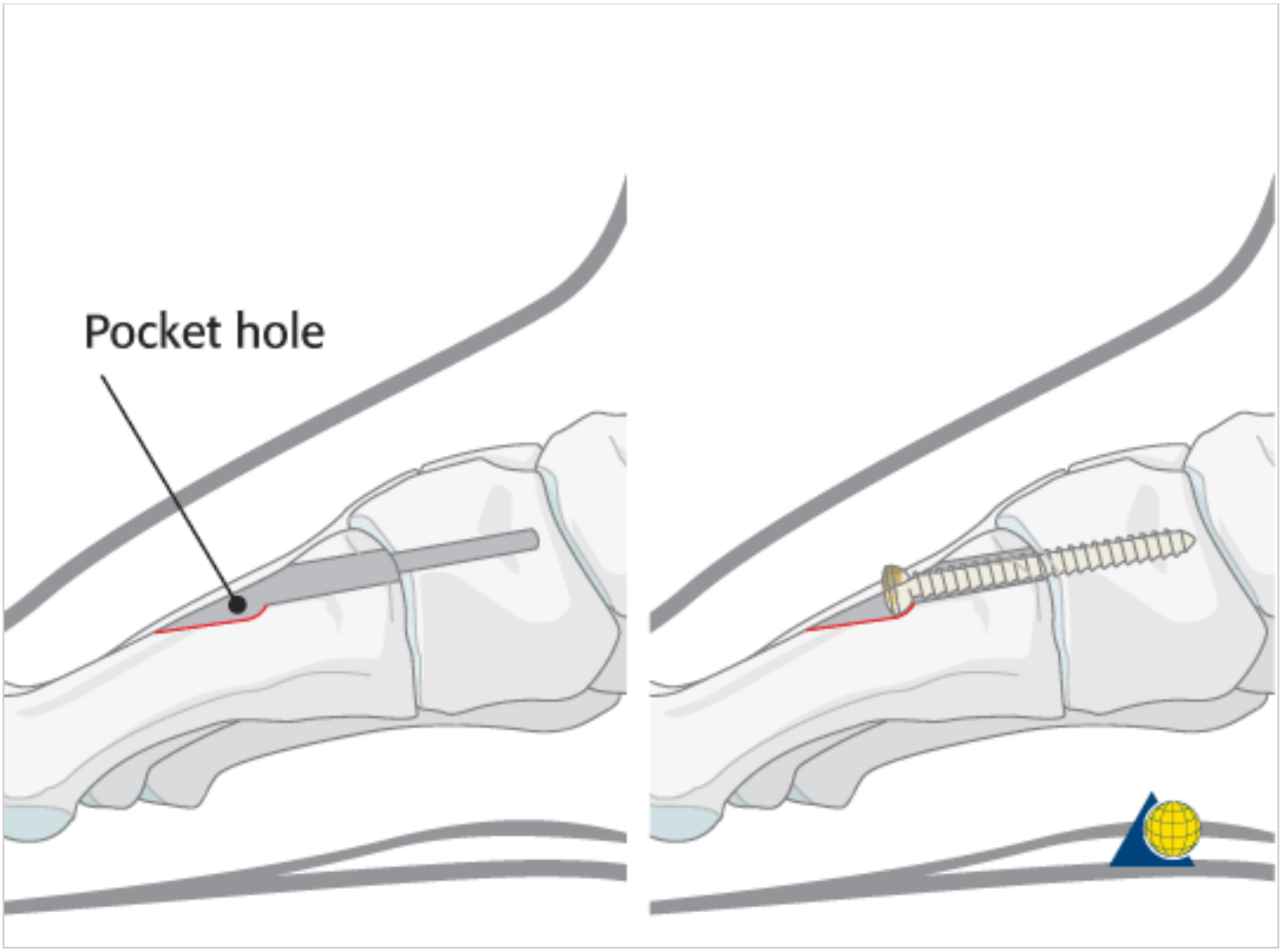
4. Reduction and fixation

Access



The dorsomedial full-thickness incision allows access to the 1st TMT and medial area of the 2nd TMT. The dorsolateral full-thickness incision allows access to the lateral area of the second TMT. Work back and forth to reduce and fix the 2nd TMT taking care not to undermine the middle area between the incisions. Care should be taken not to disturb the neurovascular bundle between the incisions in the flap.
The joints can be distracted with a bone spreader allowing access to soft-tissue interposition and bony fragments. These can be debrided and removed to allow perfect reduction of the base of the 2nd MT into the “keystone” corner of the TMT joint.

Reduction and fixation of the first metatarsal

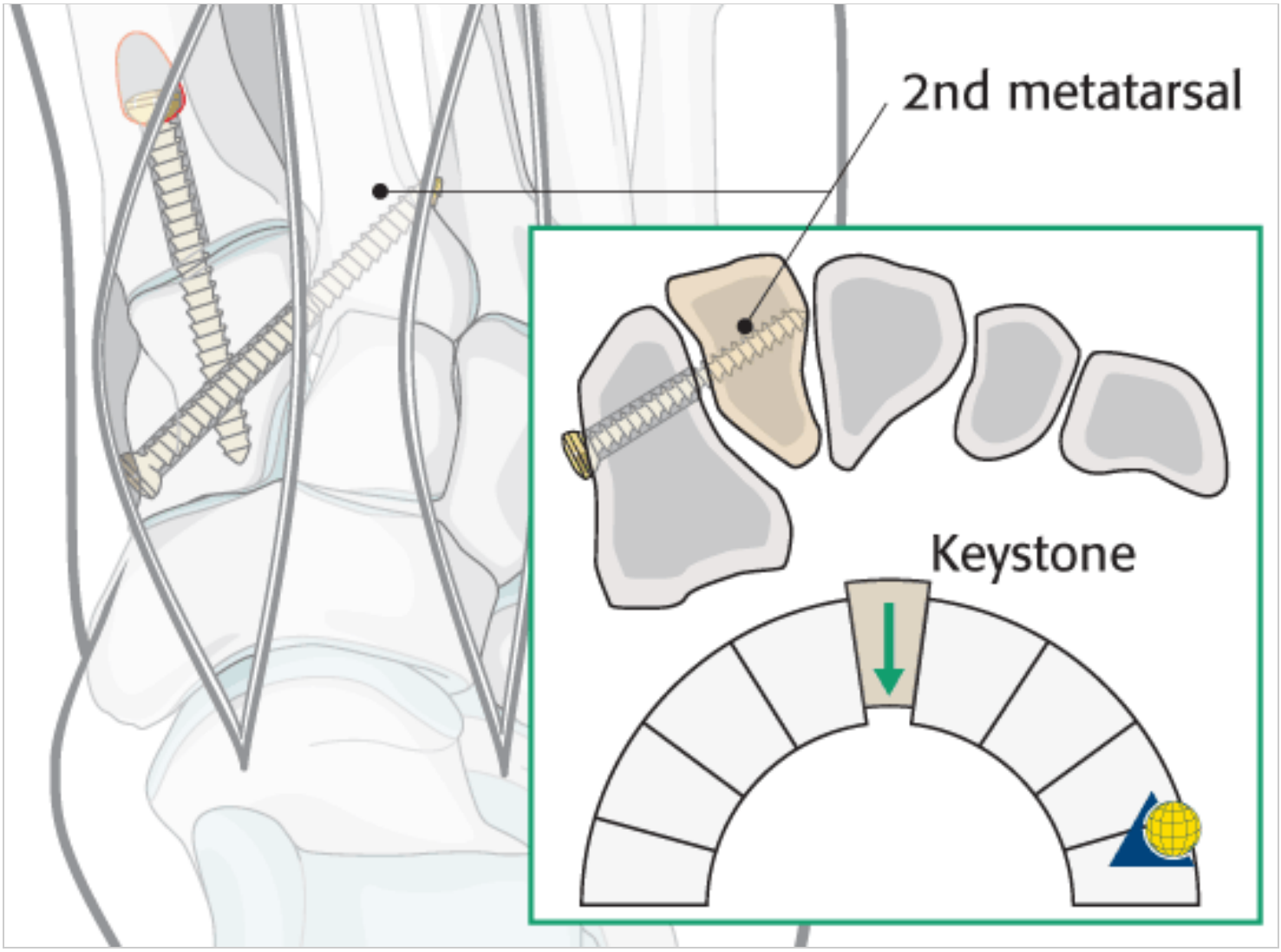


Our preferred method of achieving fixation is as follows.
The 1st TMT is reduced under direct visualization and image intensification. Provisional fixation can be done with a pointed reduction (Weber) clamp and/ or K-wires placed from the base of the first metatarsal to the medial cuneiform. A “pocket hole” is made along the dorsal base of the first metatarsal. The pocket hole allows the screw head to engage the cortex without breaking the dorsal cortex, which would result in loss of fixation.

Pearl
A 4.0/2.5 mm drill combination is used to place the lag screw from the dorsal base of the first metatarsal into the medial cuneiform. Usually for a 4.0 screw, a 2.5 mm drill can be used instead of a 2.9 mm drill as foot bones are soft and just a pilot hole is needed. The screw will hold better with the smaller pilot hole.

A second screw can be placed if desired from the dorsal medial cuneiform through the plantar base of the first metatarsal. However, it is sometimes difficult to insert the screw through the crowded area. A smaller-diameter screw may be easier to insert.

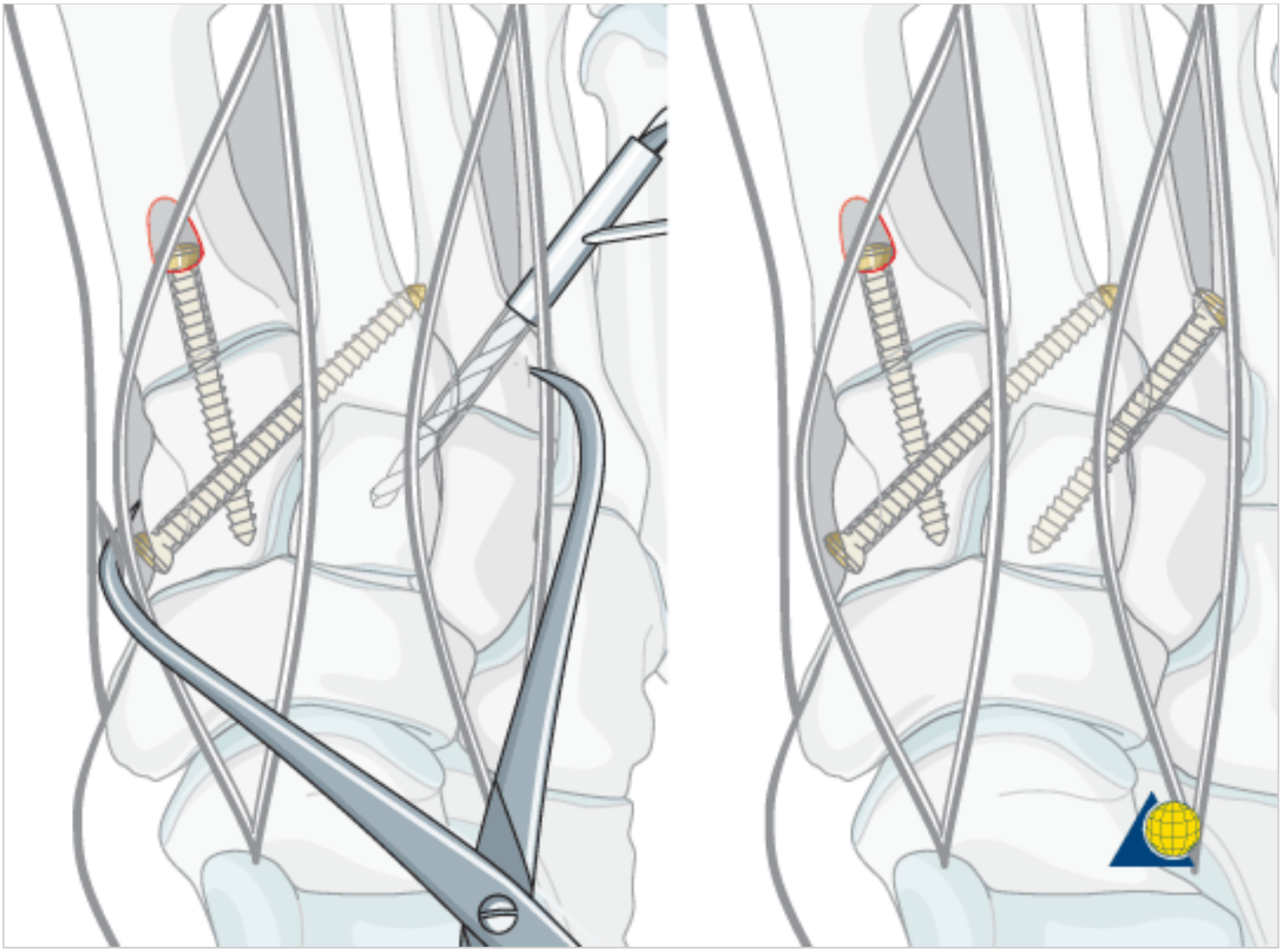
Reduction and fixation of the second metatarsal base



Once the dissociation between the first metatarsal and the medial cuneiform has been reduced and stabilized, the medial arch of the foot has been restored and we are ready to reduce the second metatarsal.
The second metatarsal is reduced into the keystone (formed between the base of the first metatarsal and the first cuneiform, the articular surface of the second cuneiform, the lateral surface of the third cuneiform and the third metatarsal).

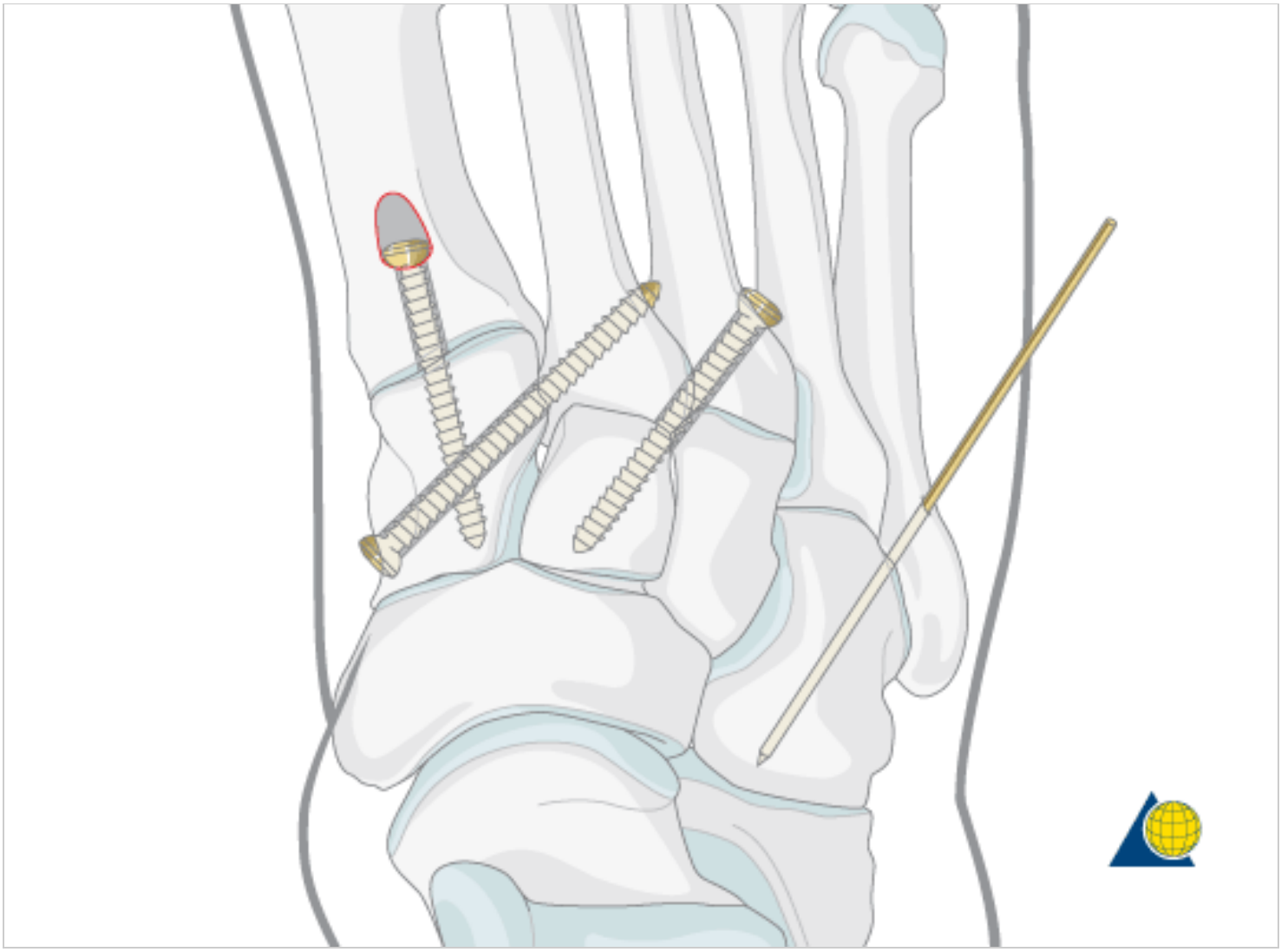
Once the second metatarsal has been reduced into place in the medial part of the “keystone”, its fixation is accomplished with a lag screw placed from the medial area of the medial cuneiform, through the base of the second metatarsal. A solid fully-threaded 4.0 mm screw gives the strongest fixation. If there is not enough space, a smaller-diameter screw can be used, but this weakens the construct.
If cannulated screws are used, there is an increased incidence of fixation failure and screw breakage. Cannulated screws are not as strong and tend to break with repeated bending forces.

Reduction and fixation of the third TMT



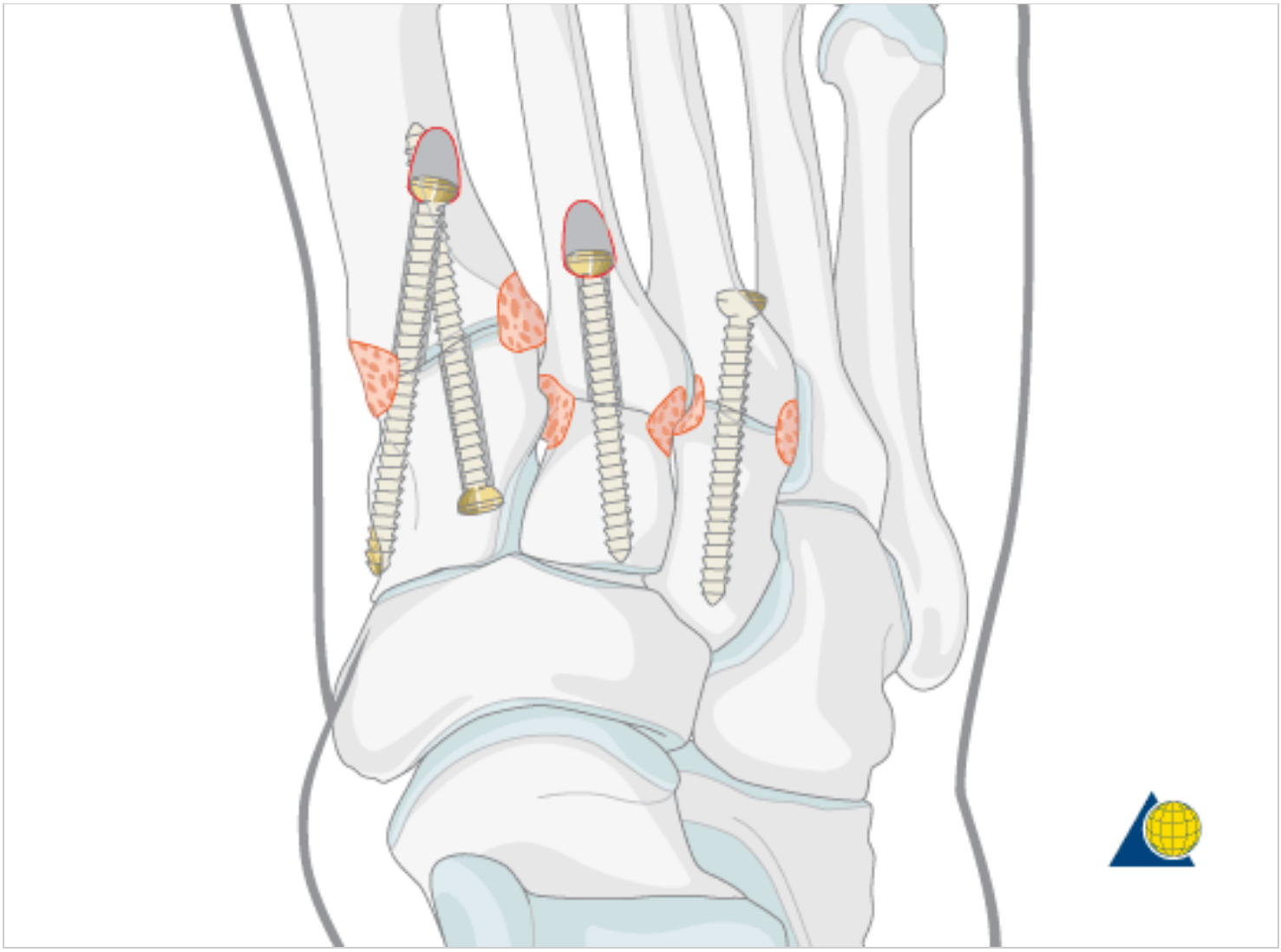
The 3rd TMT is reduced through the dorsolateral incision. The position is held using a pointed reduction (Weber) clamp, or K-wires placed under image intensification. A lag screw is then placed from the dorsal base of the third metatarsal into the cuneiform row. The screw can be inserted into either the lateral or middle cuneiform.

Reduction and fixation of the fourth and fifth TMT

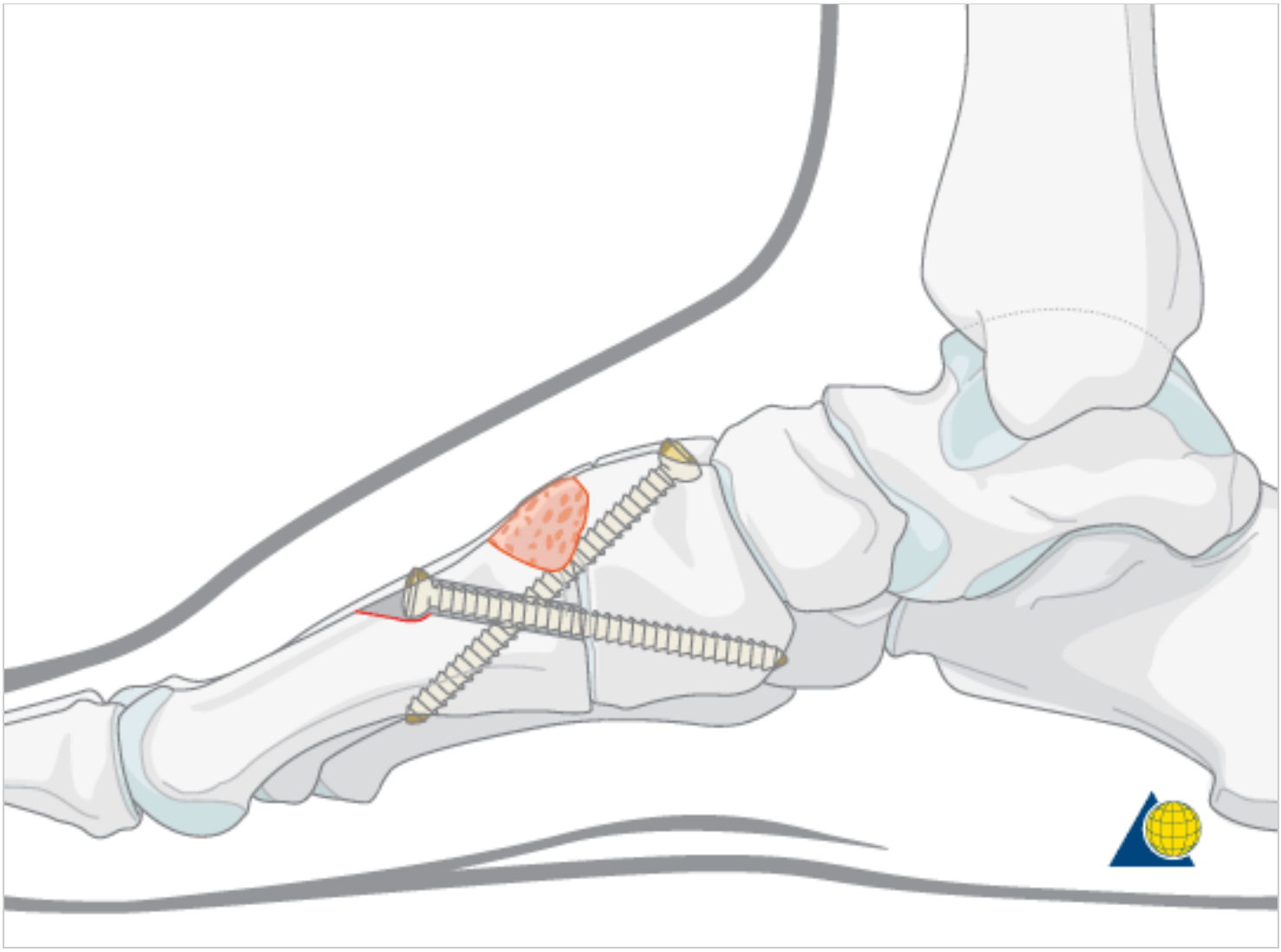


When the more medial TMT joints are reduced, the 4th and 5th TMT joints often move medially and are reduced along with the rest of the foot. As stated previously, having some motion at these joints is helpful for normal foot function.
The 5th metatarsal is positioned with a pointed reduction (Weber) clamp if further positioning is needed. The joint is then held with percutaneously placed K-wires from the proximal metatarsal into the cuboid. Alternatively, screws can be placed from the base of the 4th or 5th metatarsal into the cuboid. However, as these joints are best left mobile, the screws will have to be removed in the immediate postoperative period (8 weeks). The K-wires, which are placed percutaneously, are removed at 6 to 8 weeks in the office/clinic.

5. Pure ligamentous injury



If the Lisfranc injury includes a fracture at the base of the 2nd metatarsal, then faster, stronger bone-to-bone healing may be expected.
In the case of a pure ligamentous injury without a fracture at the base of the 2nd metatarsal, post-injury arthrosis is more likely. As such, immediate primary fusion of the first, second and third TMT is now advocated. The joint surfaces are prepared in the usual manner for fusion. The articular cartilage is removed and the subchondral bone is perforated. The hardware construct can be the same as described above, or a variation.



Supplementary bone graft should be used to facilitate fusion (shear strain relief grafting – “spot weld”).

6. Associated conditions

Metatarsal fractures / intertarsal injuries

Intertarsal instabilities can be addressed before the Lisfranc injury is fixed. Any instabilities can be compressed with the pointed reduction forceps and held with K-wires. Screws can then be placed transversely between cuneiforms.
Cuneiform or metatarsal base fractures may preclude the use of screws. In these cases, small low-profile plates can be used in the intertarsal area, or as bridge plates from the metatarsal shaft across the metatarsal base / TMT joints to the cuneiforms.

Tight calf / equinus contracture

Patients with Lisfranc / midfoot injuries often have equinus contracture. It is unclear if this plays a role in the injury, but certainly it can compromise healing by exerting forces through the midfoot. Therefore, if equinus is present, a calf or Achilles lengthening may be performed as an adjunct procedure at the time of surgery.

Appendix

Note

Assessment of the injury
Since ER x-rays (which are often non-weight bearing) may not show the extent of the Lisfranc injury, subsequent weight-bearing x-rays in the office or clinic are highly recommended.

Shortcuts

All Approaches

All Reductions & Fixations

Further reading

Surgical anatomy of the Lisfranc area

Fracture patterns of tarsometatarsal joint injuries

Preoperative planning in TMT / Lisfranc surgery

Screw principles

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