Anatomy and Biomechanics of the unstable ankle

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1 – the osseous stability

the tibiofibulotalar joint seems stable because of a conformation of mortise…

Tibiofibular mortise

- 3 malleoli
- Lateral malleolus lower = lateral stabilisation

Talar tenon

The talar surface is wider in the front part = stabilisation in dorsal flexion
Some anatomical deformities can modify this stability

- **lateral malleolus too posterior**
  Berkowitz CP, Kim DH: Fibular position in relation to lateral ankle instability.

- **Malunion with rotation**

**Tibial valgus after trauma in the child period**

The lateral malleolus is too high
However, the tibiotarsal joint is incongruent

- Trunqued cone shape

- Stress lesions if desaxation:
  - on the malleoli = stress fracture
  - tendinomuscular overuse: fibular, tibial posterior splint
  - joint disease:

Osteochondral lesion

Evolutive arthritis
Can we prevent this evolution?

Reaxation and stabilisation before joint disease

without stress  with stress in varus

yes

+ calcaneus lateral translation

Ligamentoplasty?

without stress  with stress in varus

NO
Be careful after a surgical reaxation of the hindfoot, the TT joint may be more painful after if arthritis.

Painful instability after a ligamentoplasty man of 30 years old.

Painful ankle after calcaneal osteotomy and basal elevation of the 1srt metatarsal.
Tibiotarsal joint functionally associated with the hindfoot and the midfoot
= to transmit the vertical force of the lower limb to the horizontal force of the foot
   lateromedial and rotational stability

Torque complex

In the hindfoot

In the midfoot (Kowalski)
Midfoot lesion in sprain in inversion mechanism

Chopart sprain (bifurcate ligament)

Rostrum fracture (bifurcate ligament)

5th metatarsal fracture
Midfoot lesion in sprain in inversion mechanism

Long term consequences

Test the laxity of the midfoot

Talonavicular arthritis
10 years after a sprain

Flatfoot 1 year after a sprain with rotational mechanism
Interest in these cases to stabilise the midfoot during the ligamentoplasty:

Castaing

Christman Snook

Or with arthrodesis of the Chopart joint?
2 –the ligamentous stability

A – lateral ligament = 3 fascicles

post.fibulotalar ligament:
  intra-articular

Peroneocalcaneal ligament:

Anterior insertion on the fibula
Perpendicular to the subtalar joint
  = Parallelle to the axis of Henke
Lateral posterior fascicle (rotation)
Ligamentous stability

A – lateral ligament

Lesional mechanism

Varus: foot on the ground,
above all fibulocalcaneal and talocalcaneal lesion
subtalar lesions++

Rotation: foot in weightbearing
lateral and medial lesion, posterior ankle area++

Inversion ++: foot generally not in weightbearing
lateral and anterior lesions (midfoot ++)
Ligamentous stability

A – for a lateral ligament lesion

1. To understand the mechanism if possible

2. To do a complete analysis before surgery:
   - dynamic echography
   - CT scan with contrast: articular lesions
   - MRI: the most interesting in the associated lesions

3. To use of a procedure that involve all the lesion

Don’t forget to correct the posterior talofibular ligament
Ligamentous stability

B – Médial ligament

Superficial layer

- contact with navicular bone and tibial posterior tendon

- Tibiocalcaneal ligament
- Tibionavicular ligament
- Tibiospring ligament

Deep layer

- Intra-articular extrasynovial
- Tibiotalar ligament anterior posterior

Ligamentous stability

B - Medial ligament

Shock absorber mechanism during heel strike (Kowalski)

Medial ligament rupture → hindfoot valgus

Chronic medial instability (rare) = flatfoot

Medial ligament suture & calcaneus medial translation
Ligamentous stability

C- ankle syndesmosis

Roles:
- To keep the flexible distance between tibia and fibula = lateromedial stability
- Oblique orientation = rotational stability

Ligamentous stability

D – rotational stability = complex

Confirmed by the anatomy: oblique orientation of the ligaments and tendons

Anterior painful lesions
(fibrous anterolateral conflict, Impingement exostosis)

Posterior painful lesions
posterolateral tubercle fracture, fibrous post. conflict, posterior subtalar arthritis)
Ligamentous stability

**D – rotational stability**

Medial tibiotalar arthritis + Anterior subtalar arthritis
20 years after ankle sprain

Subtalar arthrodesis in the first step to place the talus on the calcaneus

Second step 1 month after: ankle arthroplasty
(result 1 year after)
3 – the tendinous stability

- **angulation over the malleoli**:
  - pulley = stabilisation of the tendon
  - important variation of length
    (inversion: 21 mm for TP, 24 mm for PL)

- The ankle stabilisator tendons cross over the midfoot with an oblique orientation
  = rotational stability
Tendinous stability

medial stabilisator tendons

Rare injuries in ankle sprain

Tibial posterior tendon:
Sometimes, its rupture involves a flatfoot
in association with a lesion of the medial ligament:

If no valgus: medial lig & spring lig & TP repair

If valgus: the ligament and tendon repairing is not sufficient:

a calcaneus medial translation is necessary associated
Tendinous stability

The fibular tendons

- Close to the posterior and intermediate fascicle of the lateral ligament
  - actif lateral stabilisator of the ankle

- Distal insertion on the midfoot
  - Peroneus brevis = abductor
  - Peroneus longus = eversor
  - action / subtalar and midtarsal joint

- Role in the proprioception

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Tendinous stability

Fibular tendons

Lesions meet in the ankle sprains: frequent factors of risk or consequences

Peroneus tendon weakness

luxation

tendinopathy

Os peroneum fracture

splint
Tendinous stability

Achilles (gastrocnemius) tendon

Generally, not injured during ankle sprain but sometimes a factor of ankle instability:
Its retraction involves:
- a limitation of the dorsal flexion of the ankle
- hindfoot varus or valgus compensation

= gastrocnemius retraction

Lateral medial force index
The factors of stabilisation of the ankle are complex. The apparent osseous stability is attenuated by a rotational mobility.

The ligaments play a role of medial and lateral stability but also rotational helped by the muscle stabilisers of the hindfoot and the ankle which action is also focalised on the subtalar and talonavicular joints (coxa pedis).

The dynamic pedobarography seems today a very interesting exam to analyse this rotational mobility during weightbearing (lateral medial force index).

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