Pathophysiology & Treatment Algorithm of Acquired Flatfoot

With EFAS Education Committee

EFAS

Instructional

Course

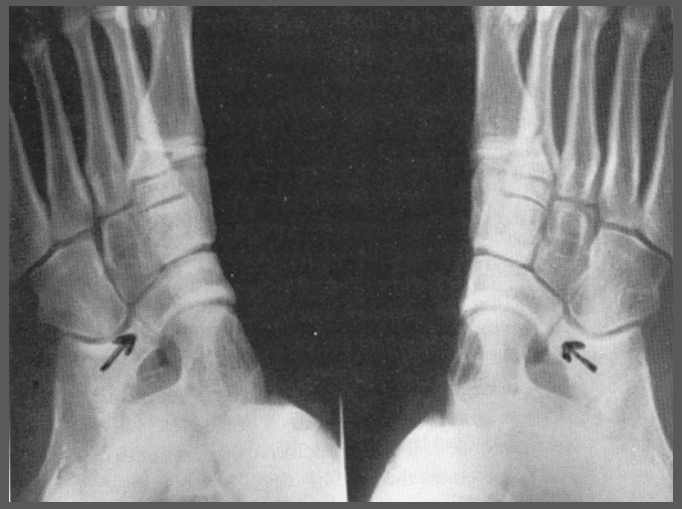
POZNAN 2014

Adult Acquired Flatfoot

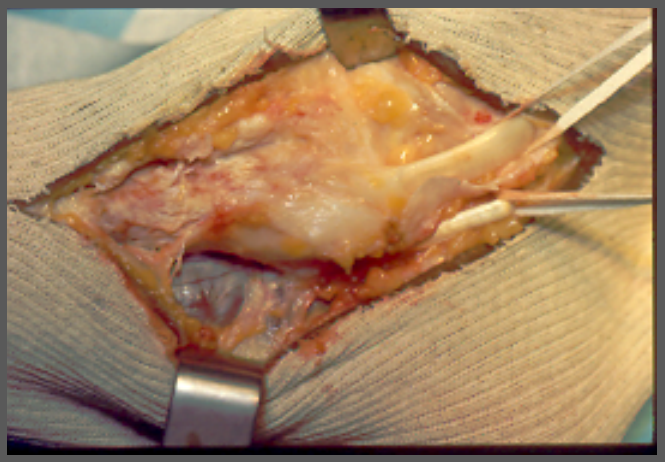
A symptomatic, progressive flatfoot deformity resulting from loss of function of the tibialis posterior muscle or tendon and/or the loss of integrity of the ligamentous structures supporting the joints of the arch and hindfoot.

In opposition with congenital FF

Idiopathic FF
Tarsal coalition
Clubfoot
Dysplasia(Marfan…)



- Tibialis posterior dysfunction
  - Primary
  - Secondary
  - *Biomechanical disorders*
  - The more frequent cause of TPTD!



- Others
  - Osteoarthritis
  - Traumatic (Lisfranc, calcaneus…)
  - Charcot' foot…

biomechanical disorders

- genu valgum, femoral \ tibial torsional defect, forefoot varus, forefoot valgus,……
- small degenerative changes of foot supporting structures occur and misalignment may generate <u>abnormal</u> pronation

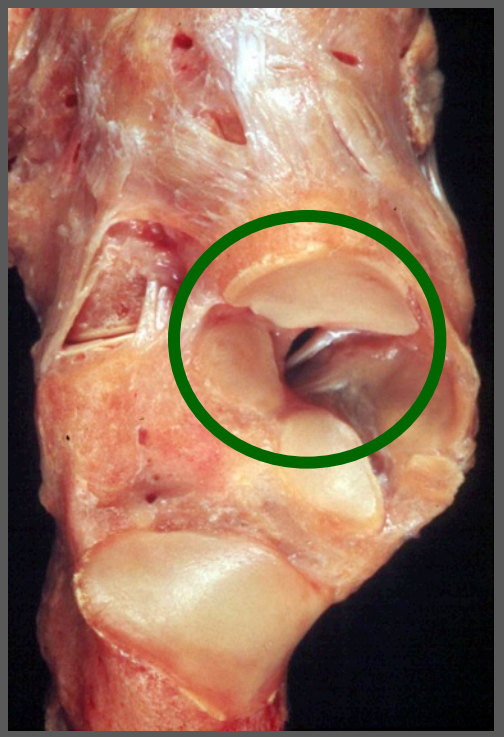
strong correlated factors
age sex obesity diabetes
veins breakdown

TPTD – Functional Anatomy

- Separate fibro-osseous groove
- Tenosynovial sheath
- Multiple insertions (plantar navicular/med. cuneiform)
- Primary antagonist is Peroneus Brevis
- TP is twice as strong as PB

TPTD – aetiologies

- Impingement in fibro-osseous groove
- Presence of accessory navicular increases dysfunction rates
- Hypovascular – behind med mall (abnormal often distal to this point)
- Chronic tenosynovitis (inflamm arthritides)
- Steroid injections
- Chronic mechanical overload & tendinosis (congen. pes planus, obesity, DM)
- Trauma



What comes first ?
static or dynamic failure

Most orthopedic surgeons support the concept that the primary mode of failure is the loss of dynamic arch support (PTT mainly)

Other research focus more on a tension failure of the static restraints of the medial longitudinal arch (spring and deltoid lig., plantar fascia)

the pathophysiology is still debated

Side effects of abnormal pronation

forces exceeding the static and dynamic restraints of the foot
create progressive medial structures degenerative dysfunction
(PTT - spring and deltoid ligaments)

progressive subluxation at subtalar and midtarsal joints

pathomechanics 1

Triple distorsion

- Definition
- Aetiologies
- Pathomechanics
- Pathoanatomy
- Clinical assessments
- Imaging
- Treatment
  - Conservative
  - Surgical
- Indications
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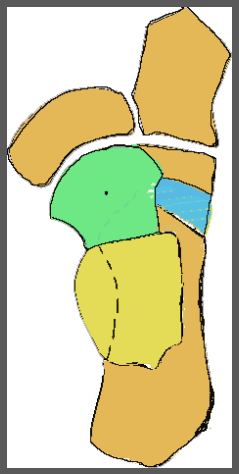
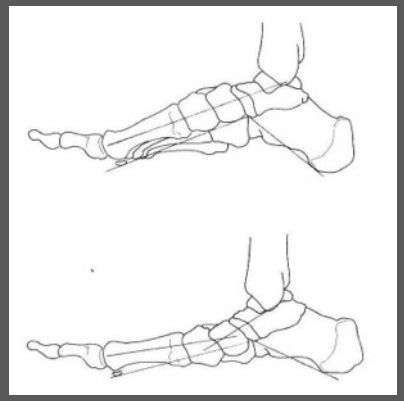
Hindfoot in valgus

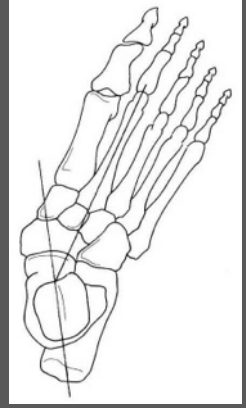
Increasing of talo-calcaneus divergence



Rotation of the forefoot & midfoot around the talus head

Lateral column insuffisiancy





Forefoot abduction

pathomechanics 2

Consequences

Medial side stuctures overuse

Soft tissues : spring ligt, CML
Tibialis posterior tendon
Medial OA

Achilles tendon retraction

Primary /secondary
Calcaneus in valgus
Equinus

pathomechanics 3

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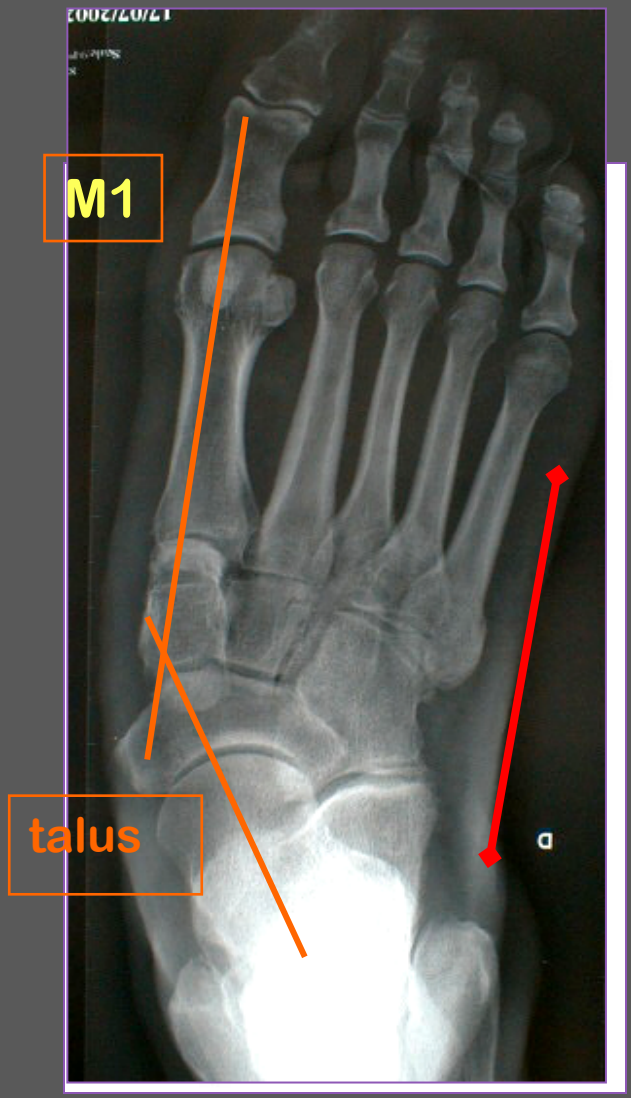
evolving of pes planovalgus in adult

progression of TP dysfunction

- *midfoot rotation*
- *peritalar subluxation*
- *collapse of the medial arch*
- *shortening of the lateral column*



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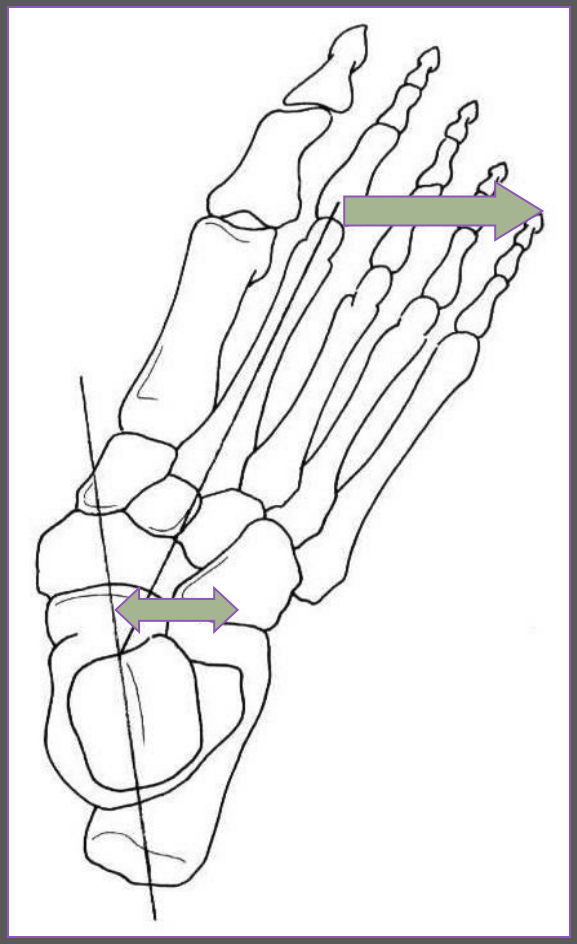

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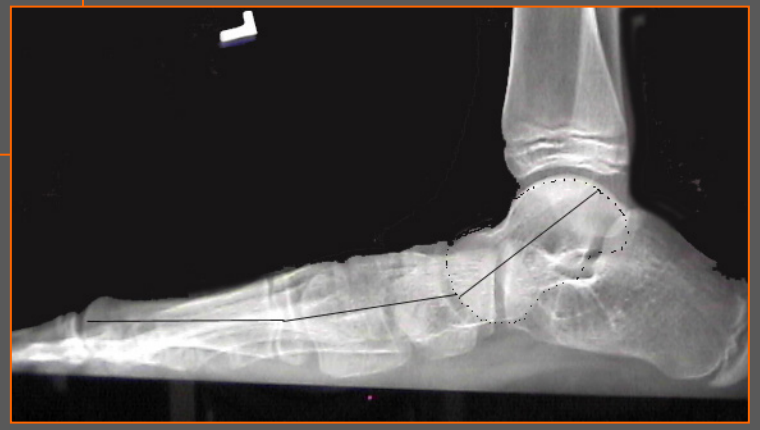
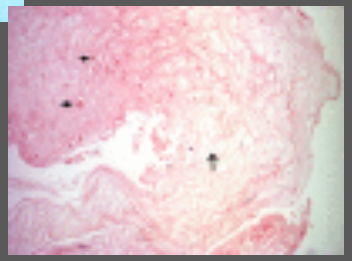


progression of TP dysfunction

- *midfoot rotation*
- *peritalar subluxation*
- *collapse of the medial arch*
- *shortening of the lateral column*

Tendinosis

- Histopathology
  - Degenerative tendinosis without inflammation



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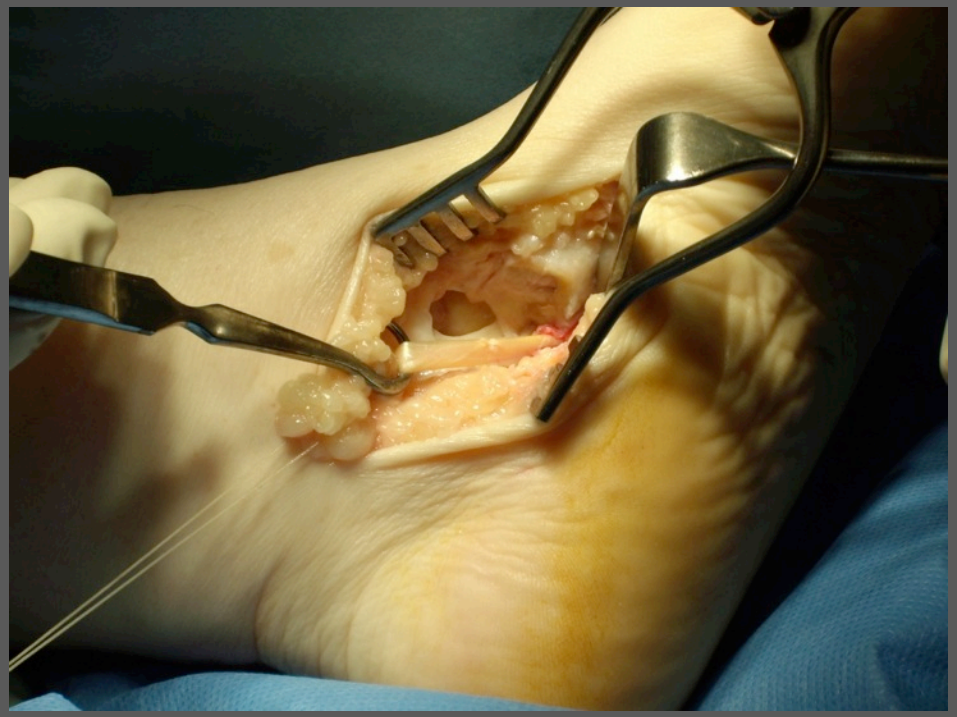

pathoanatomic findings of medial structures
(spring and deltoid ligament)

attenuation - elongation – tear

Failure of these structures necessary to create deformity

presentation

- pain on exercise
- rest pain - cramps
- swelling
- midfoot arch pain (tension)
- lateral pain (impingement)
- loss of tendon function
- “shape of the foot” changes

examination

1. valgus heel
2. lowering of the medial longitudinal foot arch
3. “too many toes” sign
4. “medial process”

examination

- Single heel raise:
- poor/ absent evidence of heel varus at heel rise

- Isolate Tib Post:
- weak/ absent PTT function inability to supinate and lock the foot during propulsion

examination

Bilateral flat foot
Valgus of the hind foot
Right TP insuffisiency
Heel rise sign +

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examination

check Achilles tendon knee extended vs flexed

Silverskjöld (1923)

examination

S.T. neutral

pronation unlocks midtarsal joints and allows forefoot dorsiflexion

examination

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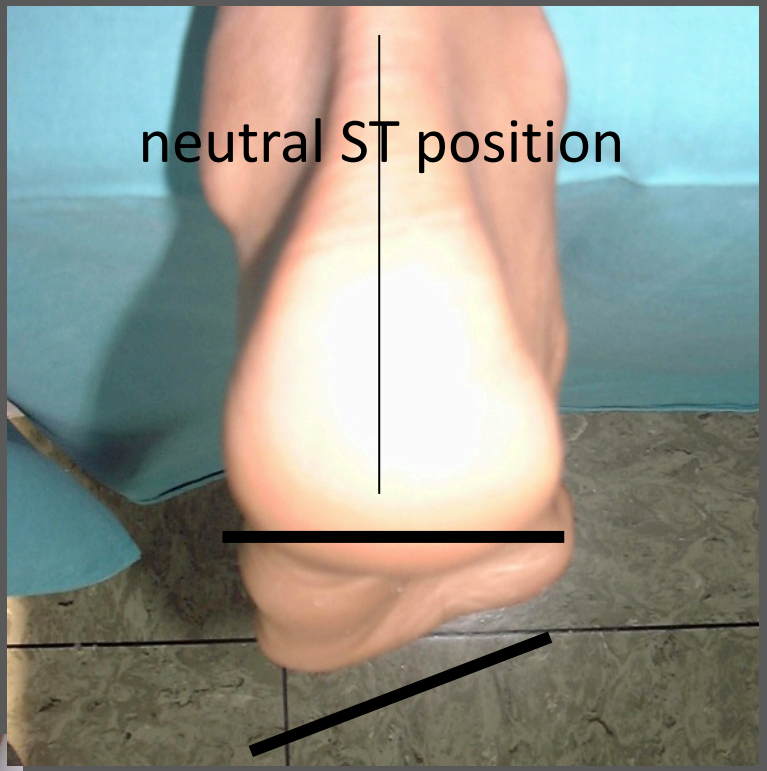
Check hindfoot to forefoot alignment
(Coleman block test)

Correct valgus heel to neutral



flexible vs fixed forefoot abduction and supination

examination

(Coleman block test)

examination

Jack's test: flexible vs fixed flatfoot

conventional Xrays

- Dorso-plantar view
  - Abduction
  - Talus head coverage

WB comparative

conventional Xrays

WB comparative

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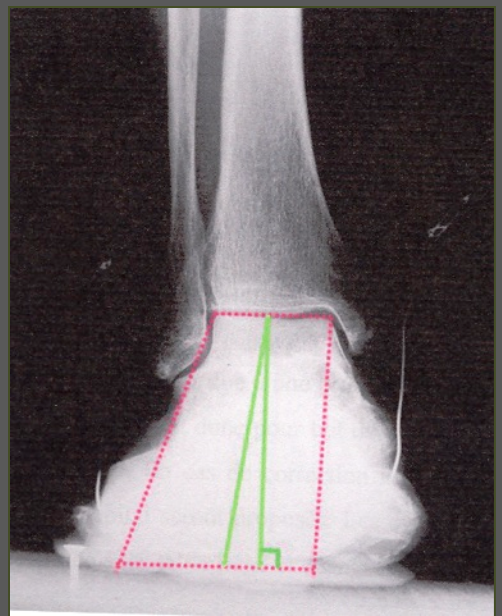
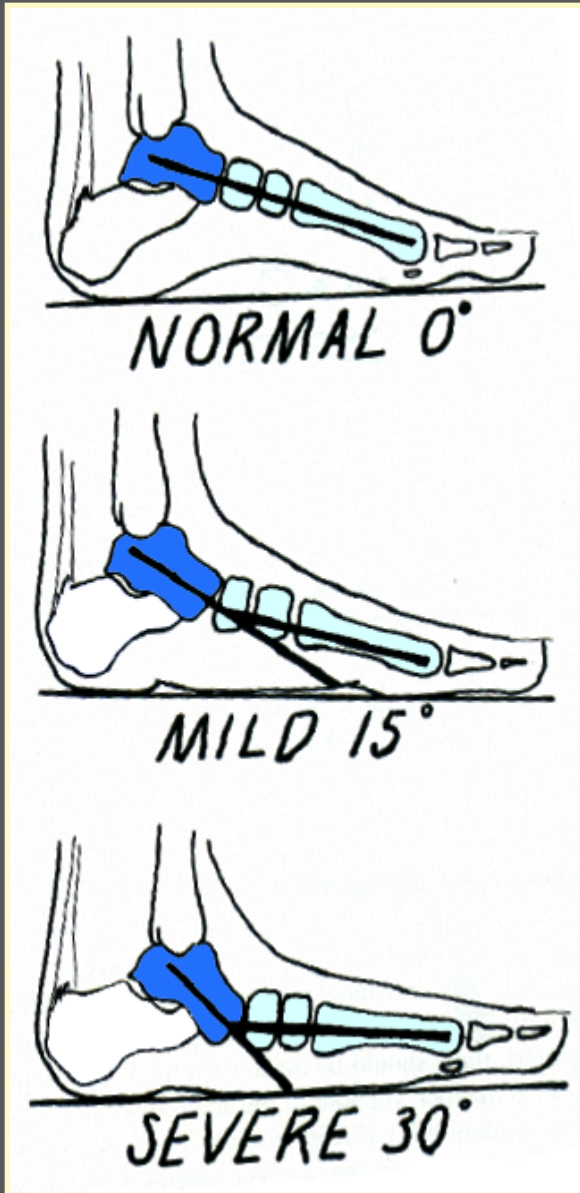
- AP view
  - Djian angle
  - Meary line
- Meary/Salzman view
  Valgus at the hindfoot



Lateral Tarso-metatarsal angle



Meary line, 1967
Reproducible
Various deformities
Correlates well with clinical features

Bordelon RL: Foot & Ankle 1:143, 1980.

ultrasound

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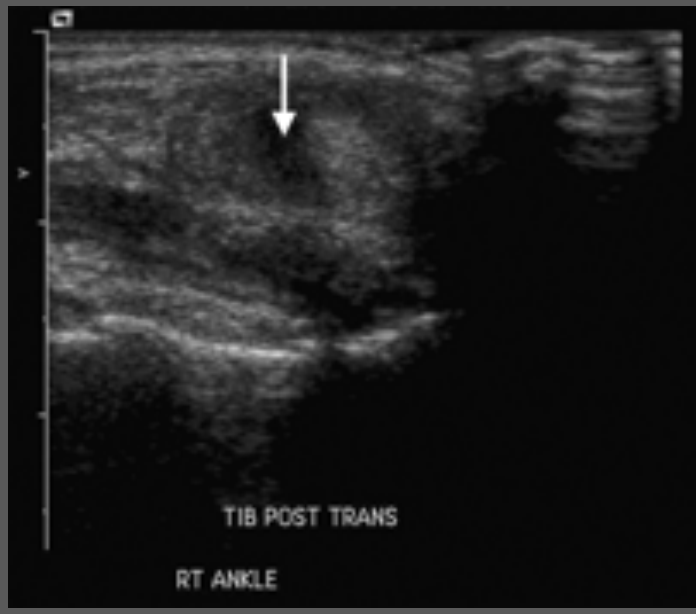
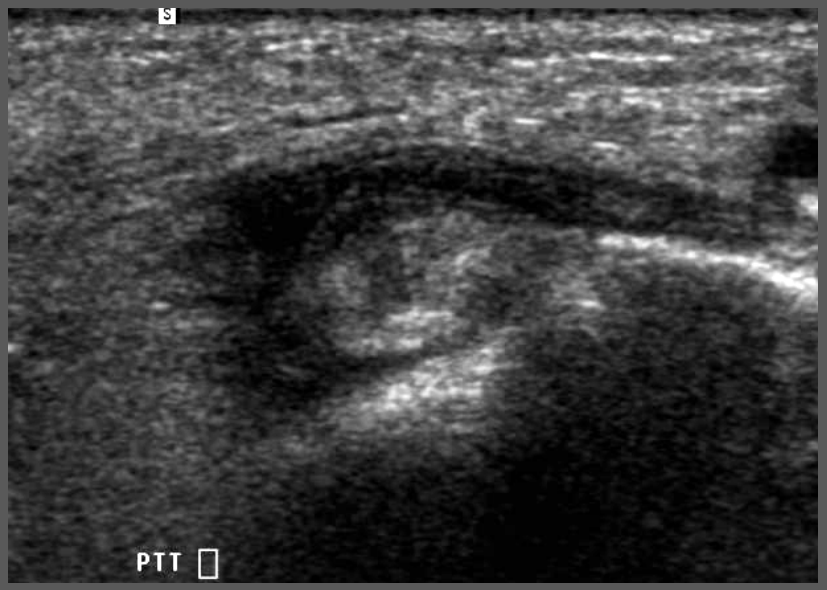
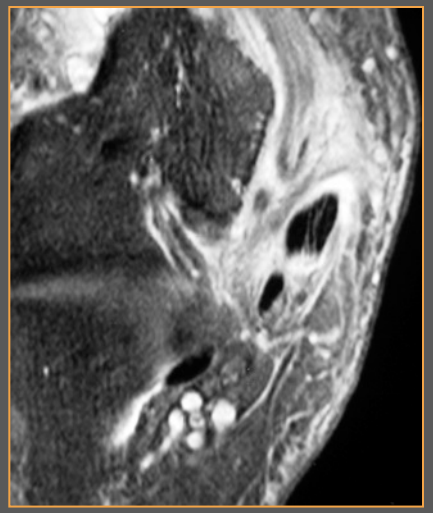
Tibialis posterior tendon

- Synovitis
- Tendinopathy
- Rupture





MRI



- TP Tendinopathy
- Other tendons pathology
- The deltoid and, to some extent, the spring ligament
- Intra-articular lesions in the ankle and other joints
- Bone oedema, sometimes seen in the lateral calcaneum in lateral impingment, or in the navicular

MRI

Conti et al (1992) classified the MR appearances:

- Type 1: longitudinal splits without tendinopathy
- Type 2: swelling and degeneration
- Type 3: replacement of tendon substance with scar
- MR appearances better guide to outcome than surgical findings.
  - Tendon transfers were significantly more successful in type 1 tendons, but tendons graded type 1 by the surgeon were graded type 2 by MR in 10/17 patients - intra-operative assessment may lead to inappropriate choice of treatment.

Tib Post Synovitis & Bone oedema

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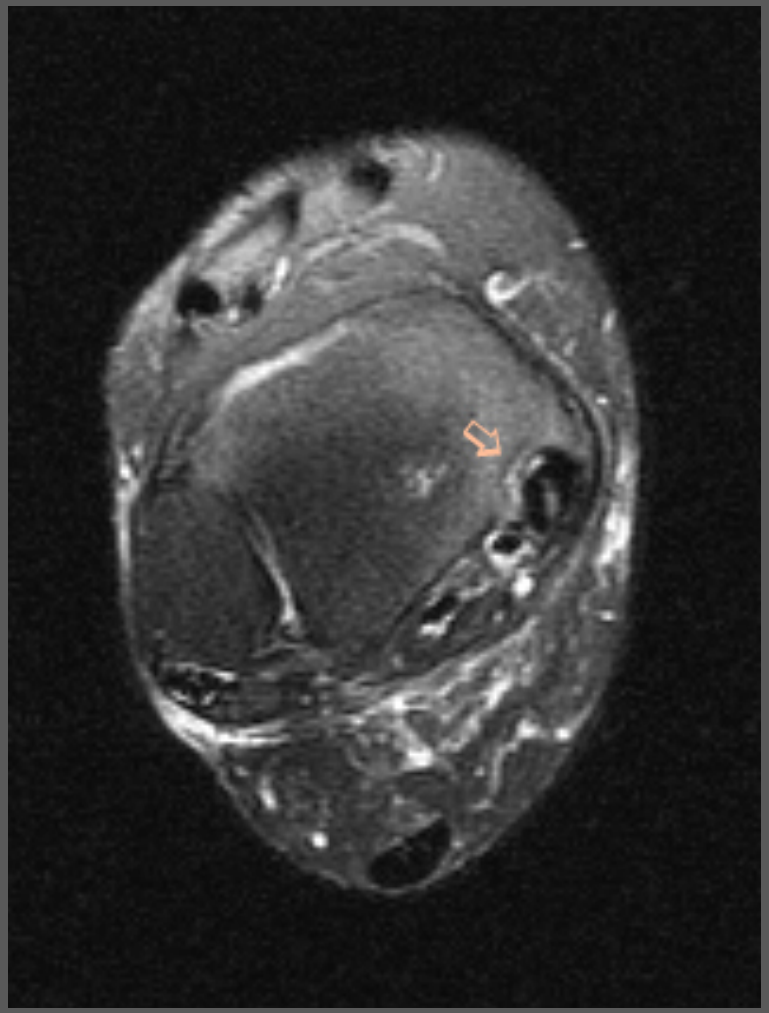
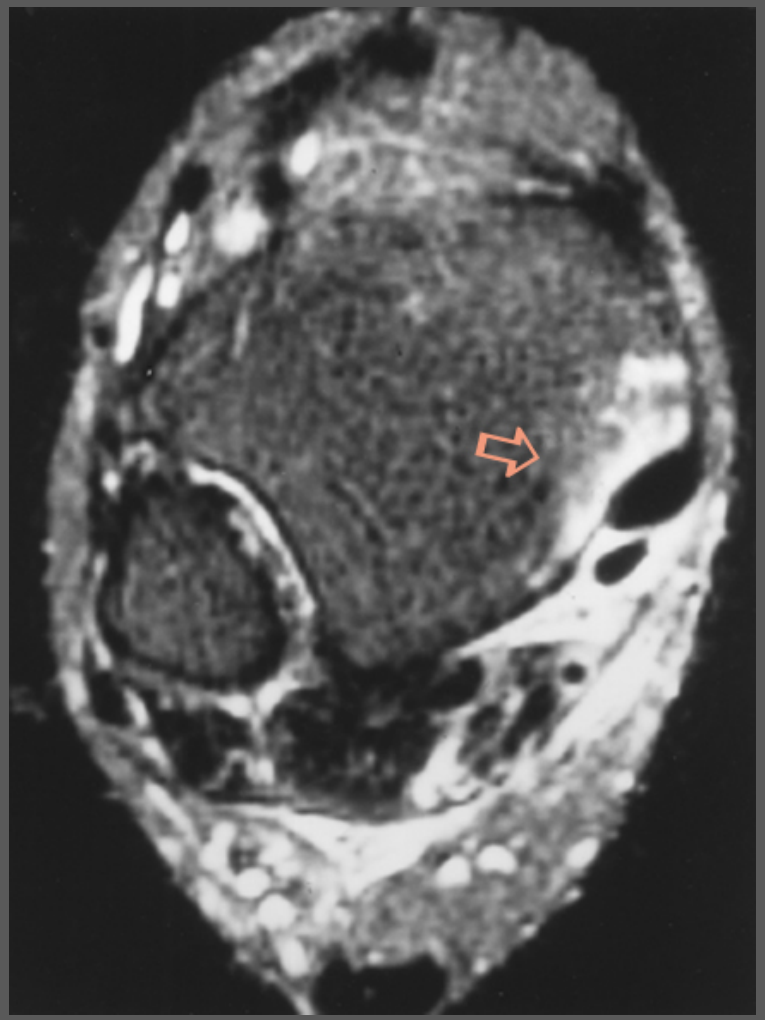
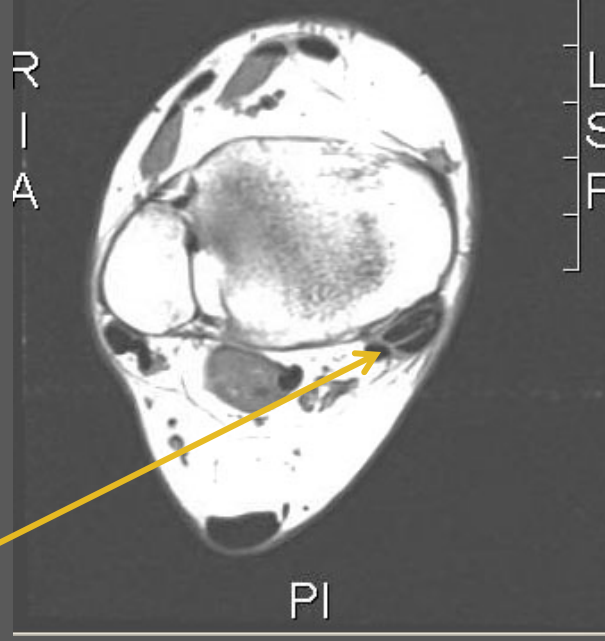
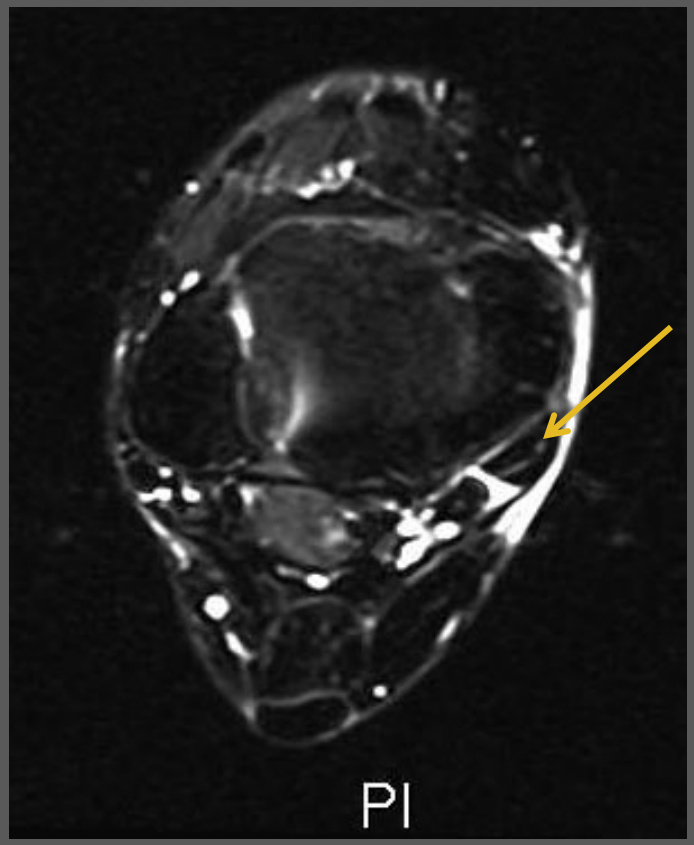




Tib Post Split





Tib post split

Tendon sheath effusion

Tib Post Tear

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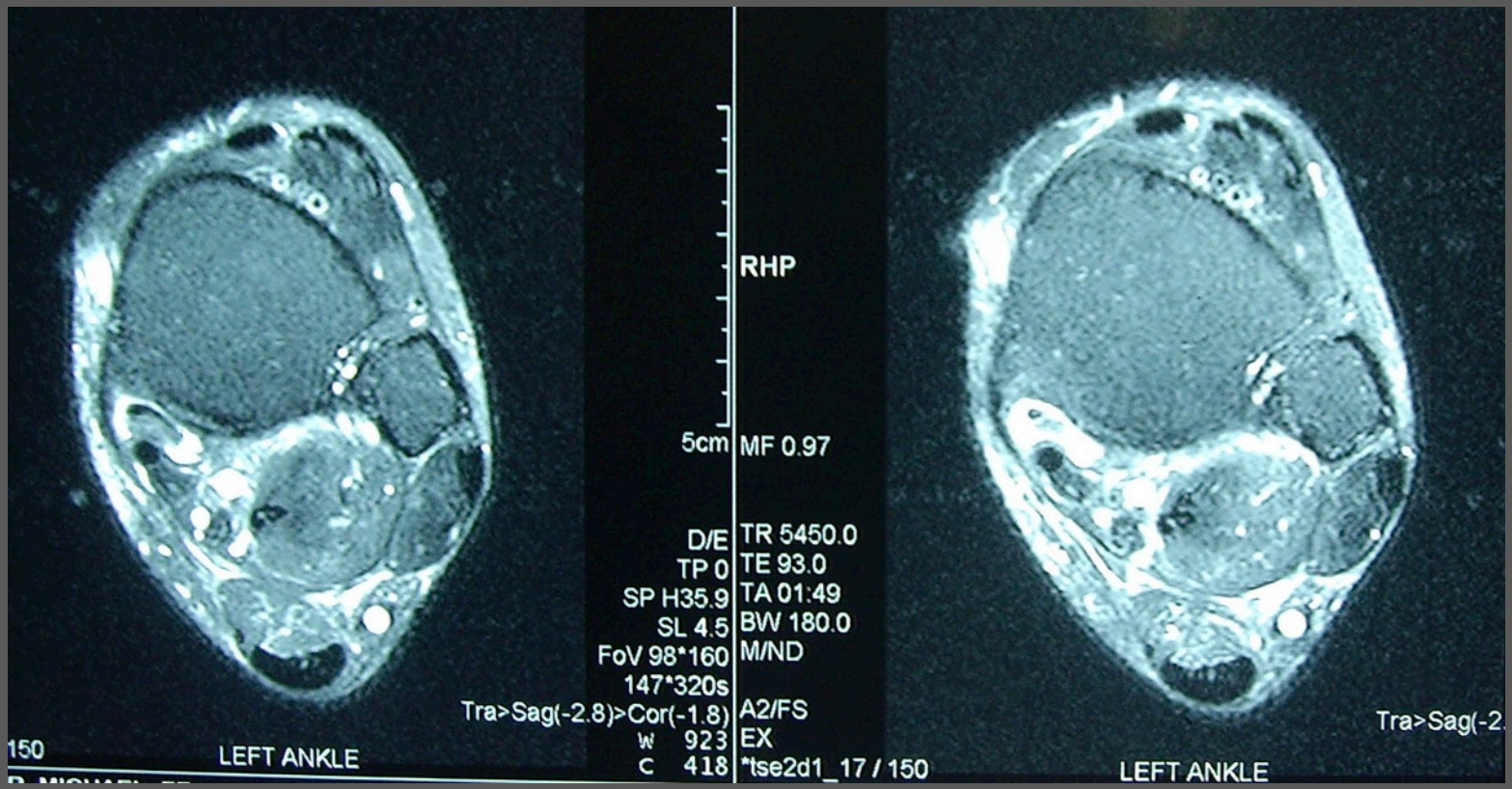

Staging – Bluman classification 2007

Replaces Johnson and Storm 1989

Stage	Substage	Clinical findings	Tendon
I	A,B	Normal anatomy, tenderness along PTT	Tenosynovitis
	C	Slight HF valgus	
II	A1	Reversible HF valgus, flexible forefoot varus	Tendon elongation
	A2	Reversible HF valgus, fixed forefoot varus	
	B	Reversible HF valgus, forefoot abduction	
	C	Reversible HF valgus, fixed forefoot varus, first ray dorsiflexion with HF reduction	

HF = hindfoot

Staging – Bluman classification 2007

Stage	Substage	Clinical findings	Tendon
III	A	Rigid hindfoot valgus, pain in sinus tarsi	Elongation or disruption
	B	Rigid hindfoot valgus, forefoot abduction, pain in sinus tarsi	
IV	A	Reversible tibiotalar valgus, HF valgus	
	B	Rigis tibiotalar valgus, HF valgus	

Conservative Treatment

All grades of TPTD…

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Stabilization and control of affected joints with orthoses can provide the patient with a decreased level of pain and an increased level of function.

The orthotic design should be acceptable to the patient's lifestyle to ensure compliance.

Conservative treatment

mild flexible deformities

supportive semirigid moulded foot orthoses
for stabilization and control of affected joints

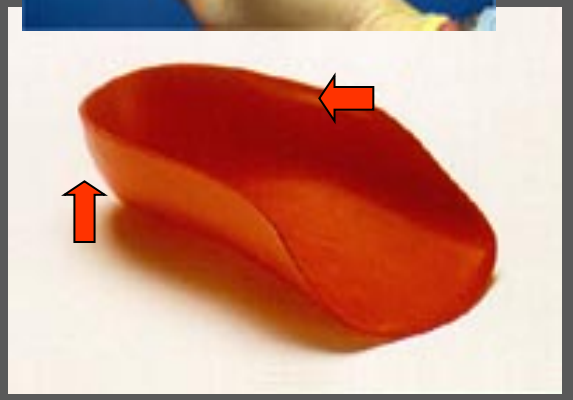
- stretching of the Achilles (gastroc)
- strengthening of the posterior tibial tendon

Conservative treatment

Severe correctable deformities

Rigid/semirigid orthoses
basic mold
made out of polypropylene

posted at rearfoot, forefoot or both, depending on hindfoot – forefoot relationships evaluated with the subtalar joint in neutral position



Severe correctable deformities not controlled by foot orthoses

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Ankle Foot Orthosis hinged - not hinged (Richie Brace)

well-fitted, custom-moulded leather and polypropylene orthosis effective for relieving symptoms

Surgical treatment

- Symptomatic patients not controlled by conservative treatment
- Clear progression of the pathology

Surgical treatment

Flexible vs Rigid

1. Tendon repair \ transfer
2. Tendon lengthening & ligamentous repair
3. Osteotomies - arthroereisis
4. Arthrodesis

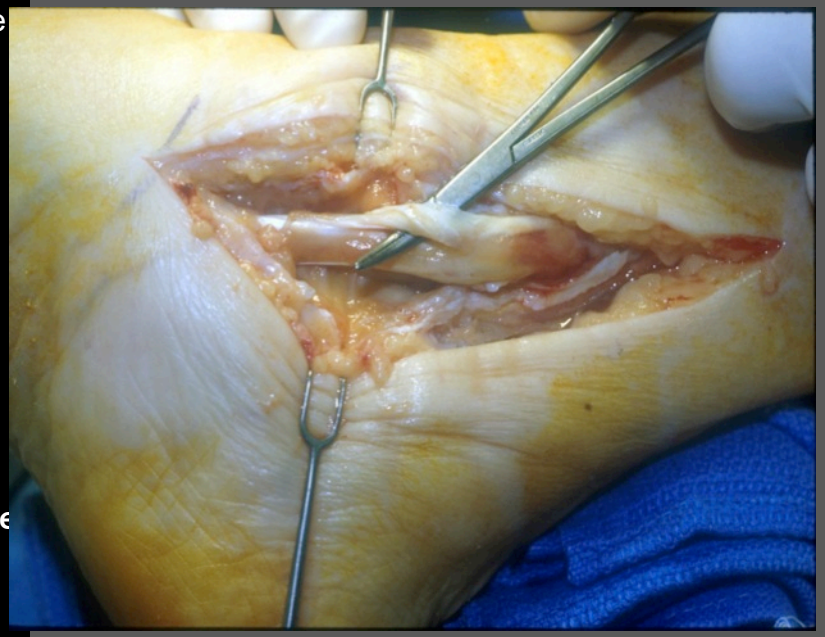
Most frequently **bone and soft tissue** procedures combined

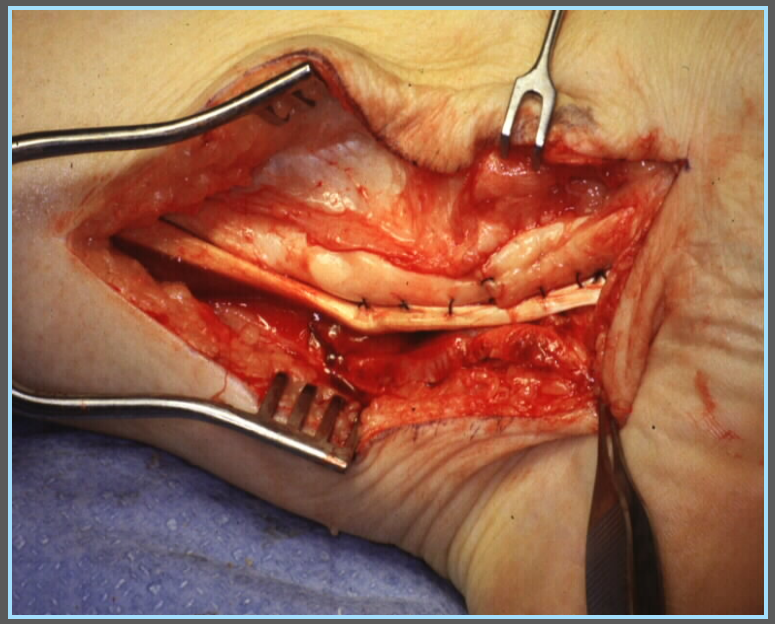
Soft tissues procedures

- *mild elongated PTT*

- debridment
- detached and given a proper tension
- augmented with a side to side

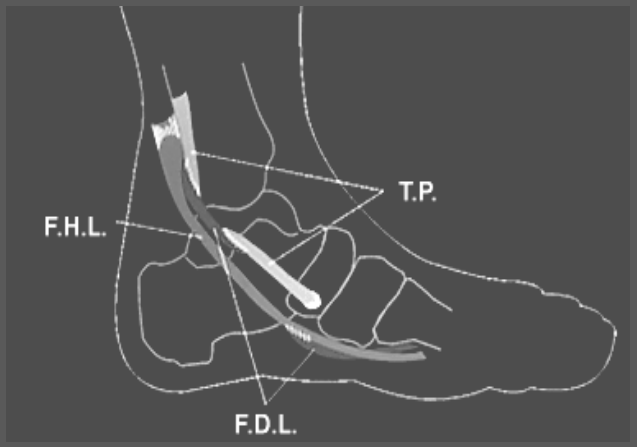
FDL tenodesis





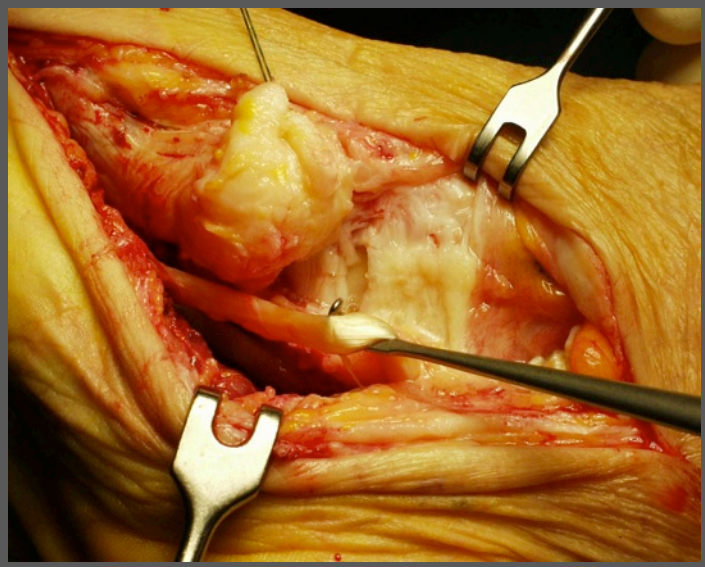
Soft tissues procedures

- *PTT degenerative elongated or ruptured*



FDL transfer into navicular

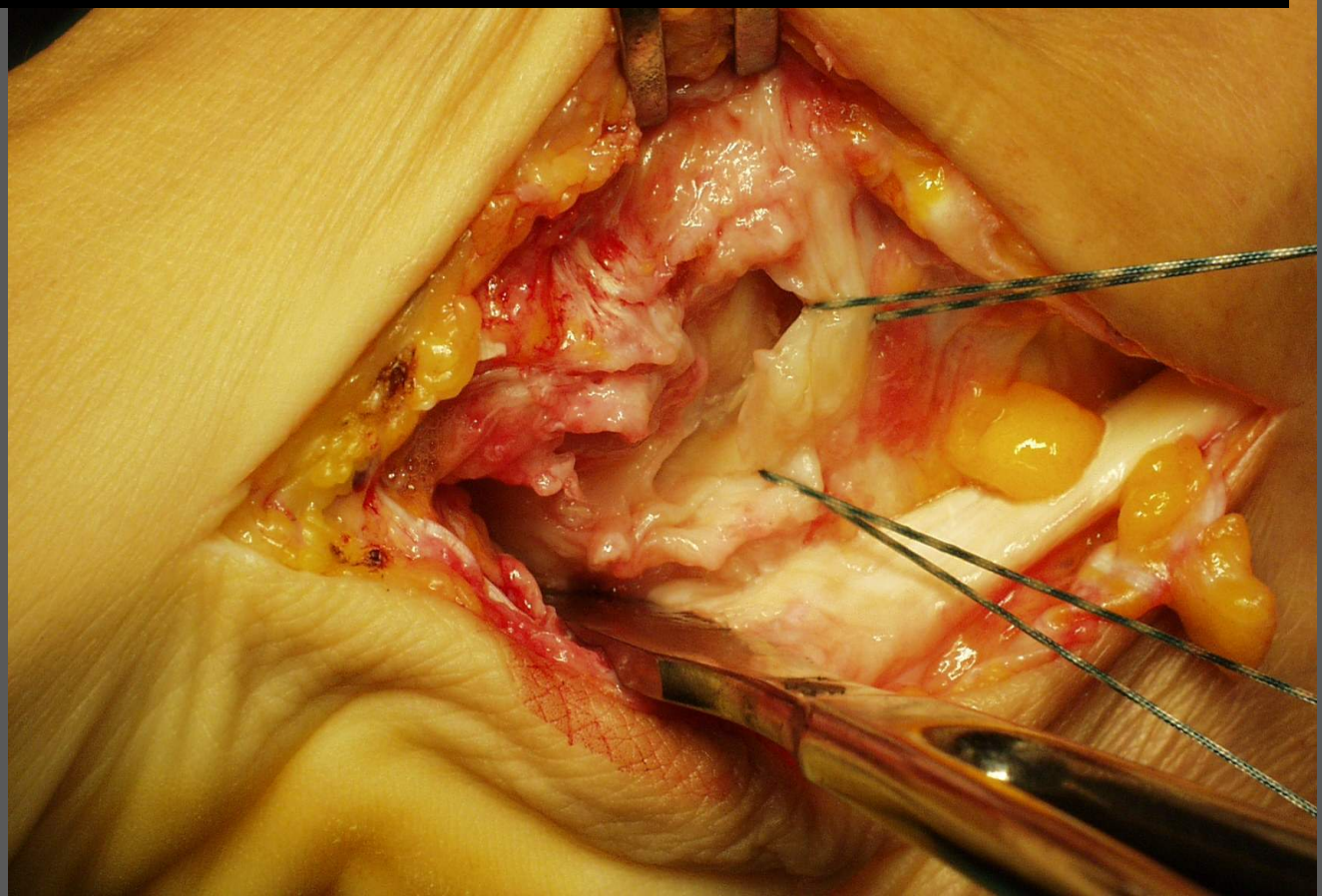
- PT and FDL like-phase tendons
- FDL most expendable of all flexor tendons



Soft tissues procedures

- *medial structures*

to be investigated and repaired
- spring lig.
- deltoid lig.



Soft tissues procedures

- *Achilles tendon lenghtening*

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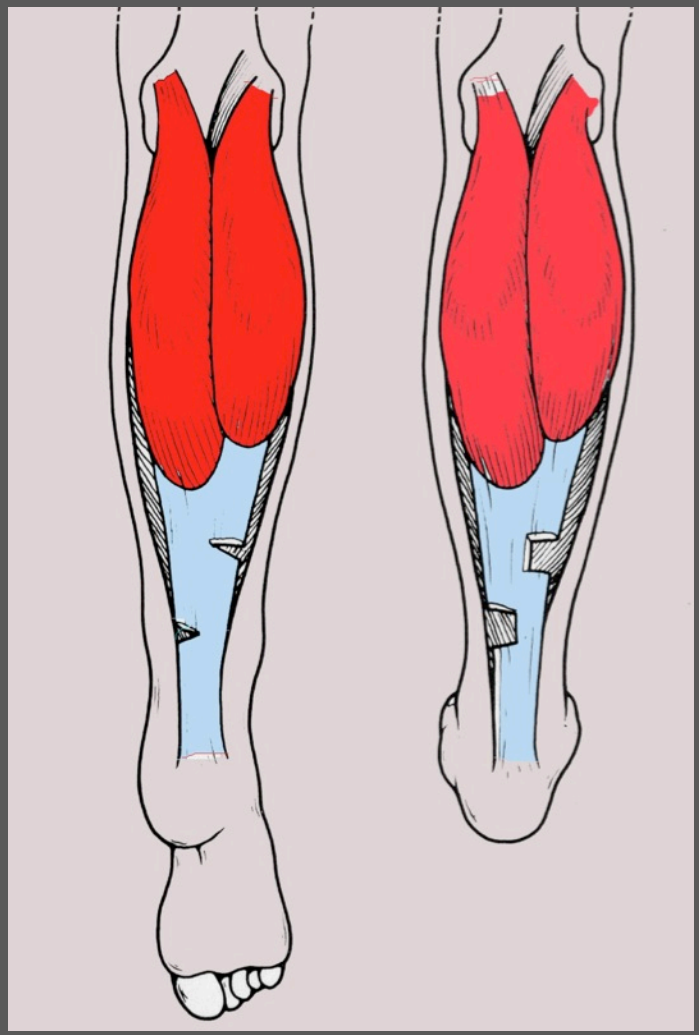
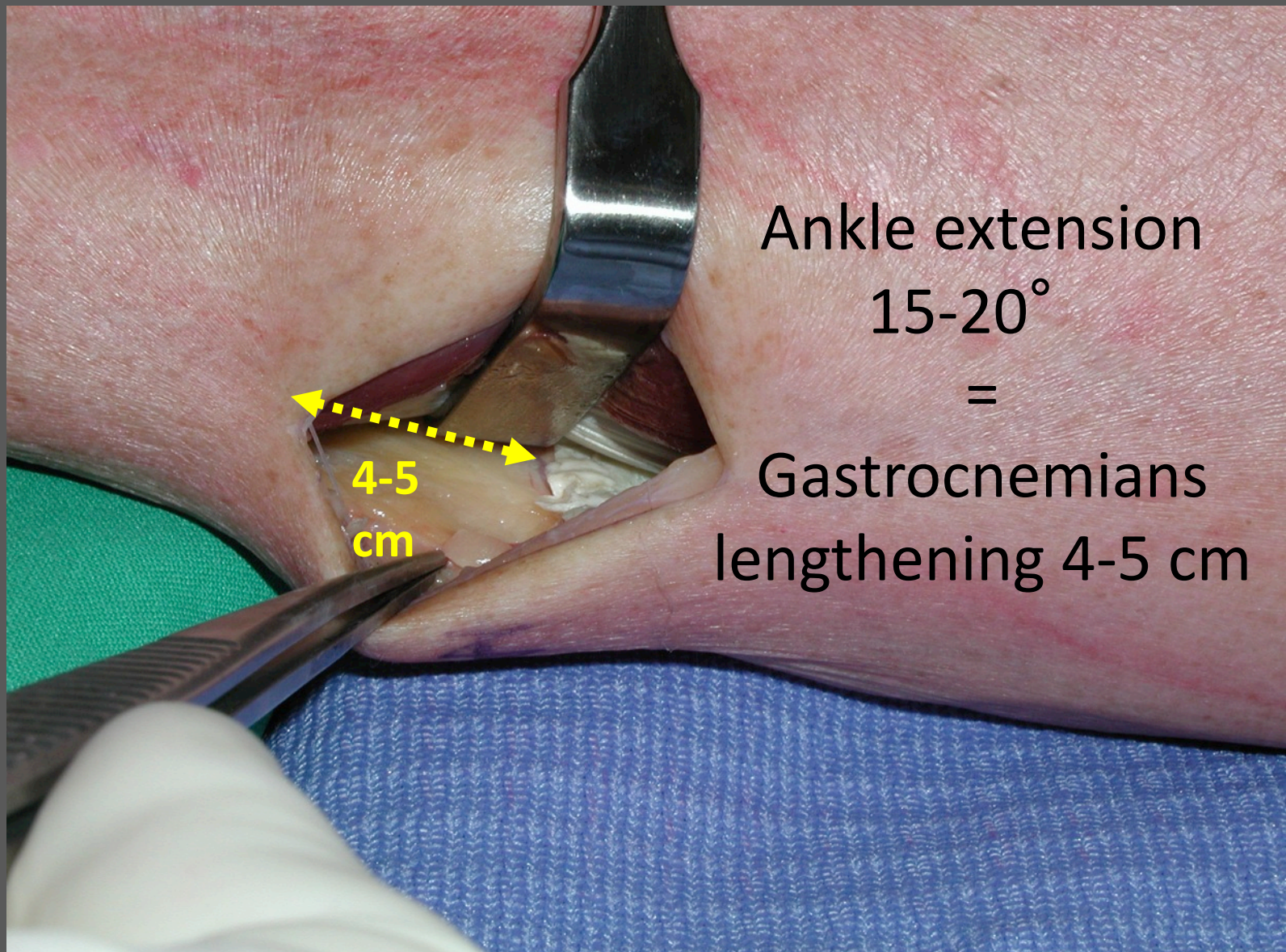
1) gold standard: percutaneous TA triceps fascia section

2) open lengthening in major lengthening



• Gastrocnemius lenghtening



Flexible Deformities

Isolated repair of tendons and ligaments

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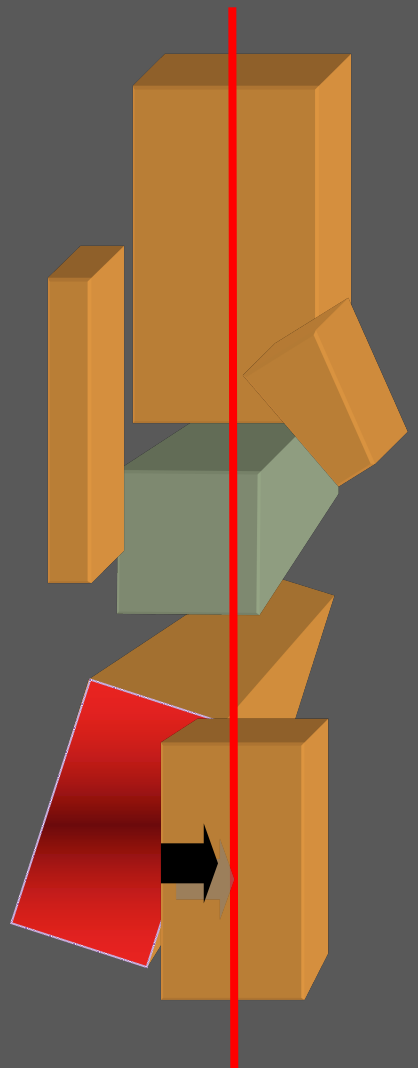
demonstrates:

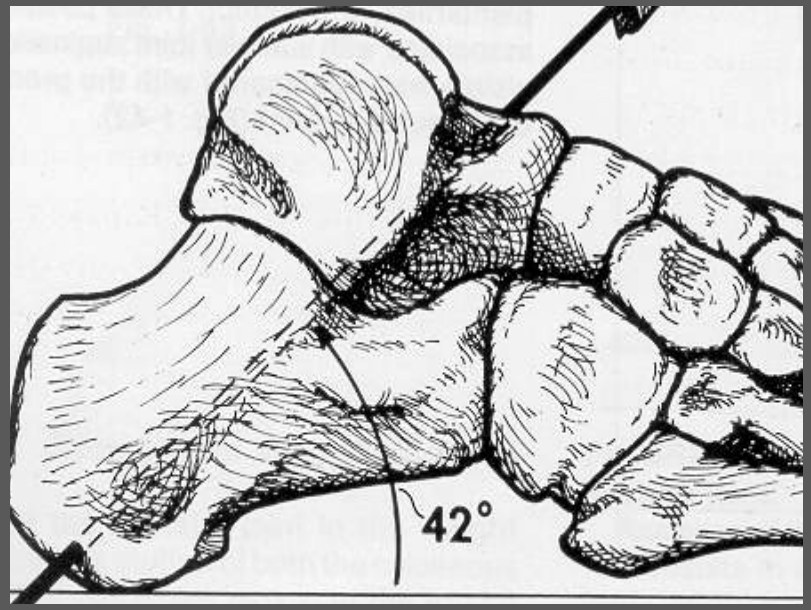
- Insufficient correction of bone misalignment
- Loss of primary correction

calcaneal osteotomies and arthroereisis revealed adequate mechanical control of deforming forces



Which calcaneal osteotomy ?

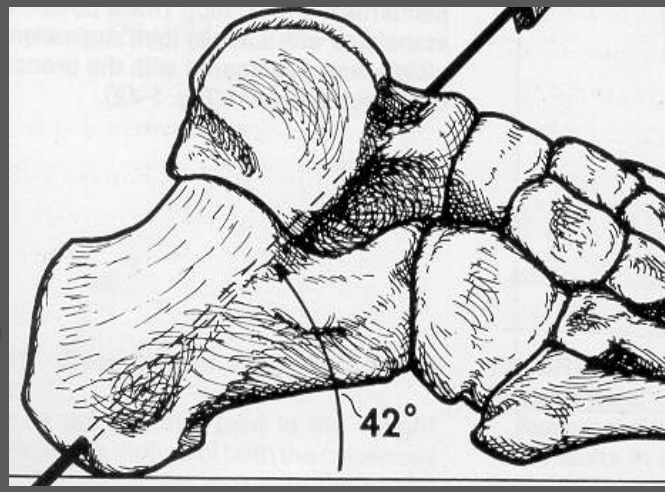
Peritalar complex compensation occurs in planes related to the ST joint axis orientation



Reference
42° to the transverse plane
16° to the longitudinal plane

Large individual variations of the S.T. axis orientation are frequent and vary the planes in which the peritalar complex may compensate

The same pathomechanics generate different clinical conditions with different therapeutic solutions

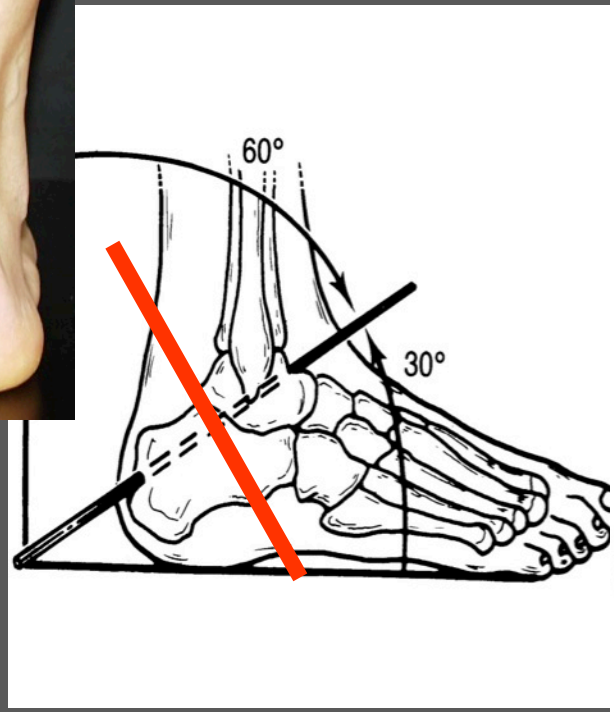


planar dominance of the deformity

1. compensation mainly in the frontal plane

dominant **hindfoot valgus**

flexible hyperpronated



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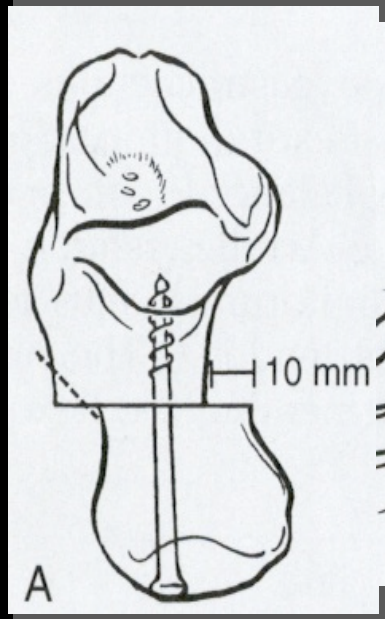
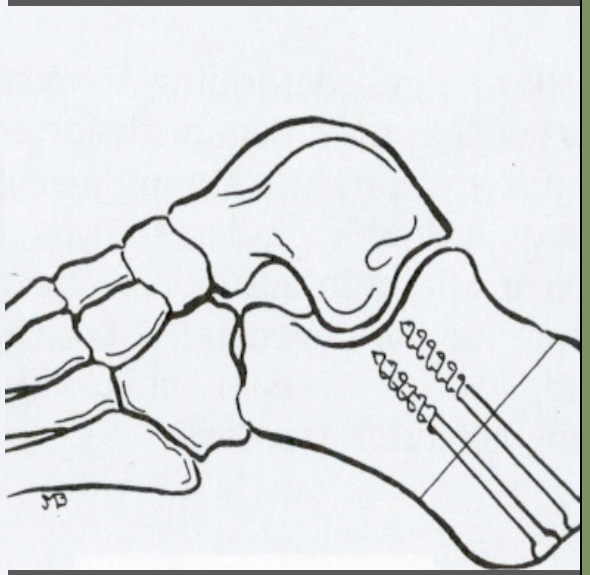
Flexible hyperpronated foot with dominant hindfoot valgus





→ medial displacement calcaneal osteotomy (MDCO) works in the frontal plane (Gleich 1893, Myerson 1993)

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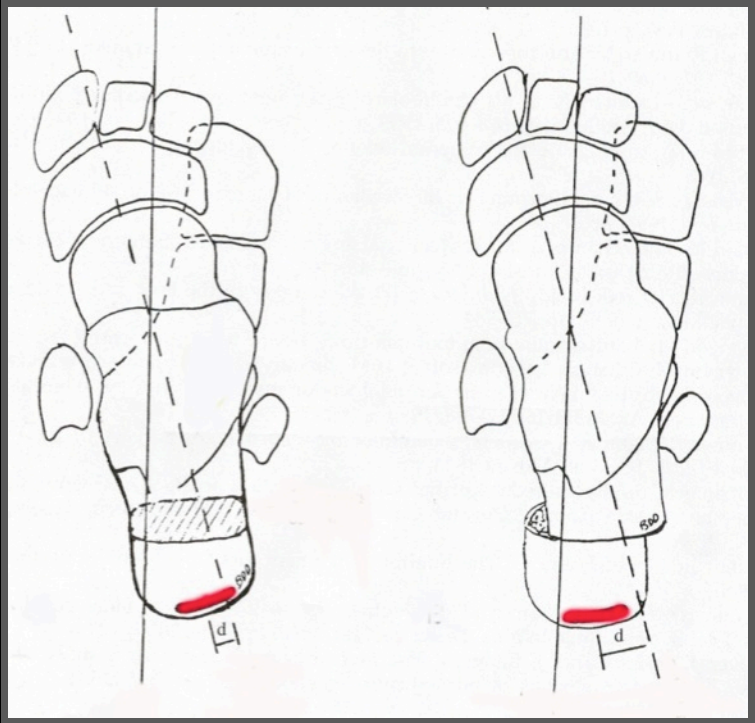
Flexible hyperpronated foot with dominant hindfoot valgus

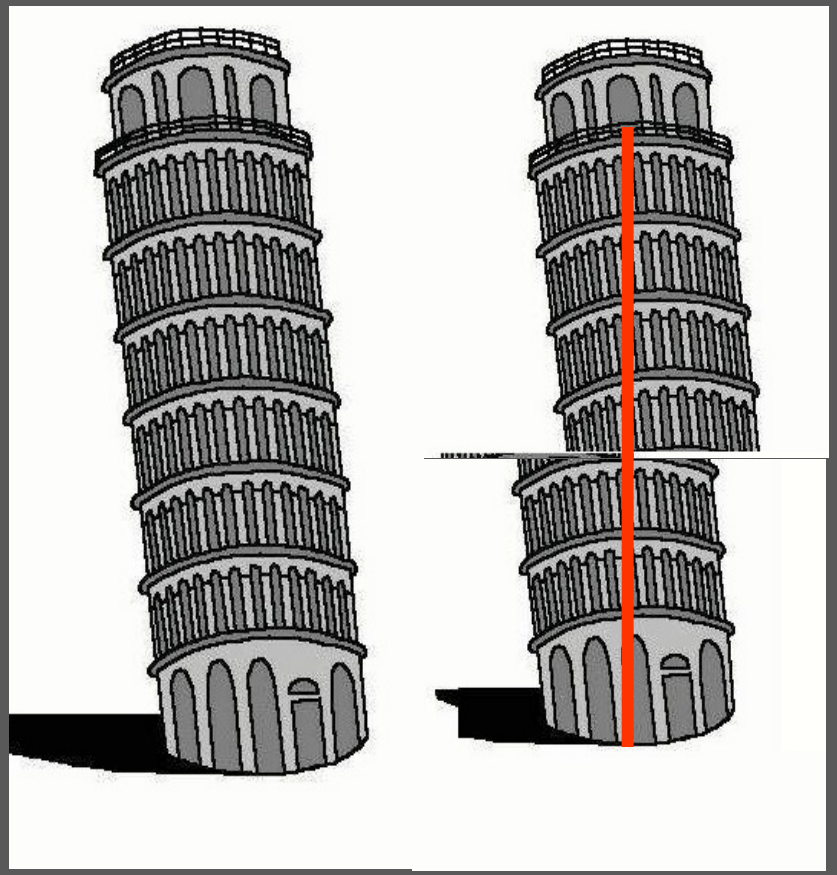
→ medial displacement calcaneal osteotomy (MDCO) works in the frontal plane (Gleich 1893, Myerson 1993)

MDCO rationale

Reduces the gastrocnemius valgus moment

Improves the mechanical axis of the lower limb





Achilles tendon insertion moves medially

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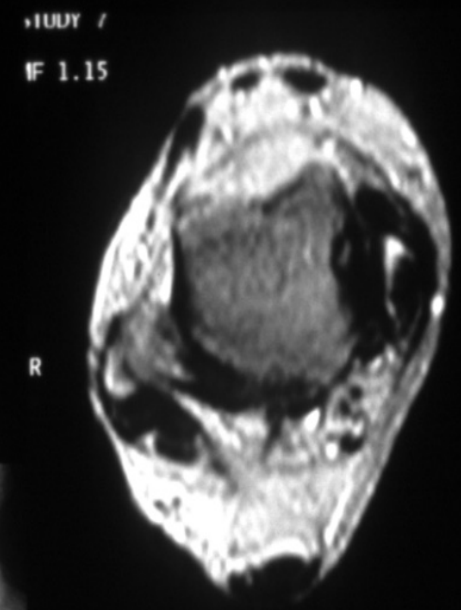
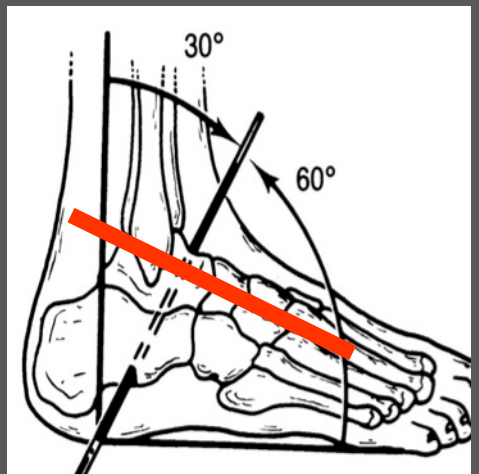
T.P.T.
synovitis
and degeneration
97137

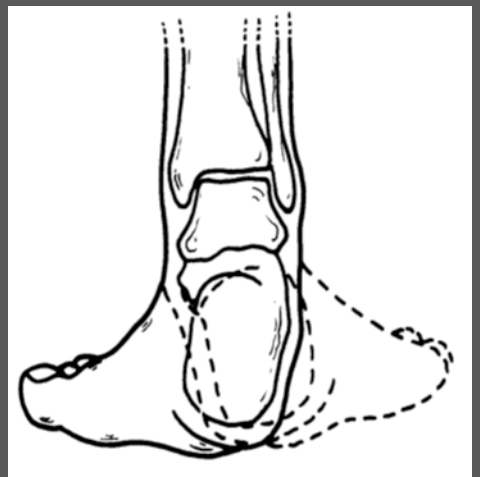


97137 3 YEARS .

2. compensation mainly in the transverse plane

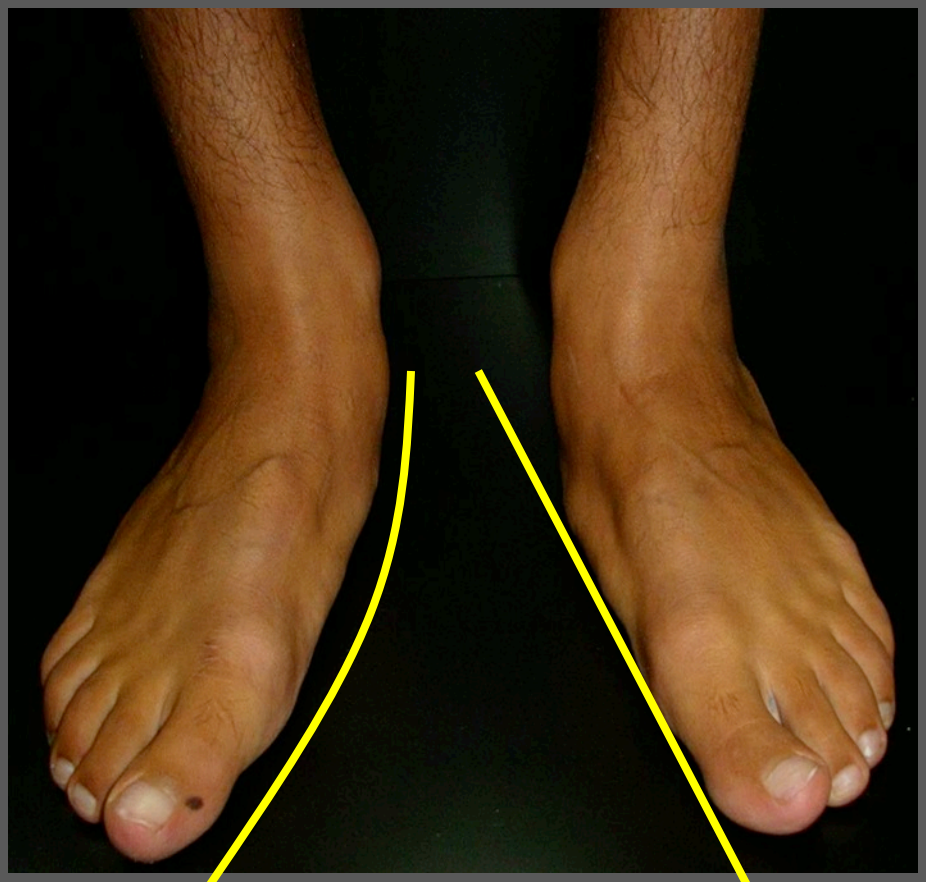
dominant **forefoot abduction**
flexible hyperpronated

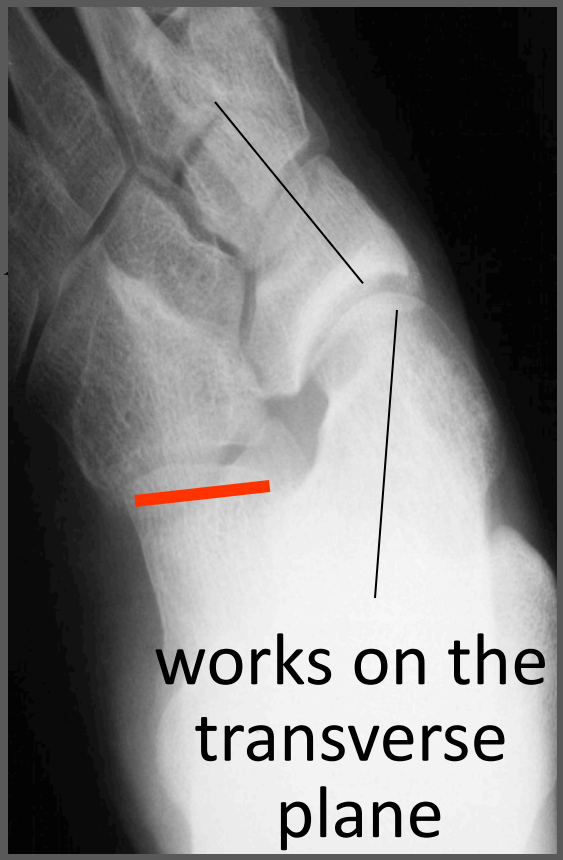




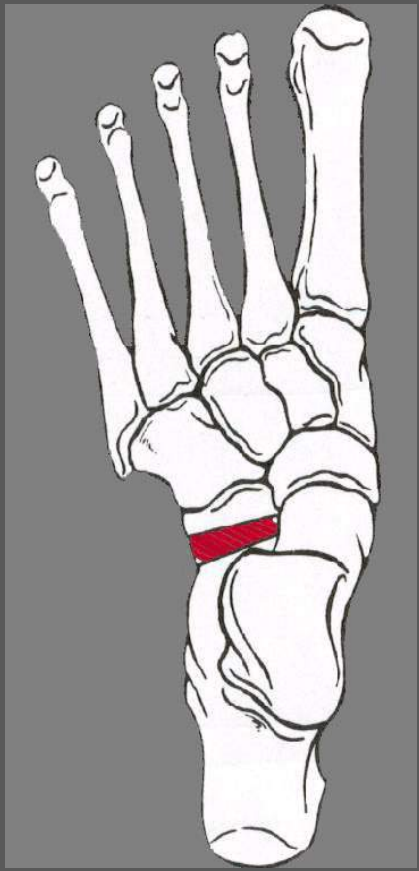
Flexible hyperpronated foot with dominant forefoot abductus

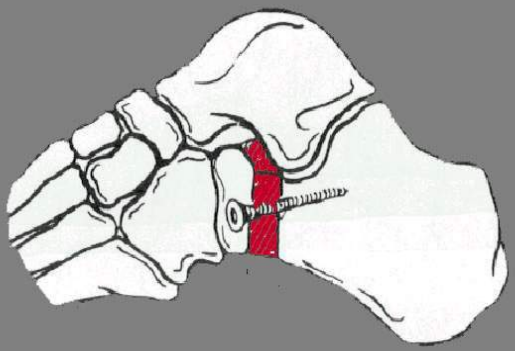
→ osteotomy of the anterior calcaneal tuberosity "lateral column lengthening" (Evans, 1975)

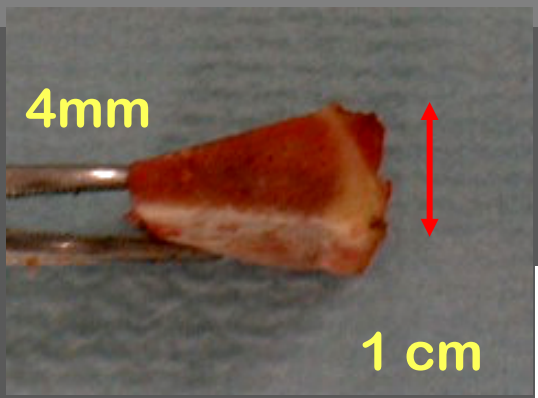


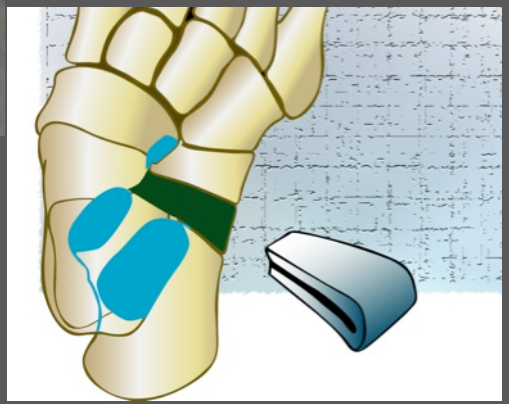


Osteotomy 10 mm from CC joint open wedge - graft - internal fixation combined with medial reconstruction









Rationale

- *correction of midfoot abduction and supination*
- *to increase talus head coverage*
- *to decrease lateral fibular impingment*
- *restricts rotation and further subluxation at TN joint*

double threaded screw

Rationale

- *correction of midfoot abduction and supination*
- *to increase talus head coverage*
- *to decrease lateral fibular impingment*
- *restricts rotation and further subluxation at TN joint*

plate

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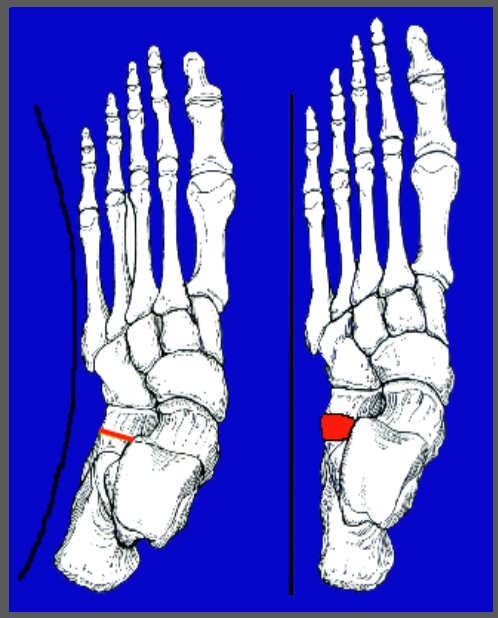
staples



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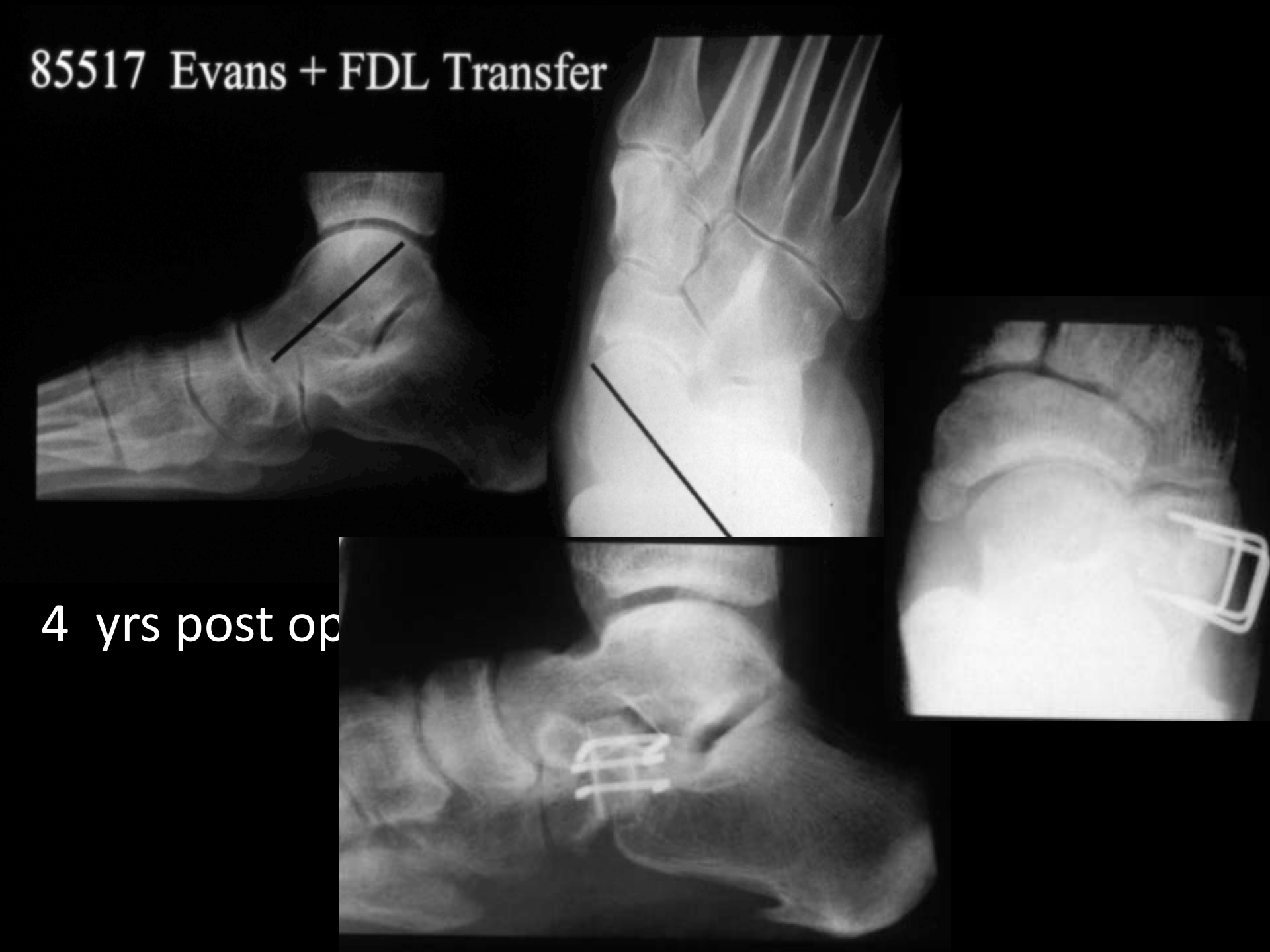
85517 Evans + FDL Transfer
4 yrs post op

- increases the intra-articular pressure in the calcaneo-cuboid joint
  (Cooper PS, Foot Ankle Int, 1997)
- Calcaneo-cuboid joint distraction arthrodesis may be preferable in the old or obese patient
  (slightly greater loss of motion)

- increases the intra-articular pressure in the calcaneo-cuboid joint
  (Cooper PS, Foot Ankle Int, 1997)

- Can be associated with a calcaneal medial sliding osteotomy
  (Pomeroy JC, Foot Ankle Int, 1997)

Subtalar Arthroereisis

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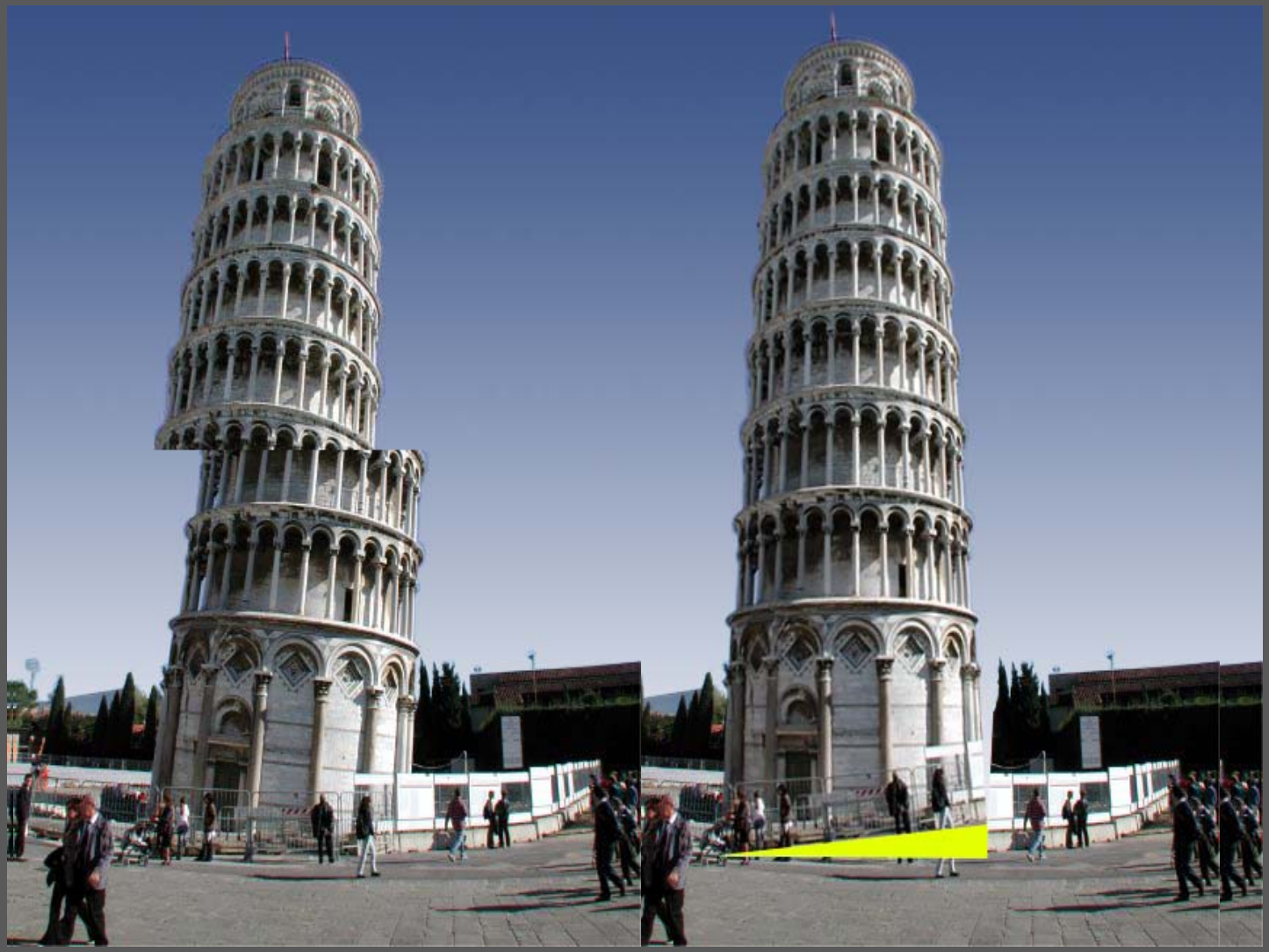

But no published results with adults acquired Tib post insufficiency

Subtalar Arthroereisis

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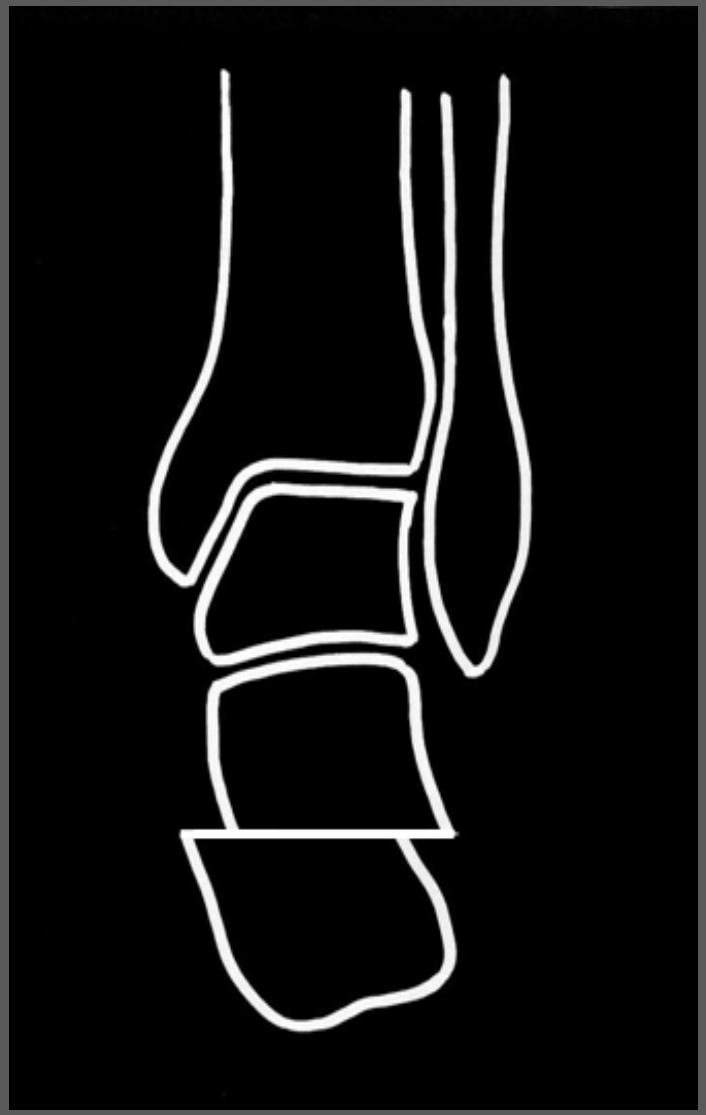

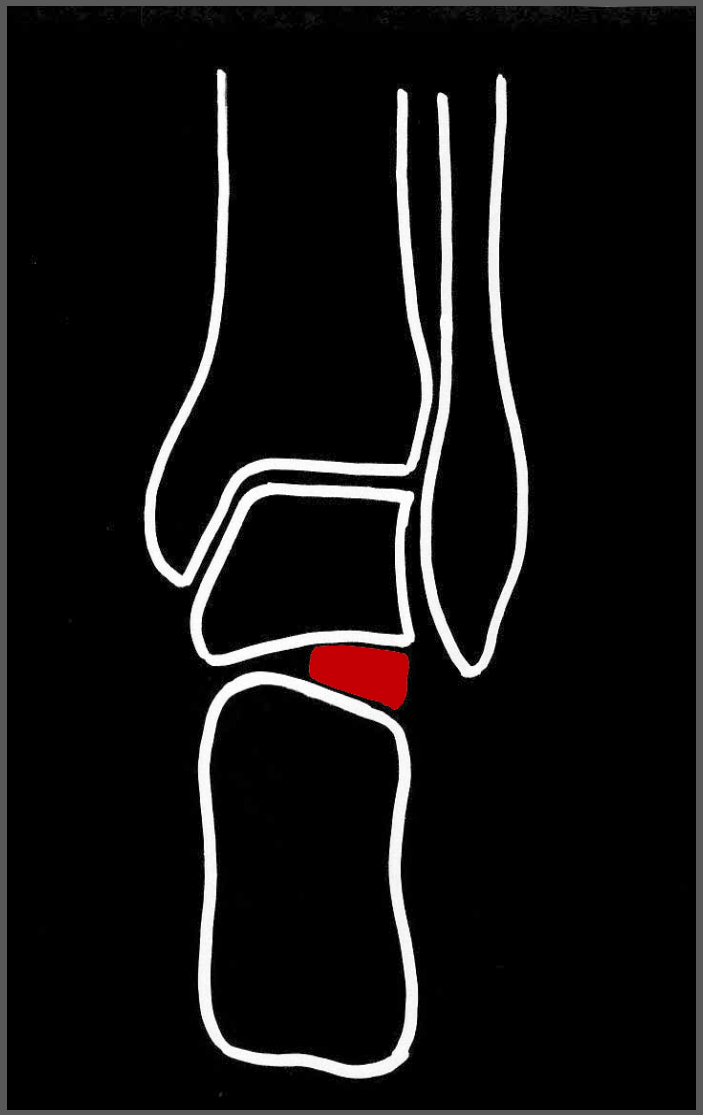

Subtalar Arthroereisis

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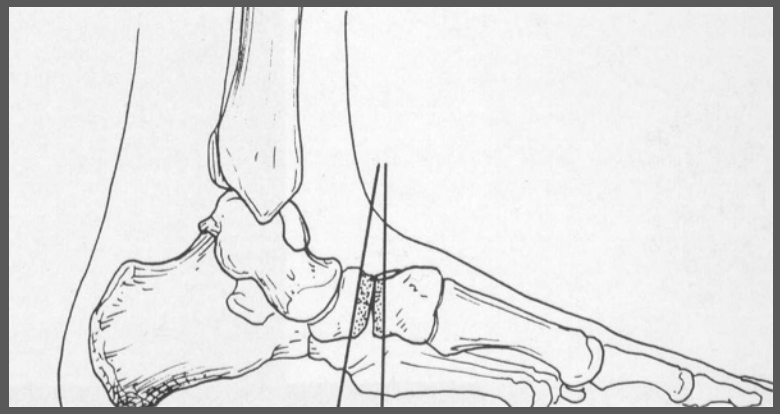
But no published results with adults acquired Tib post insufficiency

others

residual fixed supinated forefoot
- residual medial column instability
→selective medial arch
arthrodesis - osteotomies



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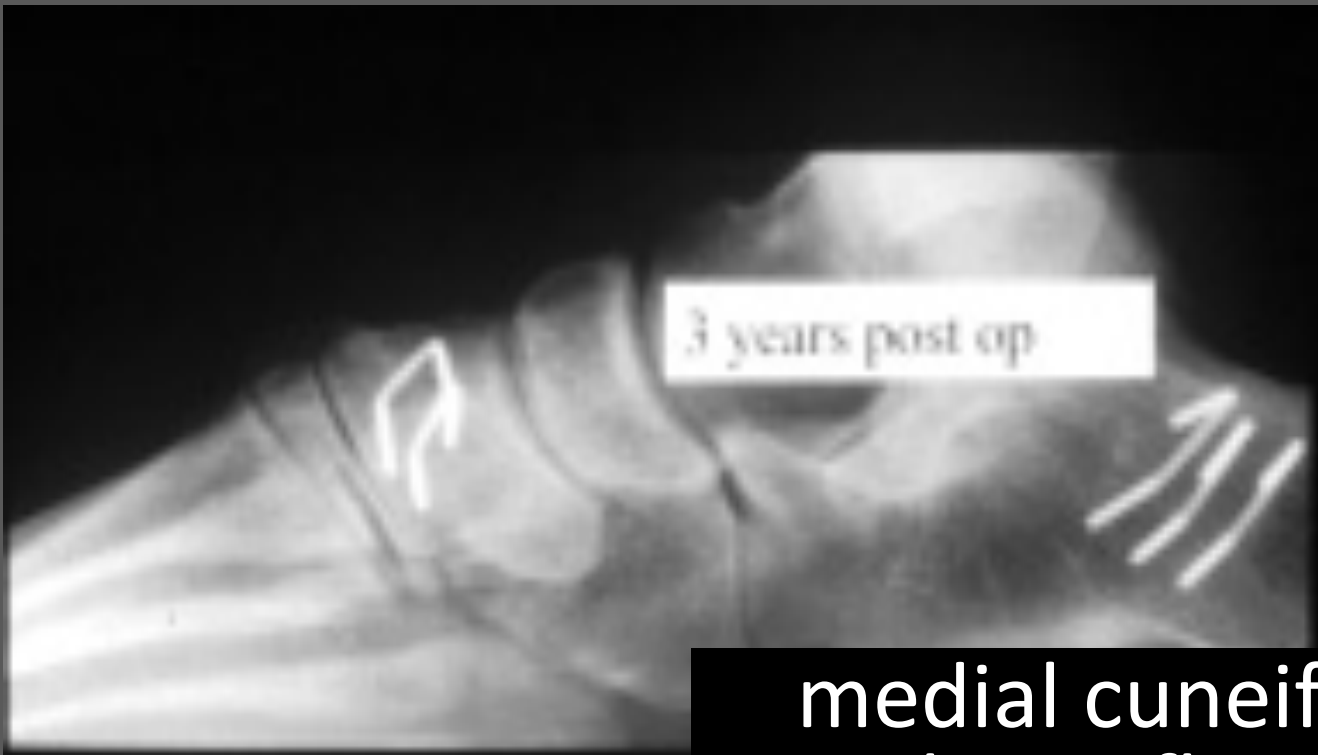
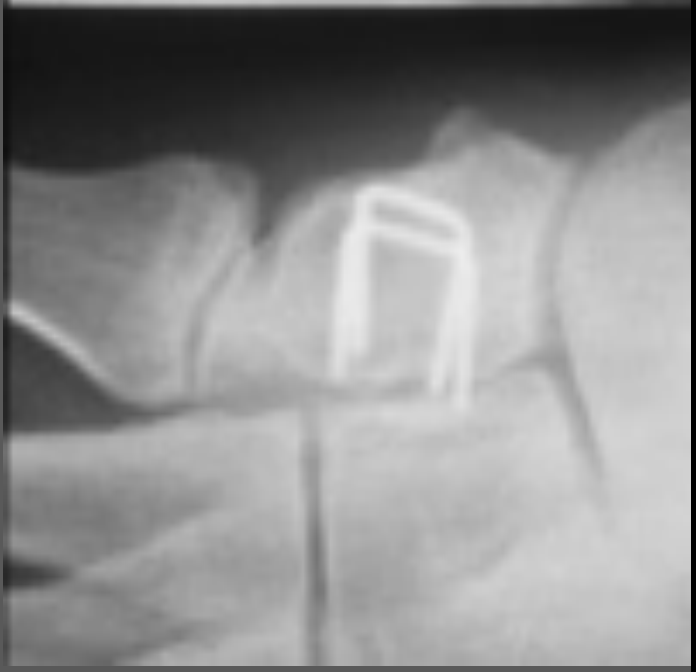




medial cuneiform plantarflexion osteotomy associated with calcaneal osteotomy

=

Cotton Osteotomy

Triple arthrodesis

In case of fixed deformities and DJD
whatever the etiology
provides a plantigrade reasonable painless foot

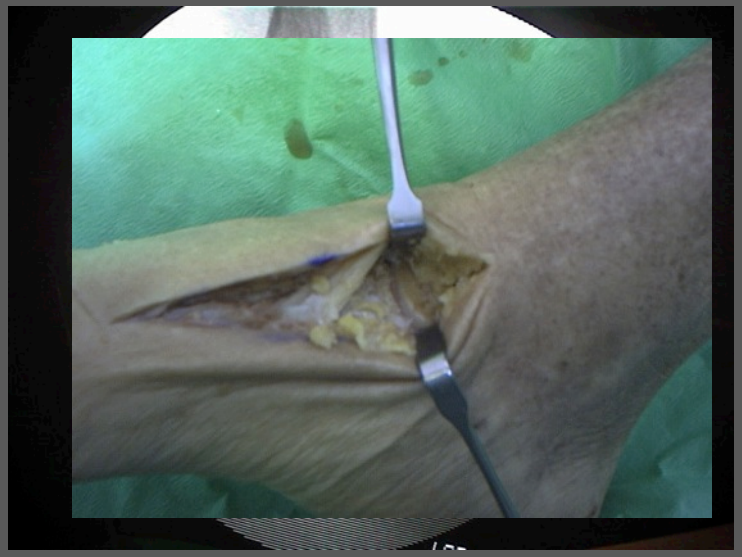
Consider isolated (ST, TN) fusion in selected cases

Other indications for fusion

- Major deformities even flexible
- Older people
- major capsulo-ligamentar tears
- Obesity
- Major associated deformities i.e. knee valgus

Goals of triple arthrodesis

- CC,TN and ST
- Double approach
- Reduction of calcaneus valgus
- Restauration of normal TC divergence
- Stapples and screw fixation
- Beware of forefoot pronation



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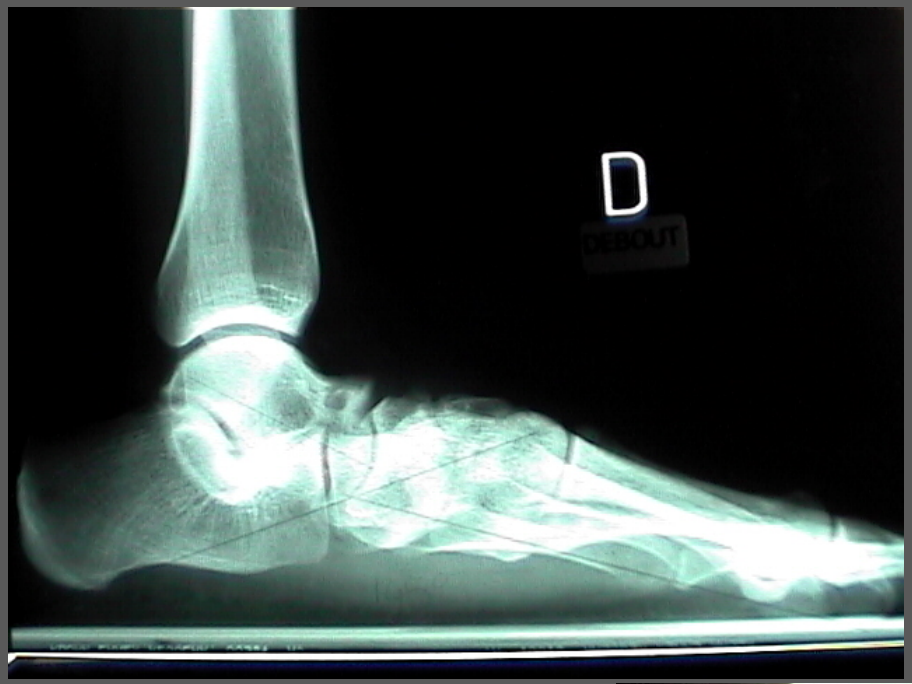

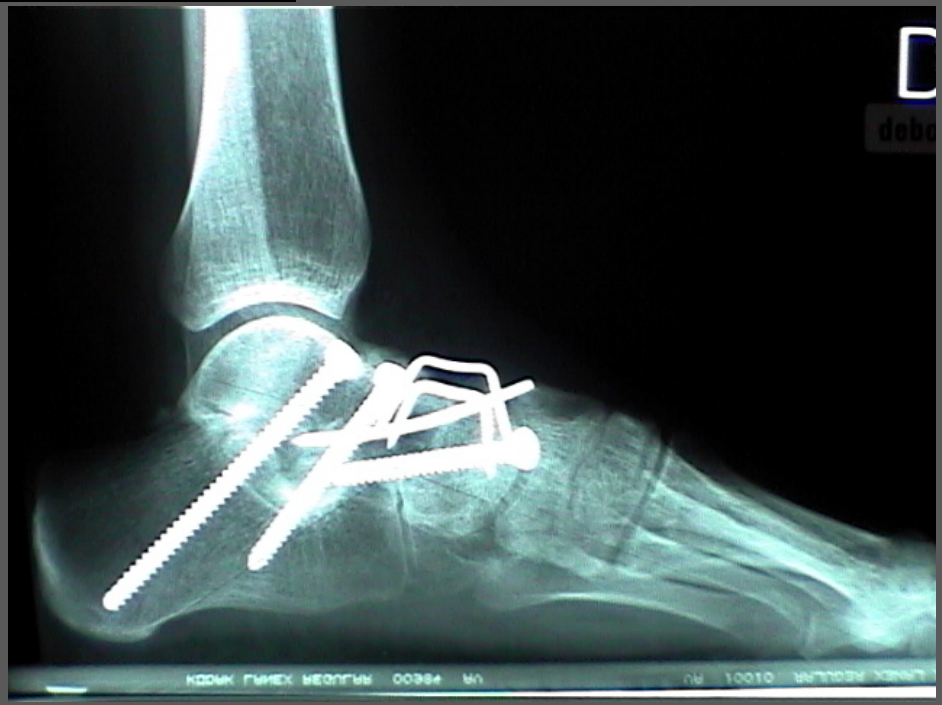

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Beware of under-corrected ST fusion

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pantalar fusion

ankle involvement

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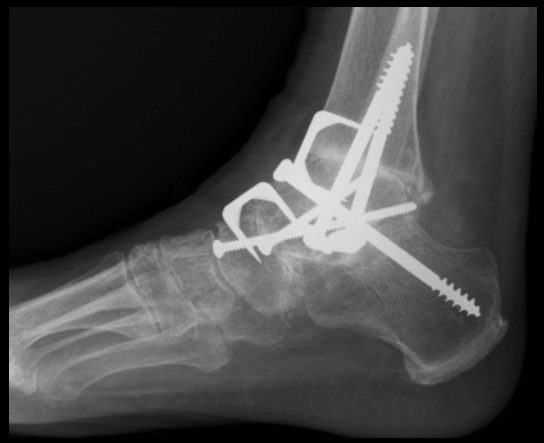

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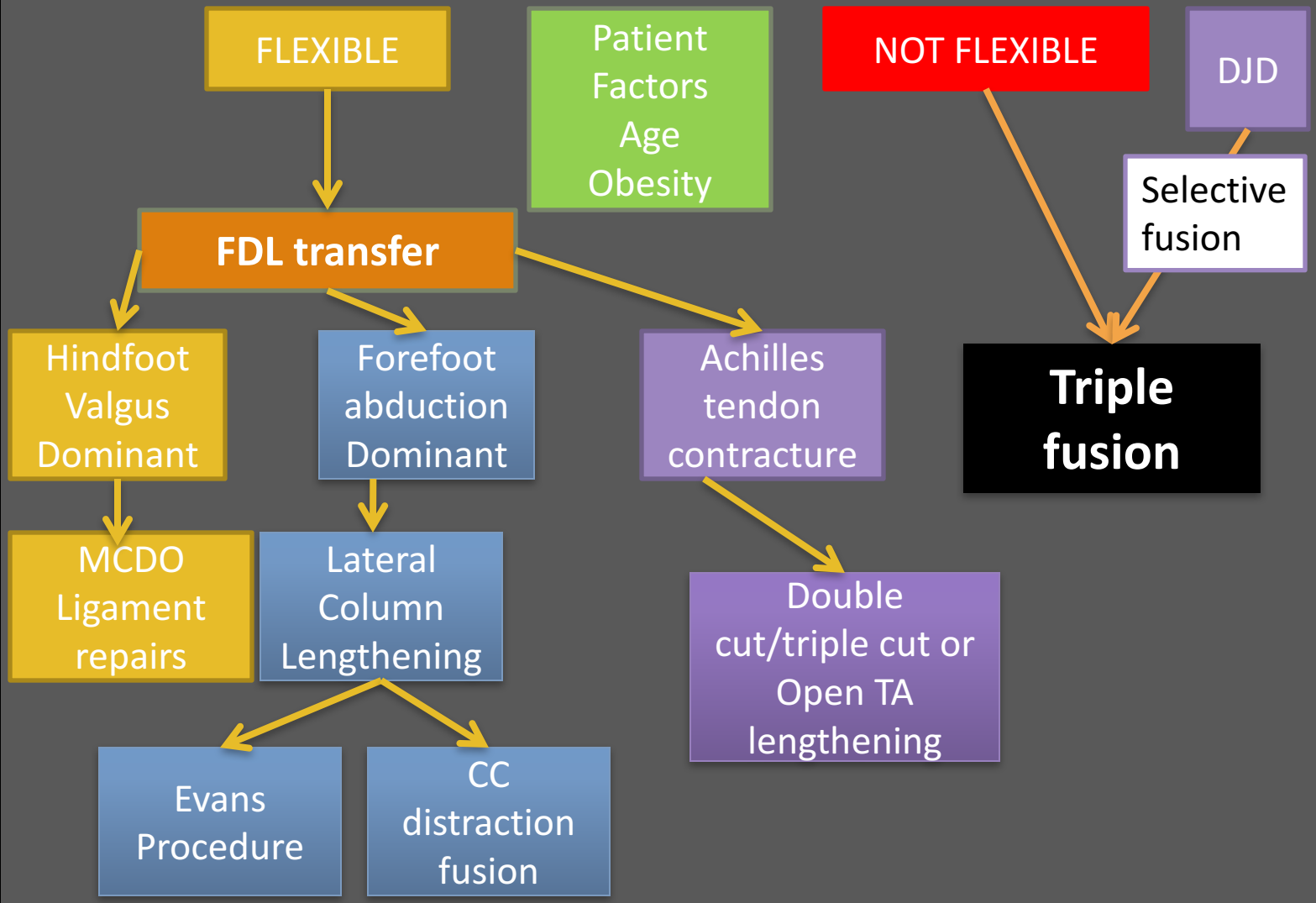
Surgical Algorithm – Painful Pes Planus



Overall indications

according to Bluman staging

- **grade 1**
  - Conservative TTT
  - Insoles, rehab, stretching
  - Loss of weight
- **grade 2**
  - Soft tissues procedures
  - Associated with extra-articular bone procedures
- **grade 3**
  - Hind foot arthrodeses with malalignment correction
- **grade 4**
  - **Pantalar fusion**

Take Home Messages

soft tissue involvement to be considered and properly managed

always associated to bony procedures

excepted are selected patients with stage 1 PTT lesion (without flatfoot)

Take Home Messages

- Role of osteotomies and arthroereisis : mechanical control of the peritalar joint complex
  - **Planar dominance of the deformity in osteotomies dictates the procedure**

- good results at long term for calcaneal OT and FDL transfer
- No data available for arthroreisis in adults

Take Home Messages

Arthrodesis in case of
DJD
fixed deformities
major instability
provides a reasonable
painless foot if plantigrade

THANK YOU

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