Pes Planus / Pes Cavus

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Arches of Foot

Function : shock attenuation

even distribution of weight

1. Longitudinal arch

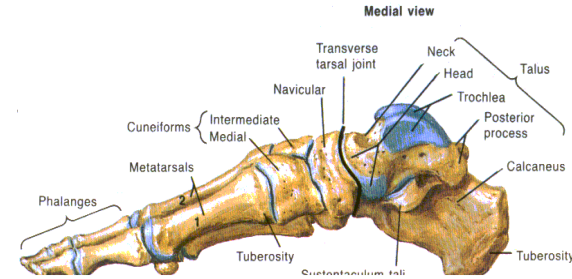
medial : Cal-Tal-Nav-Cuneiforms-3metatarsals

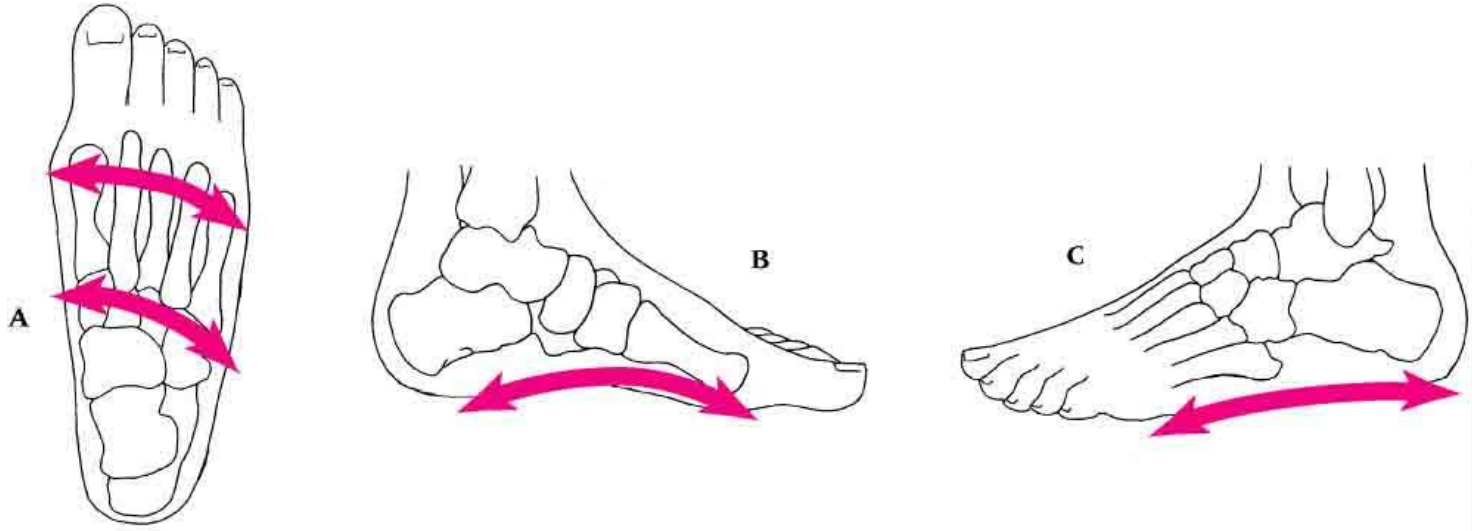
lateral : Cal-Cuboid- 2 metatarsals

2. Transverse arch

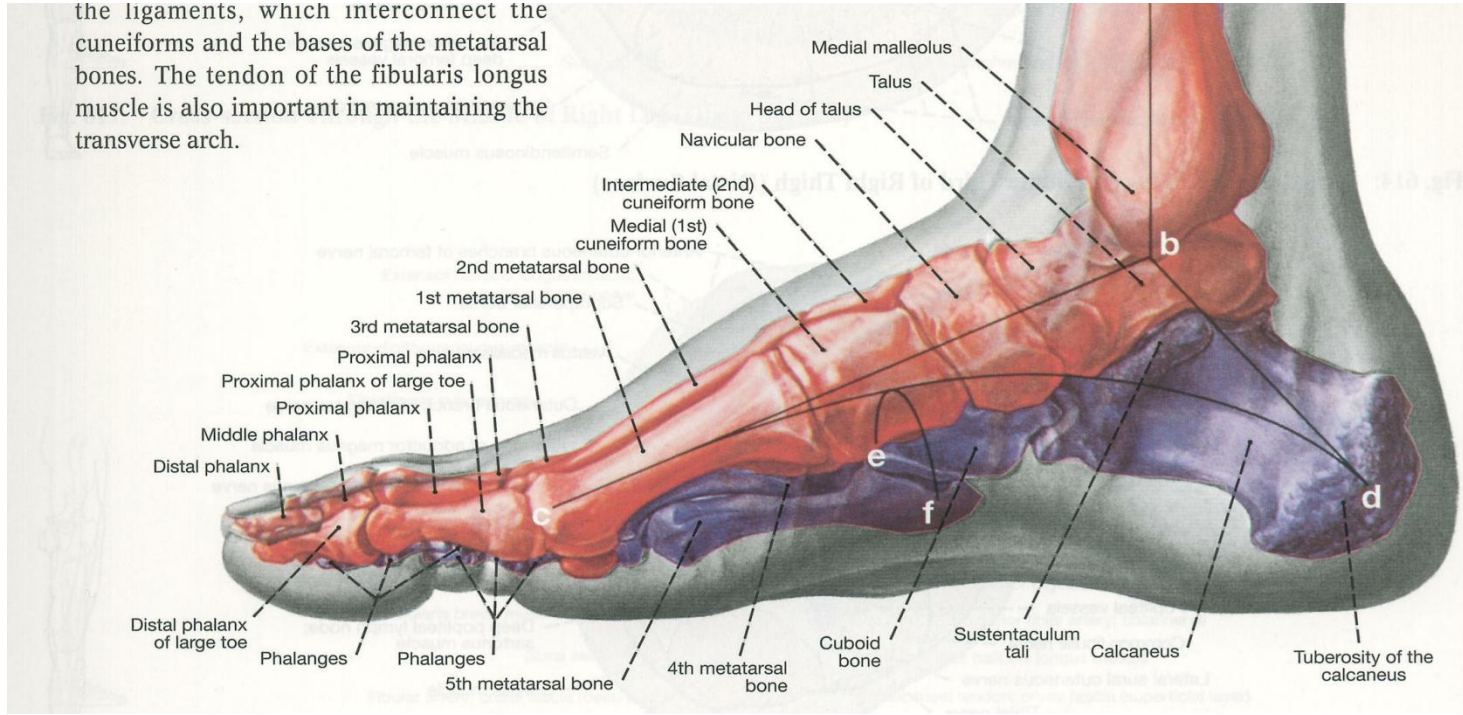
base of metatasal head

cuneiform-cuboid

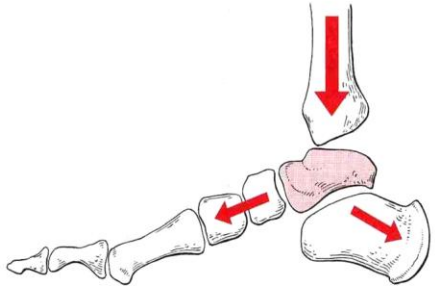


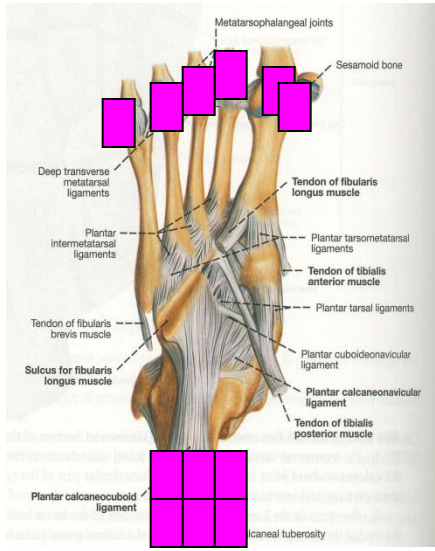


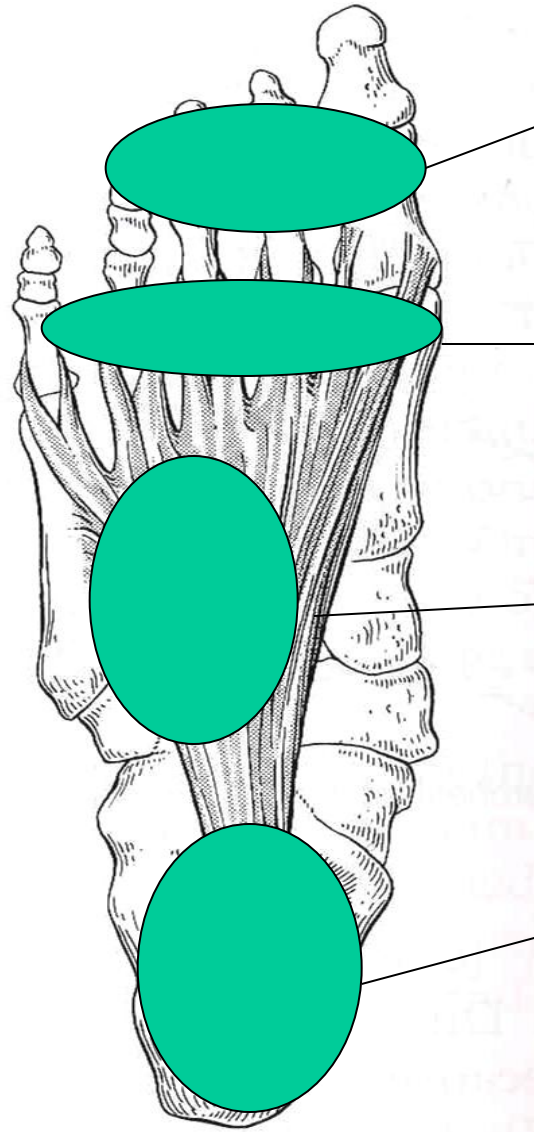
the ligaments, which interconnect the cuneiforms and the bases of the metatarsal bones. The tendon of the fibularis longus muscle is also important in maintaining the transverse arch.



기립시 체중분담 비율







족지부 : 3.6%

중족골두부 : 28.1%

중족부 : 7.8%

후족부(발 뒤축) : 60.5%

Maintenance of arches

1.Medial arch : first tarsometatarsal lig
cuneonavicular lig
spring lig :calcaneonavicular

2. Lateral arch : 4,5th tarsometatarsal lig
long and short plantar lig

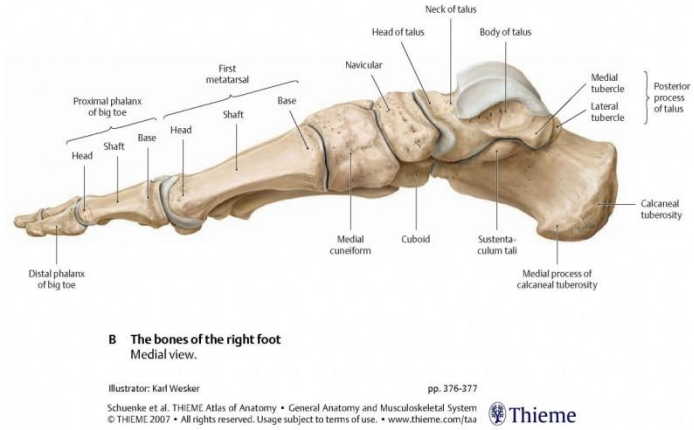
3. Plantar aponeurosis(fascia) :
plantaris m. fascia와 연결

3. Long flexor tendons

4. Tibialis posterior & Tib. Anterior

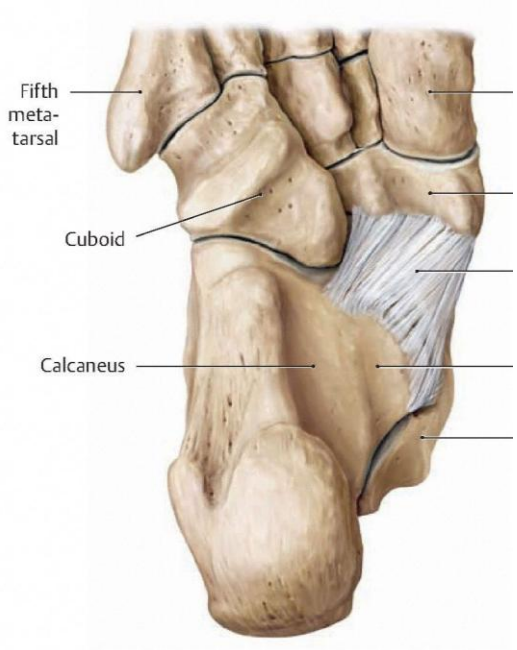
5. Small intrinsic muscle

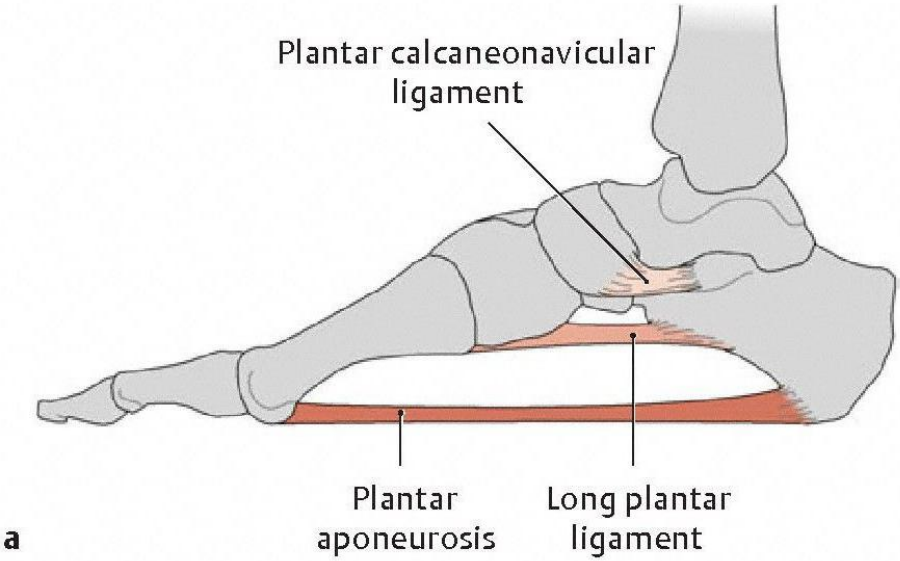
Arch support

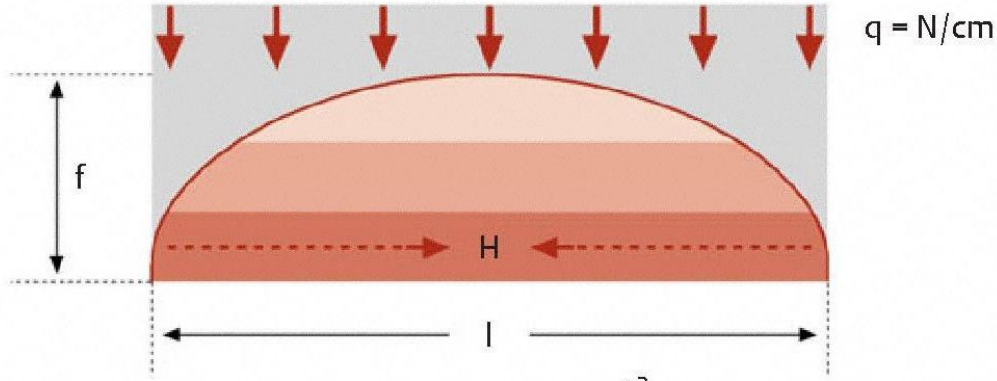


B **The bones of the right foot**
Medial view.

Illustrator: Karl Wesker pp. 376-377



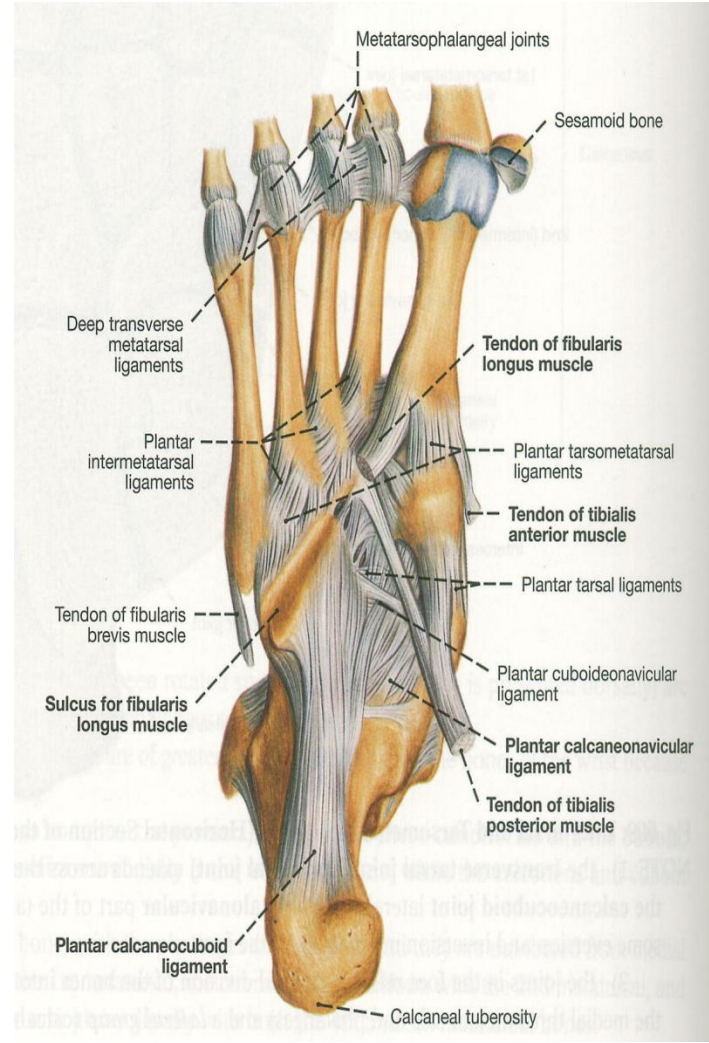




$$H\ (\text{constraining force}) = \frac{q \times l^2}{8 \times f}$$

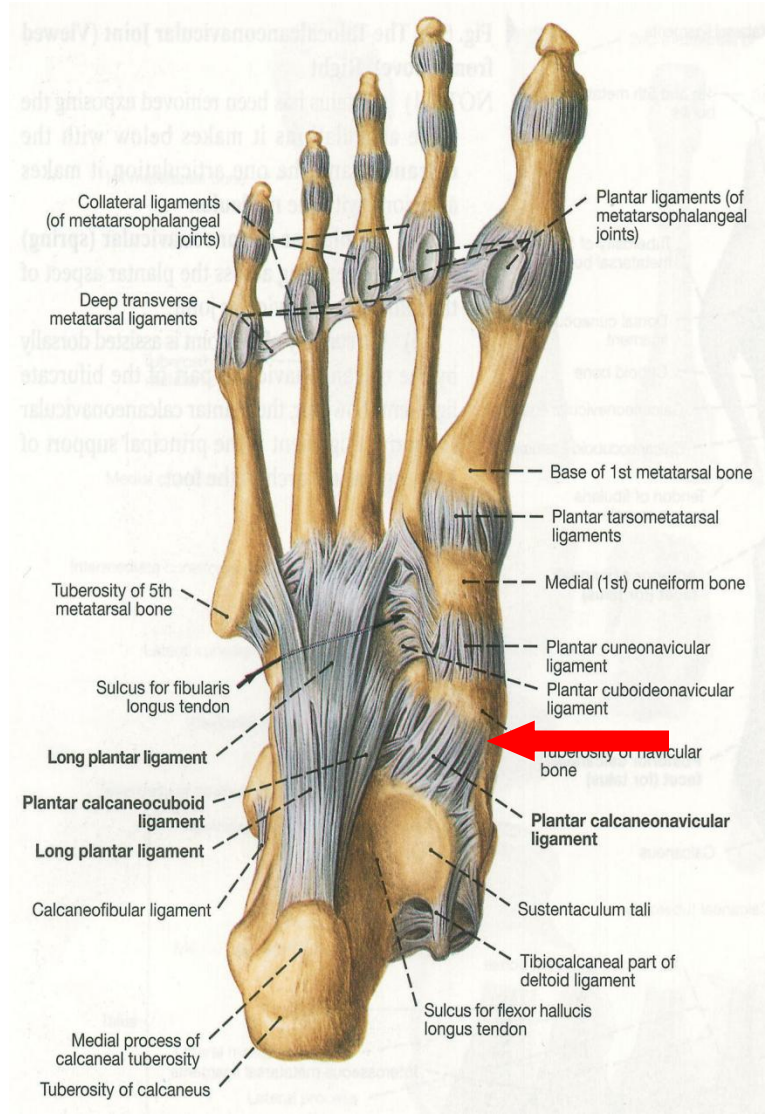
Ligaments of Foot(sole)

- Dorsal tarsal ligament
- Plantar tarsal ligament
- Intermetatarsal ligament :
  prevented from spray foot
- Interosseus tarsal ligament

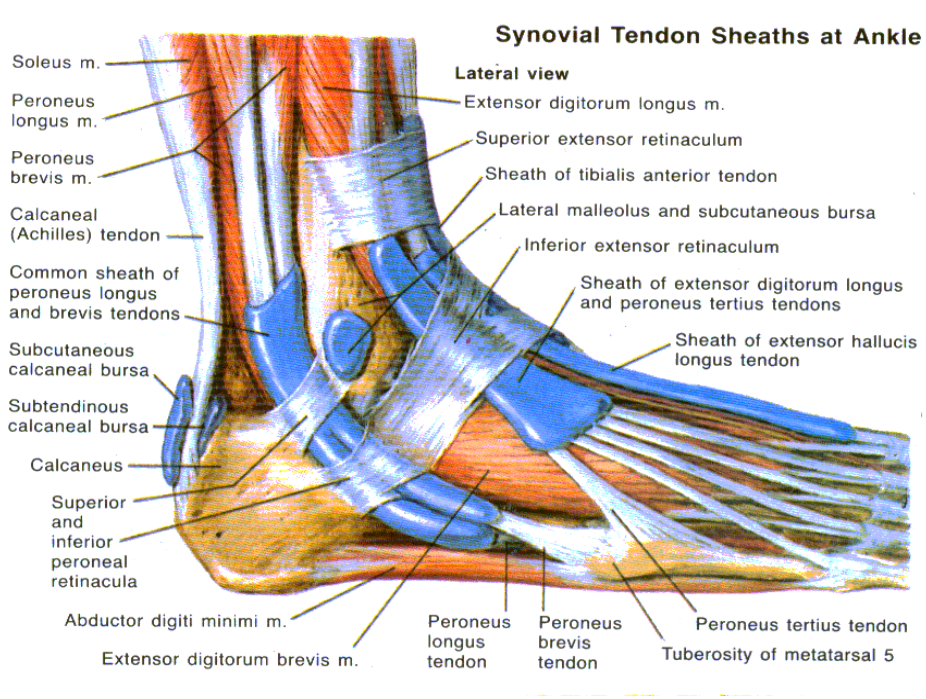


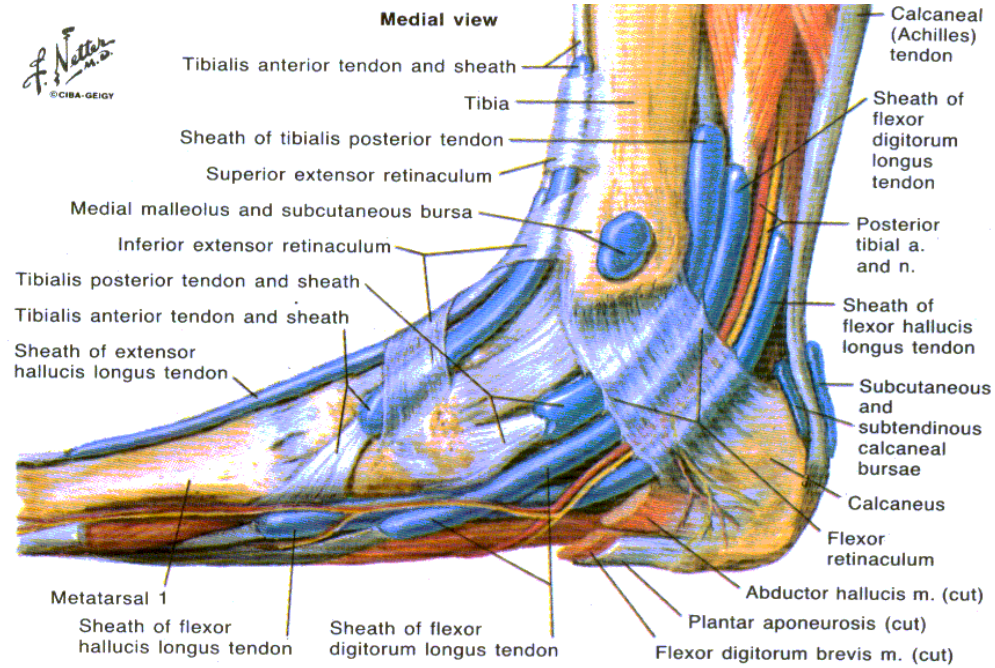
Plantar tarsal ligament

- Unite tarsal bone
- Maintain the arches of the foot
  - –Spring lig: chief support
    plantar calcaneonavicular lig
  - –Long plantar lig.:
    (calcaneus – cuboid, metatarsals)
  - –Short plantar ligament
    (plantar calcaneocuboid lig)

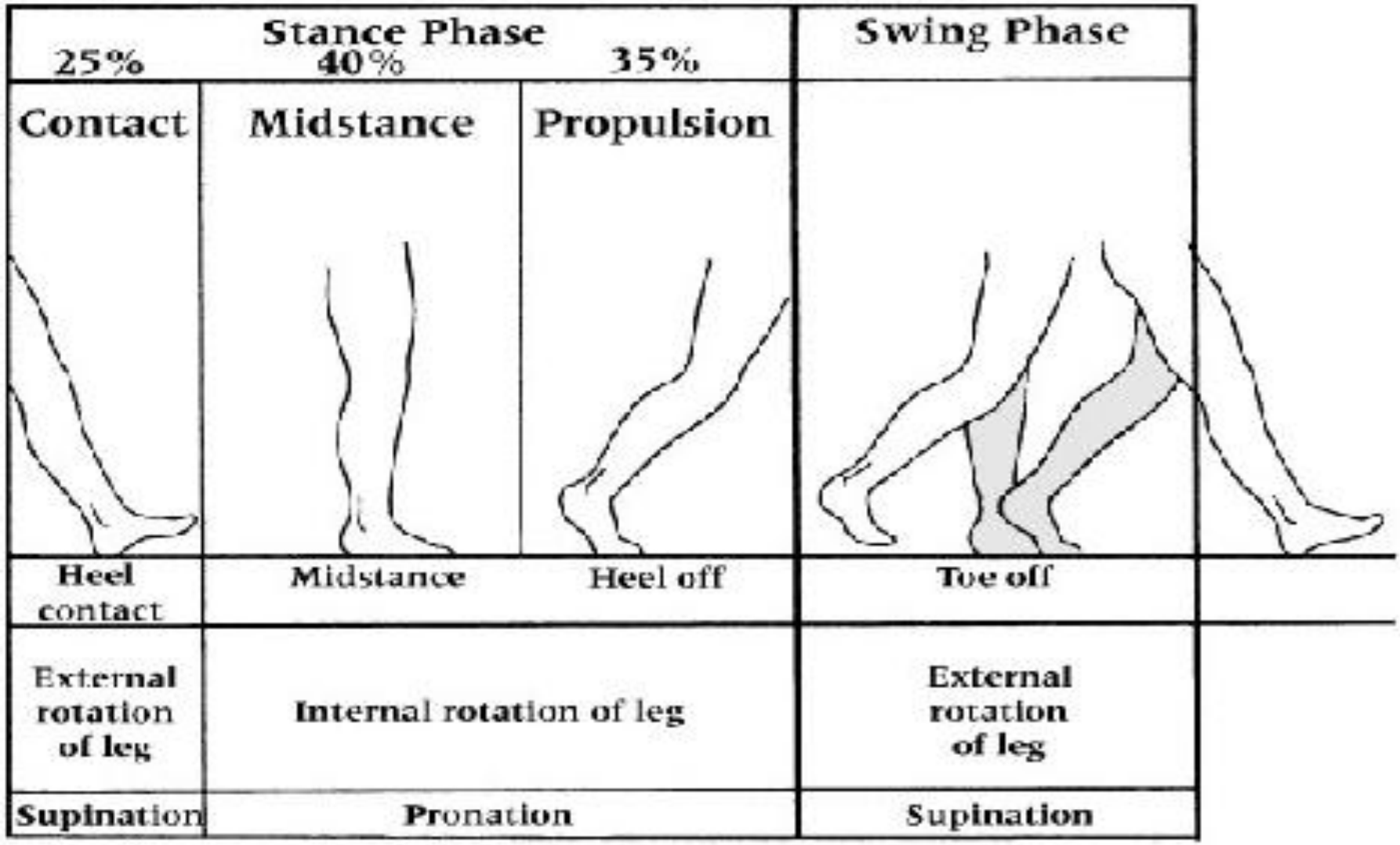


Tendons of Ankle Joint





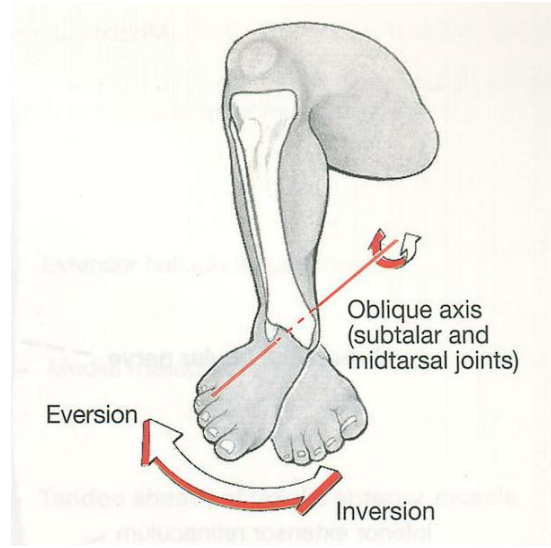
Gait Cycle


Stance Phase
25%
40%
35%
Swing Phase
Contact
Midstance
Propulsion
Heel contact
Midstance
Heel off
Toe off
External rotation of leg
Internal rotation of leg
External rotation of leg
Supination
Pronation
Supination

Ankle Movement

Motion

- –inversion & eversion
- –adduction & abduction
- –DF & PF



Combination of all these motion

Supination : inversion,adduction & plantarflexion

Pronation : eversion,abduction & dorsiflexion

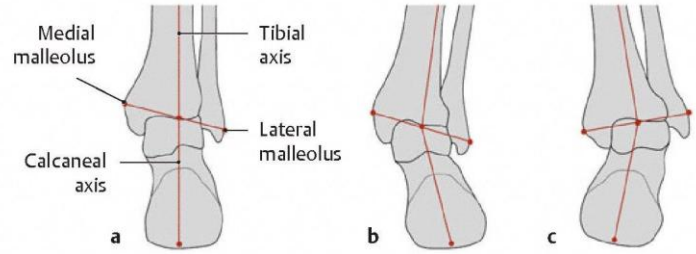
Motion of Foot & Ankle

Pronation

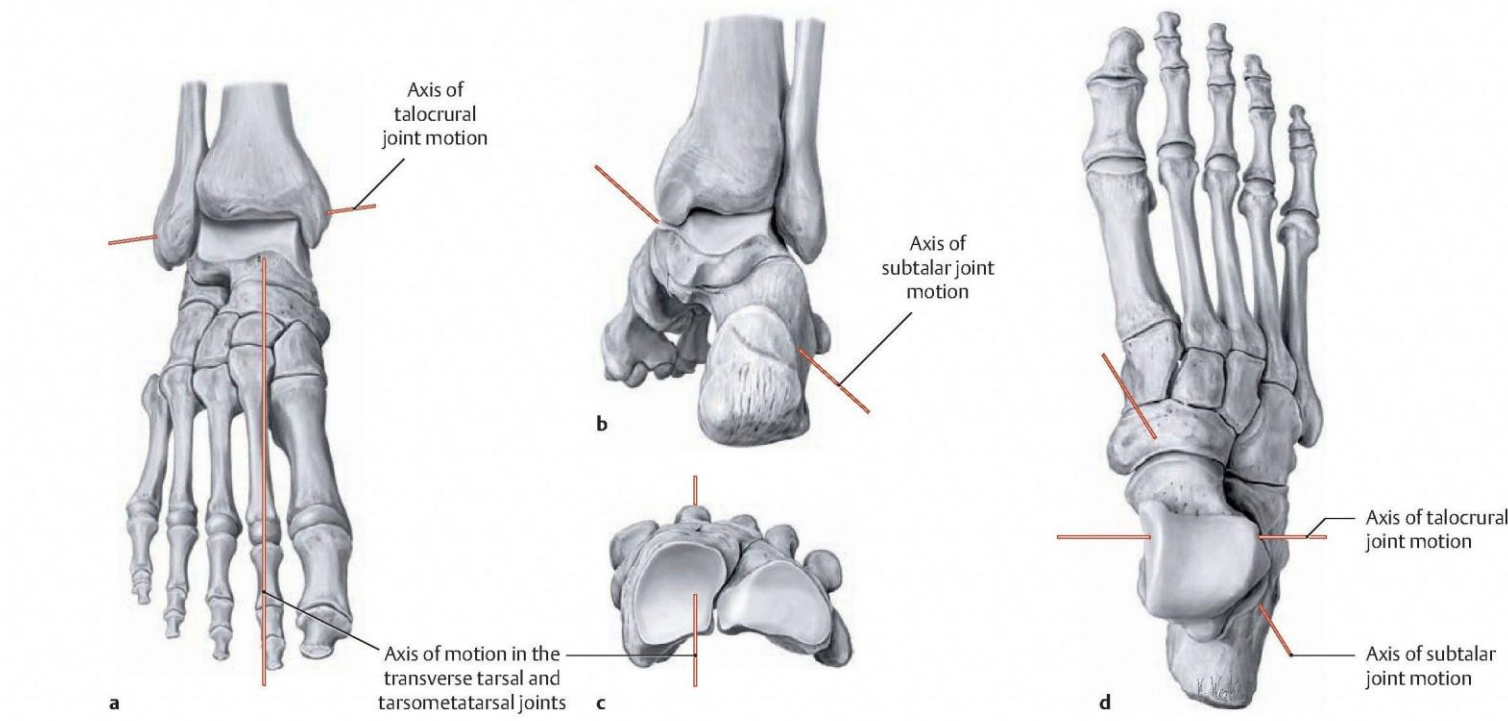
- → Over pronation
- → Flat feet
- → Pes planus

Supination

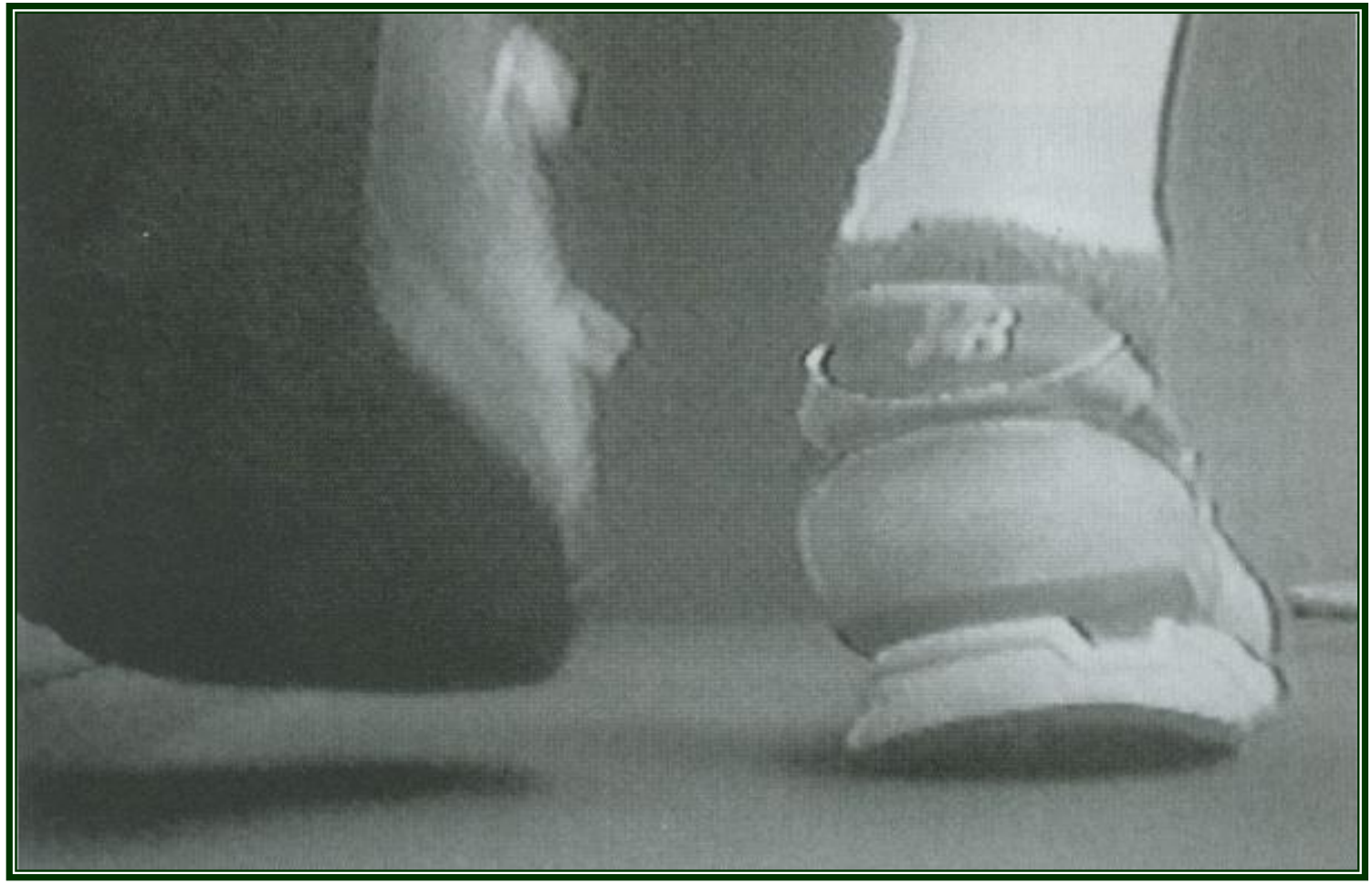
- → Over supination
- → High arch foot
- → Pes cavus



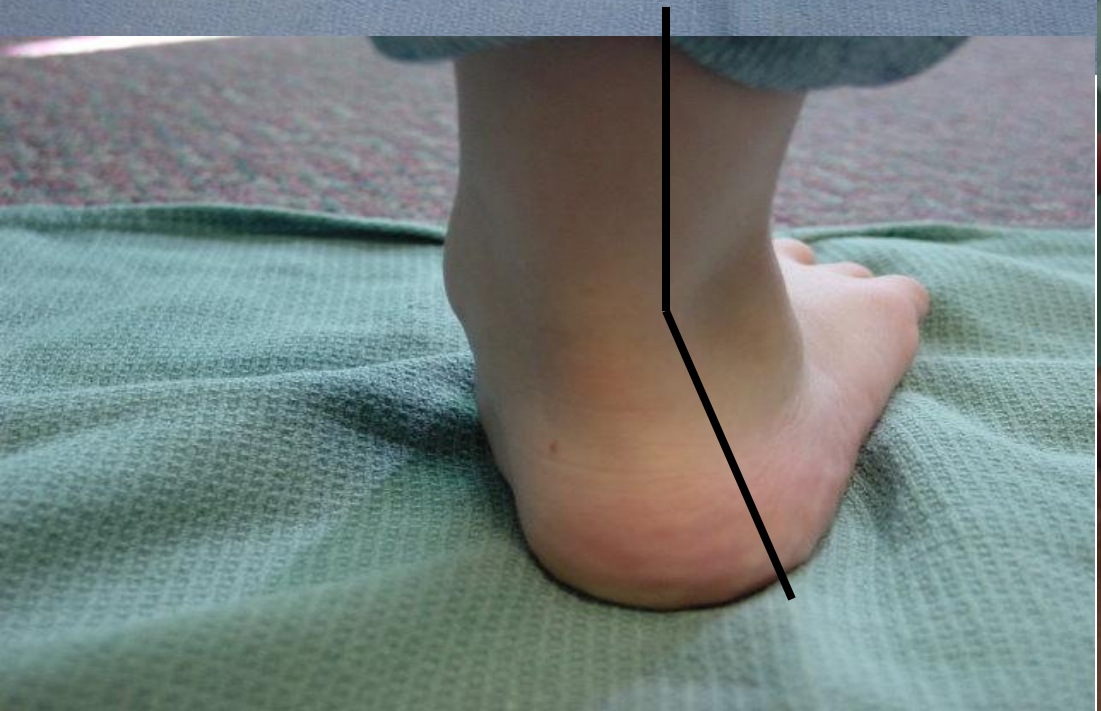
Motion of Foot & Ankle



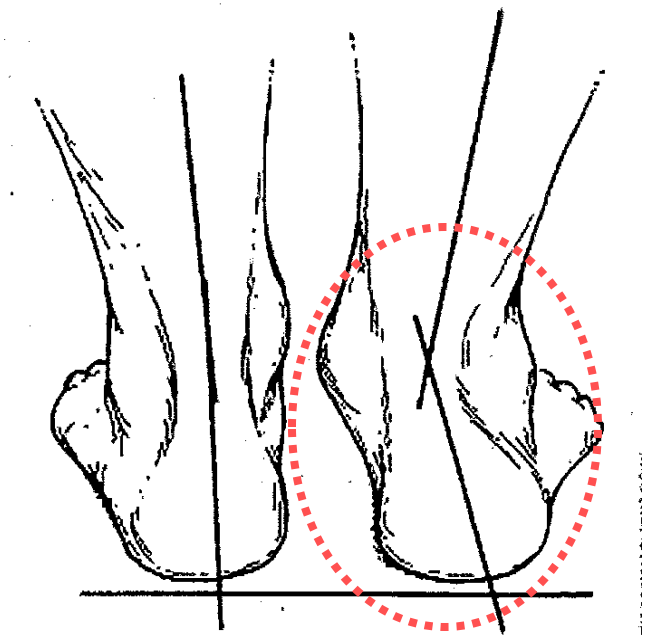
과회내(hyperpronation)



Pes Planus



Hyperpronation at Subtalar Joint

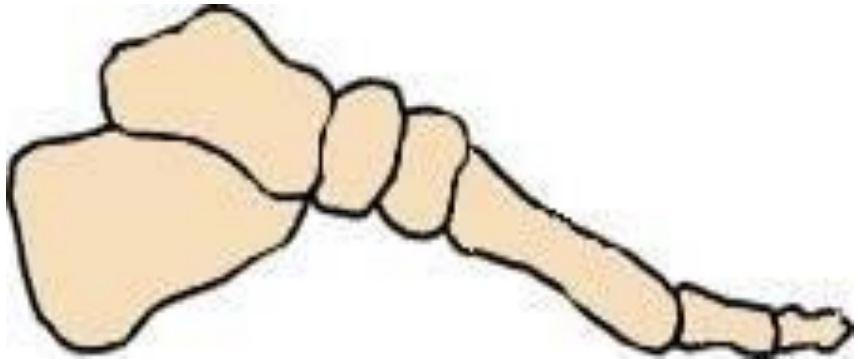


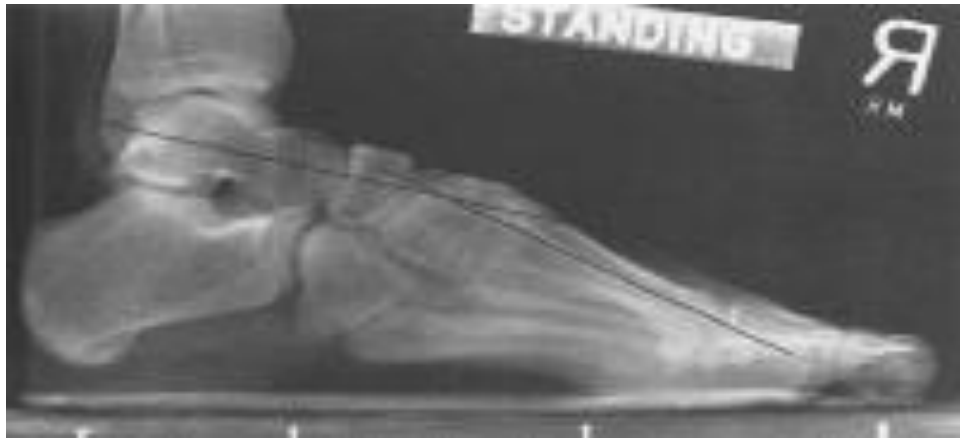
Pes Cavus (High Arch Feet)

Oversupinated Foot
(Cavus foot)

- High arched foot
- 특징
  - Limited pronation
  - Rigidity in all muscle
  - Uneven weight distribution to lateral foot
  - ↑ tendency to lateral ankle instability
  - Digital deformity
  - ↓ ankle DF by osseous block

Pes Cavus





- Abnormally High and Rigid Arch
- Plane of metatarsals
- Hypomobile
- Common complaints

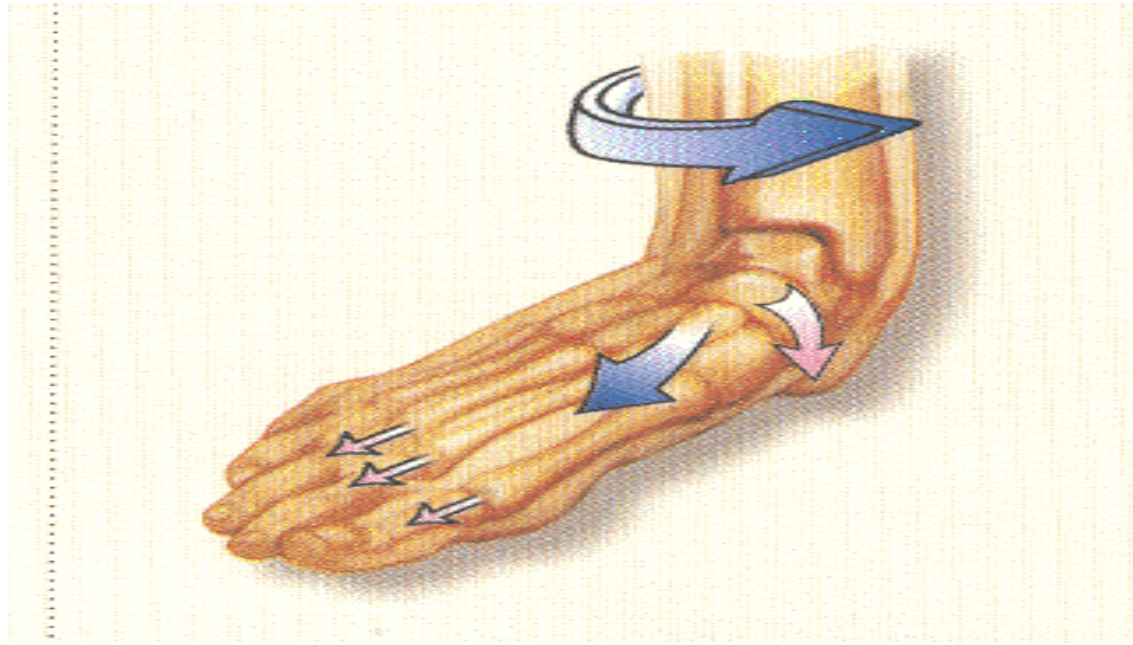
Pes Planus

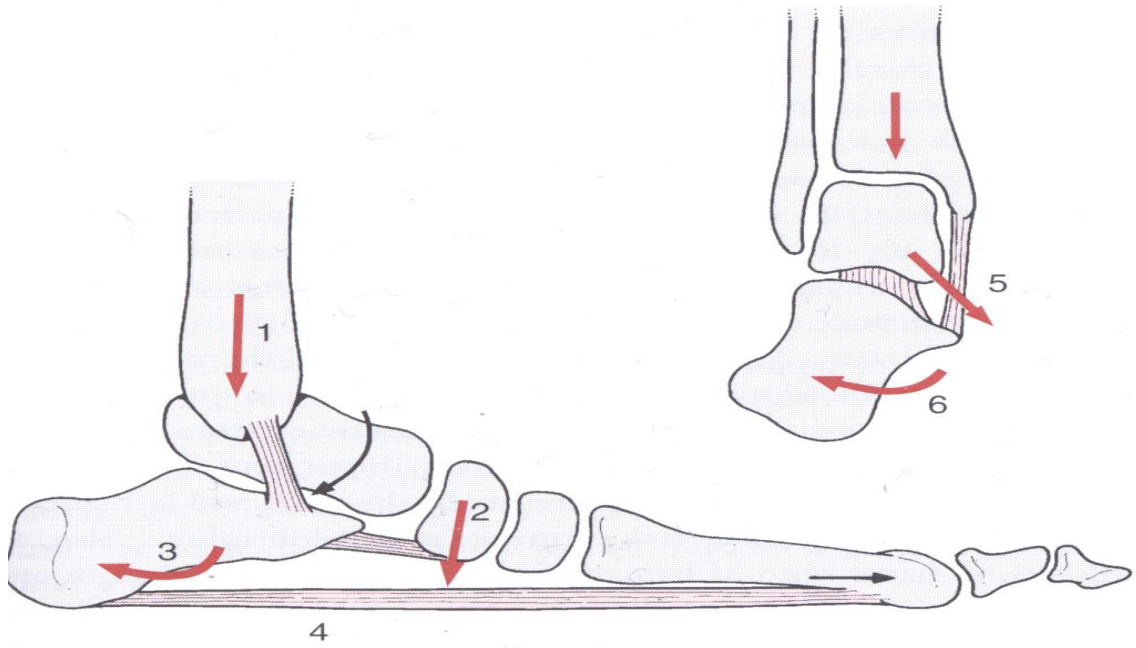
- Flat feet
- Hypermobile
  - Results in:
- Common Complaints
- Assess Using
  - Feiss Line
  - Navicular Drop Test

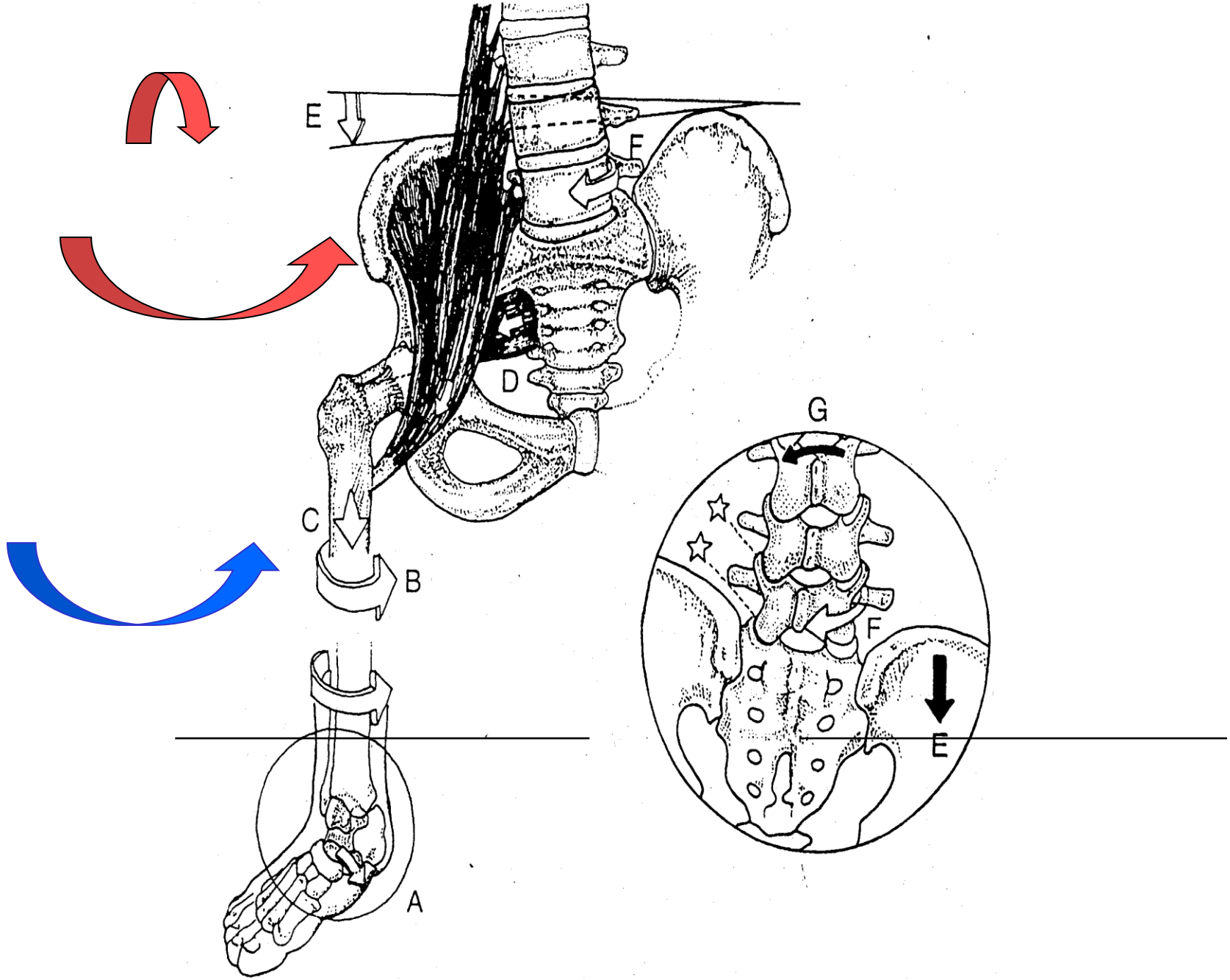
STJ pronation

→ Loosening of tarsal & metatarsal bone

→ Reaction force on medial foot

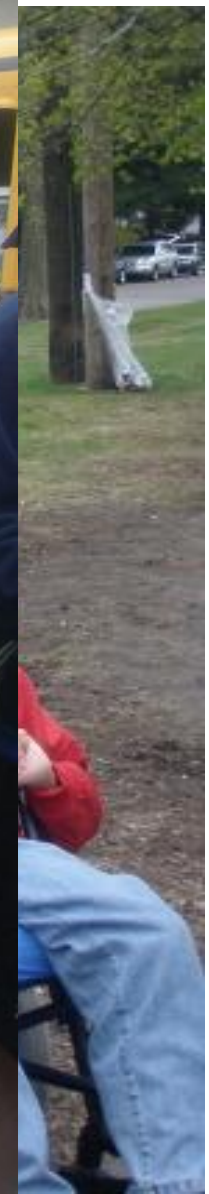





E
F
D
C
B
A
G
F
E

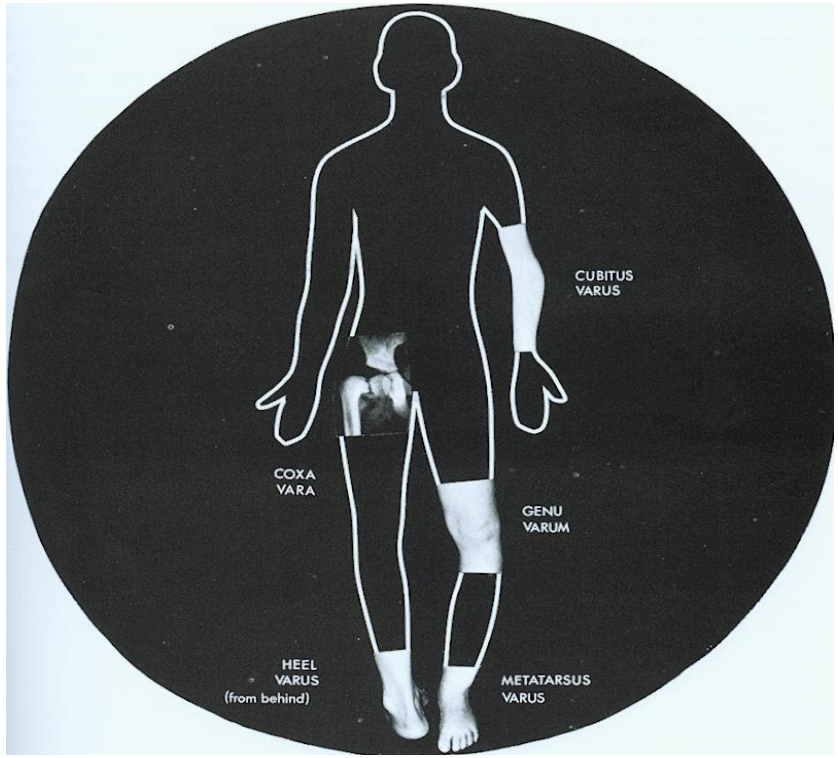
Boston marathon 2010. 4.19.

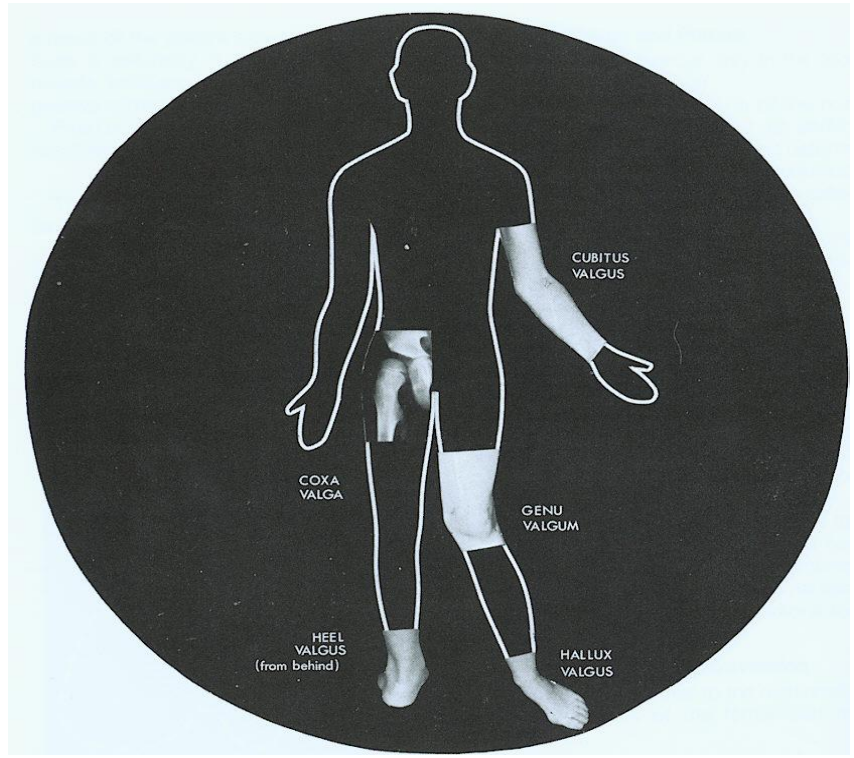
Jackie = Jaeki
同聲異名



Anatomy/Terminology

- Varus/Valgus





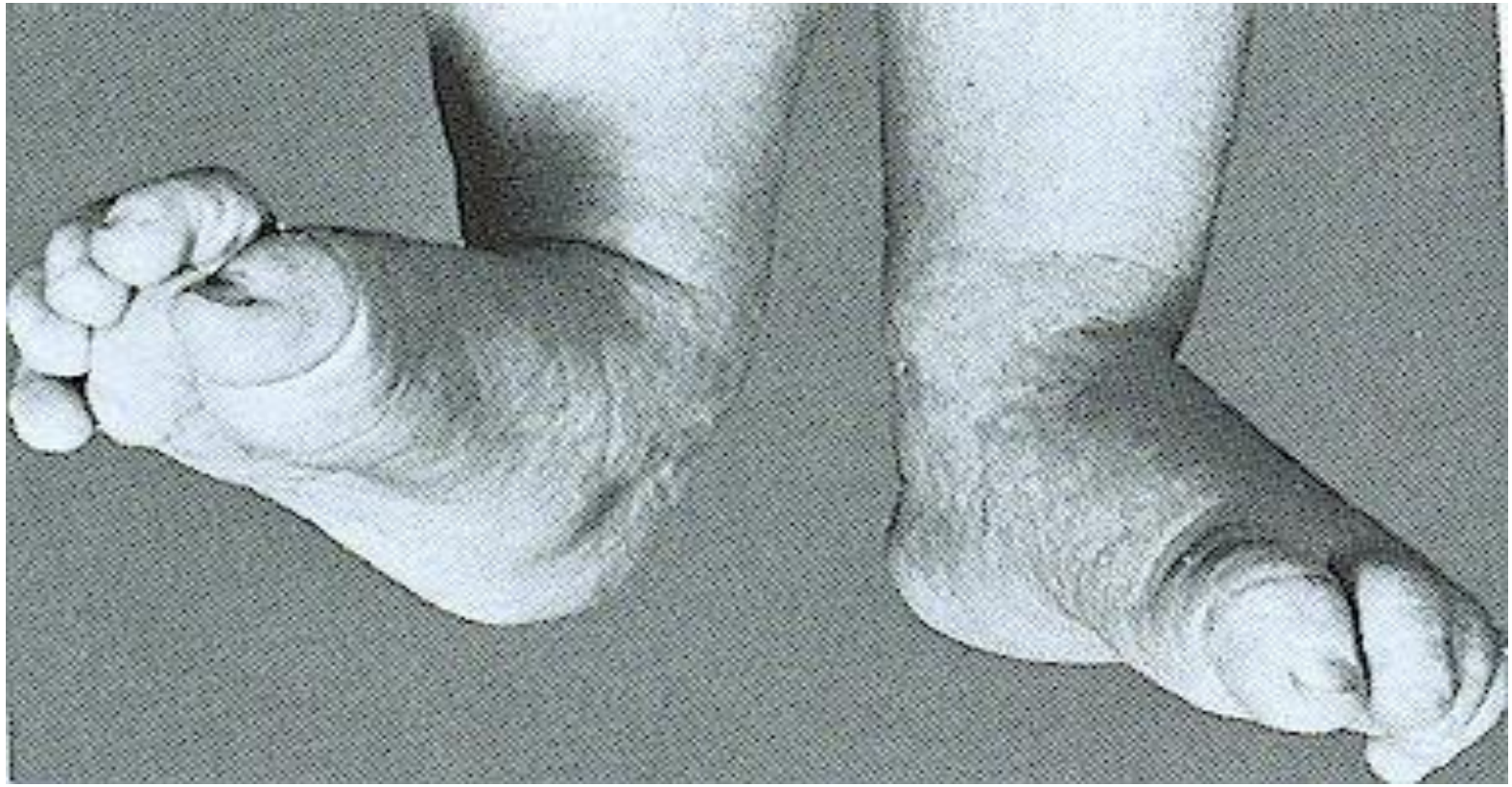
Pes Planus

- Loss of the medial longitudinal arch of foot.
- various types and causes of flat feet.
- Usually, treatment is only needed if PP is new, painful or progressing, or when there is a fixed deformity or other associated problem.

Pes Planus

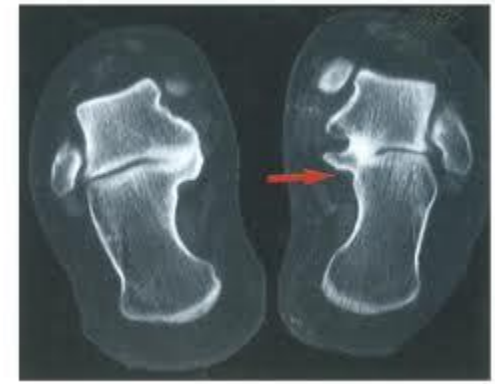
- Congenital flexible flat foot
  - calcaneovalgus
  - congenital rigid flat foot
  - congenital vertical talus
  - tarsal coalition
- Acquired flexible flat foot

Calcaneovalgus foot

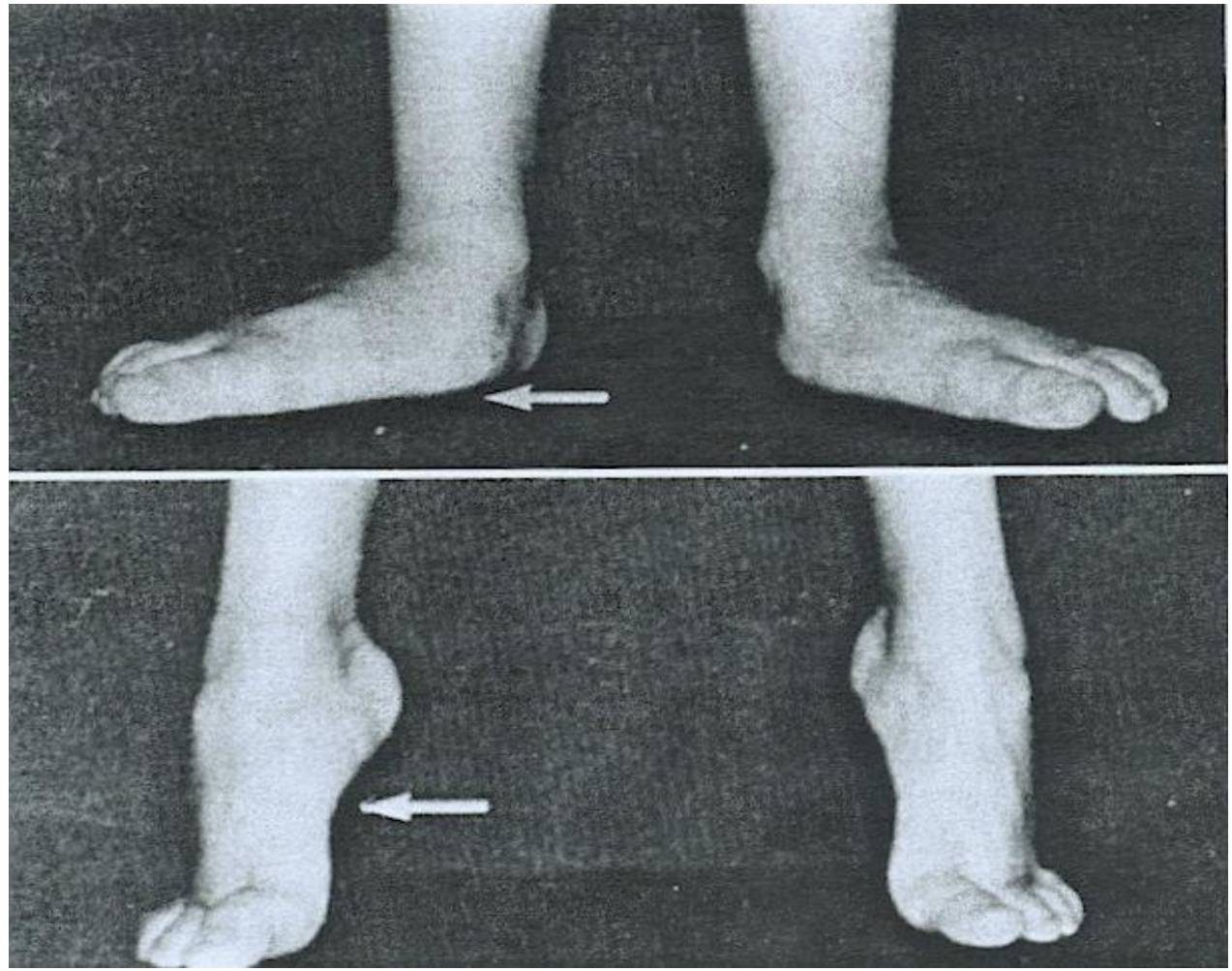


Tarsal Coalition

- Bony, fibrous or cartilagenous union between two or more tarsal bones
- Etiology
- Sx/Sn



Pes Planus (flatfoot)



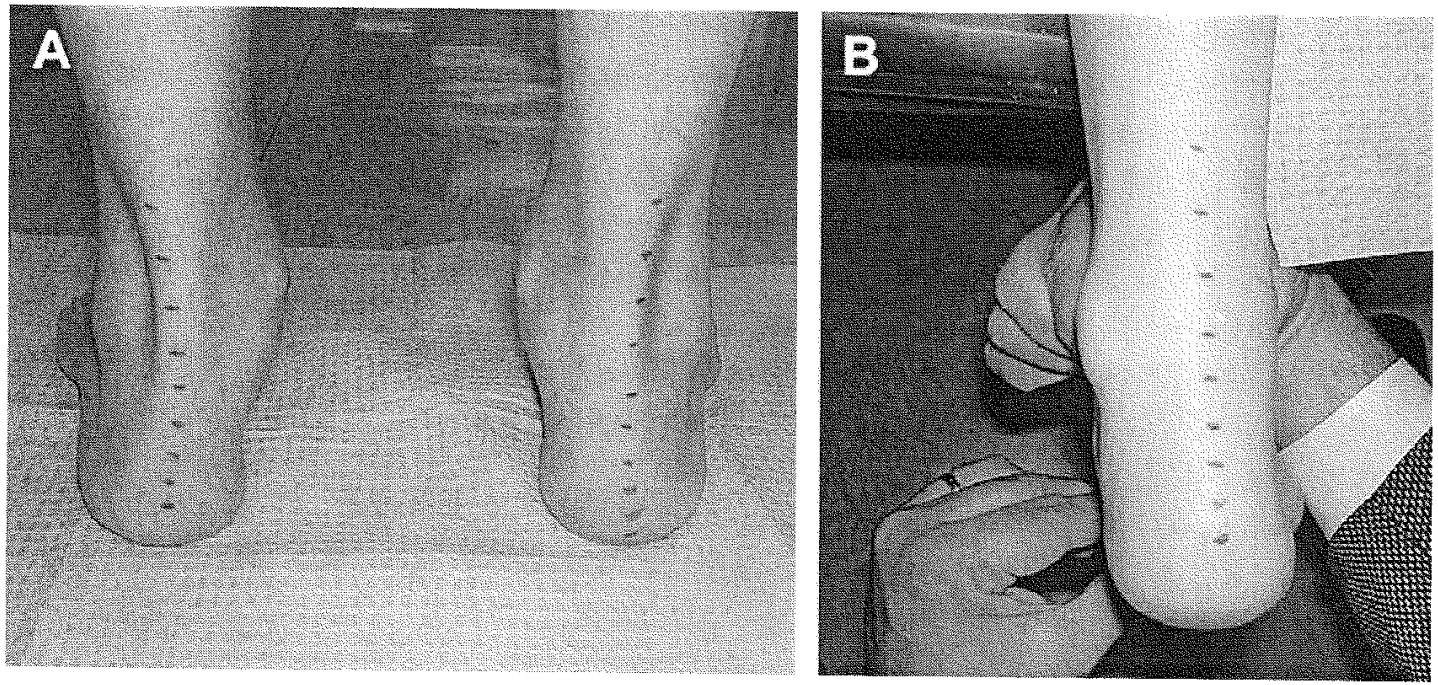


Fig. 23. (*A*) The resting calcaneal stance position is assessed while the patient is standing in normal angle and base of gait. (*B*) Frontal plane forefoot-to-rearfoot relationship with the child in a prone position and the calcaneus properly bisected. Placing a dorsiflexory force on the plantar surface of the fifth metatarsal to resistance locks the midtarsal joint with the subtalar joint maintained in neutral position.

Table 1
Volpe's treatment classification system

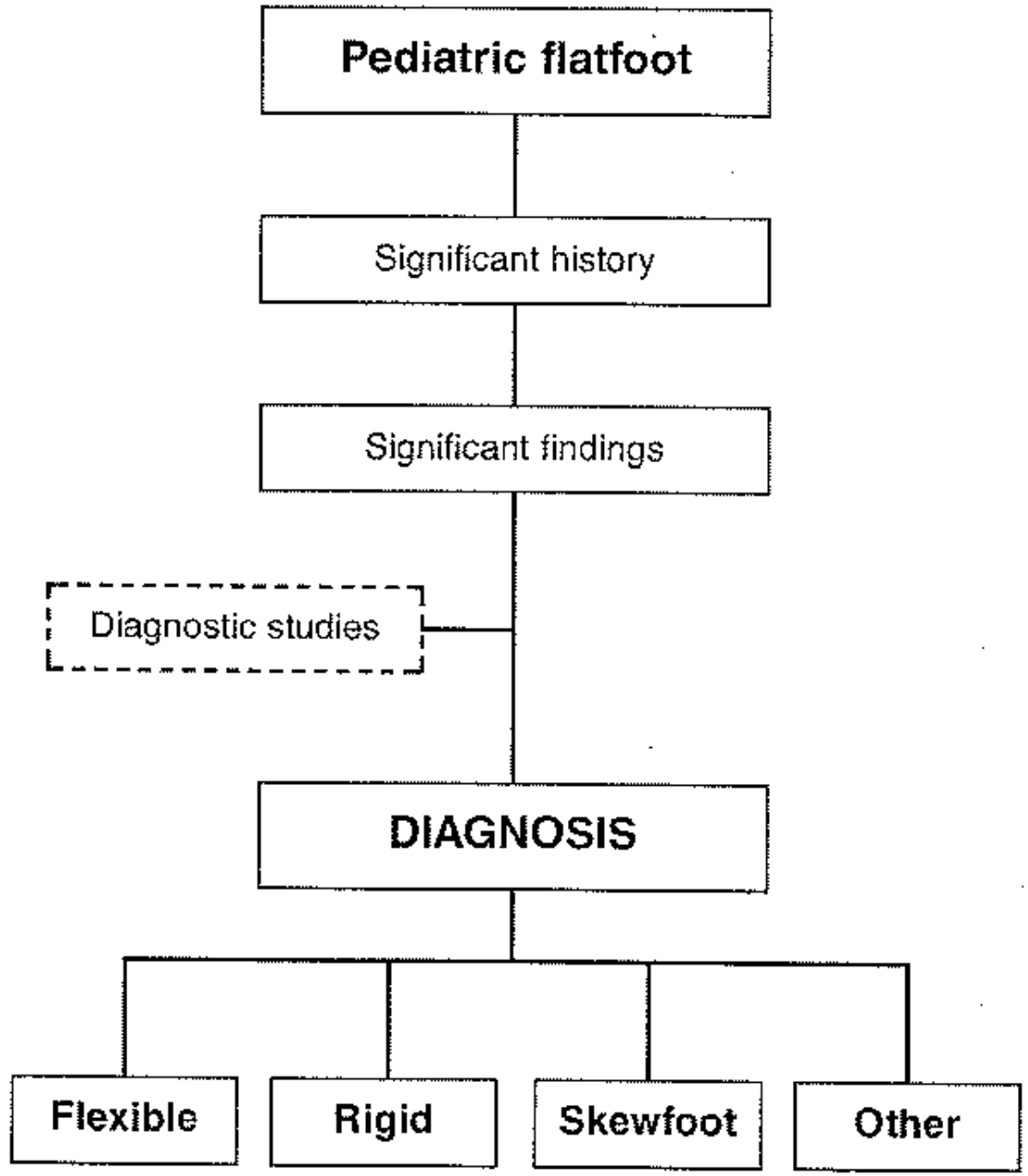
	Mild	Moderate	Severe
Collapse of medial arch	Collapsed but arch is visible	Not visible	Not visible, convexity noted from talar head
RCSP (children >7 y)[a]	2°–5° valgus	6°–10° valgus	>10° valgus
Too many toes sign	Toes 4 & 5	Toes 3–5	Toes 2–5

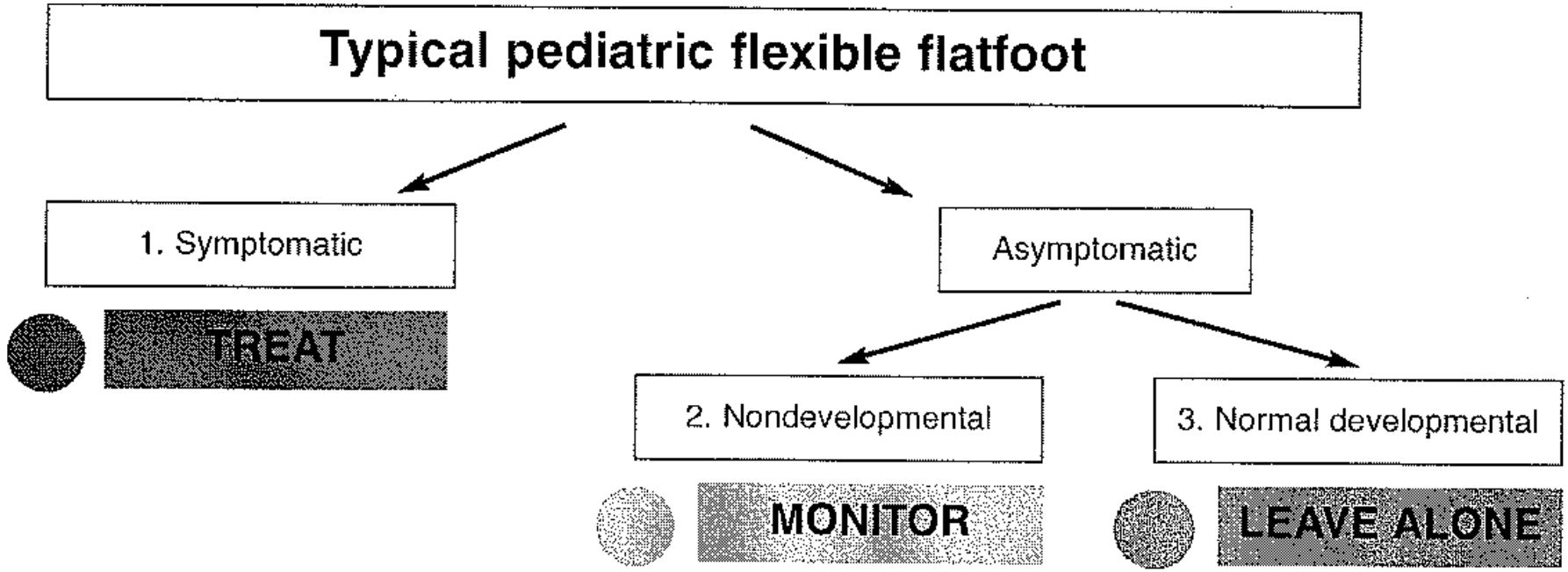
Etiology(Children)

- Pes planus (PP) can be part of normal development:
  - Infants typically have a minimal arch.
  - Many toddlers have flattening of the long arch, with forefoot pronation and heel valgus on weight-bearing.
  - There may be ligamentous laxity, which is probably determined genetically.
  - Most of these children spontaneously develop a strong normal arch by around age 10.

Etiology(Children)

- Abnormal development of foot, producing PP
  - Neurological problems, e.g. cerebral palsy, polio.
  - Bony or ligamentous abnormalities,
    tarsal coalition (fusion of tarsal bones),
    accessory navicular bone.
  - Small proportion of flexible flat feet do not correct with growth. Some of these may become rigid if the PP leads to bony changes.


Pediatric flatfoot
Significant history
Significant findings
Diagnostic studies
DIAGNOSIS
Flexible
Rigid
Skewfoot
Other


Typical pediatric flexible flatfoot
1. Symptomatic
TREAT
Asymptomatic
2. Nondevelopmental
MONITOR
3. Normal developmental
LEAVE ALONE

Assessment

- History
- Patients may present with noticeable pes planus (PP), parental concerns, or foot pain.
- History of the PP and any changes.
- Symptoms:

  walking/running ability and any foot pain.
- Past medical history:

  other diseases, developmental delay.

Assessment

- Examination

  Observe the PP.

  Is the PP flexible?

  Look for signs of tibialis posterior dysfunction

  (if history is suggestive of this):

  Assess related problems,

  if relevant, e.g. neuropathy or arthritis.

Radiographs

Foot AP and obligue

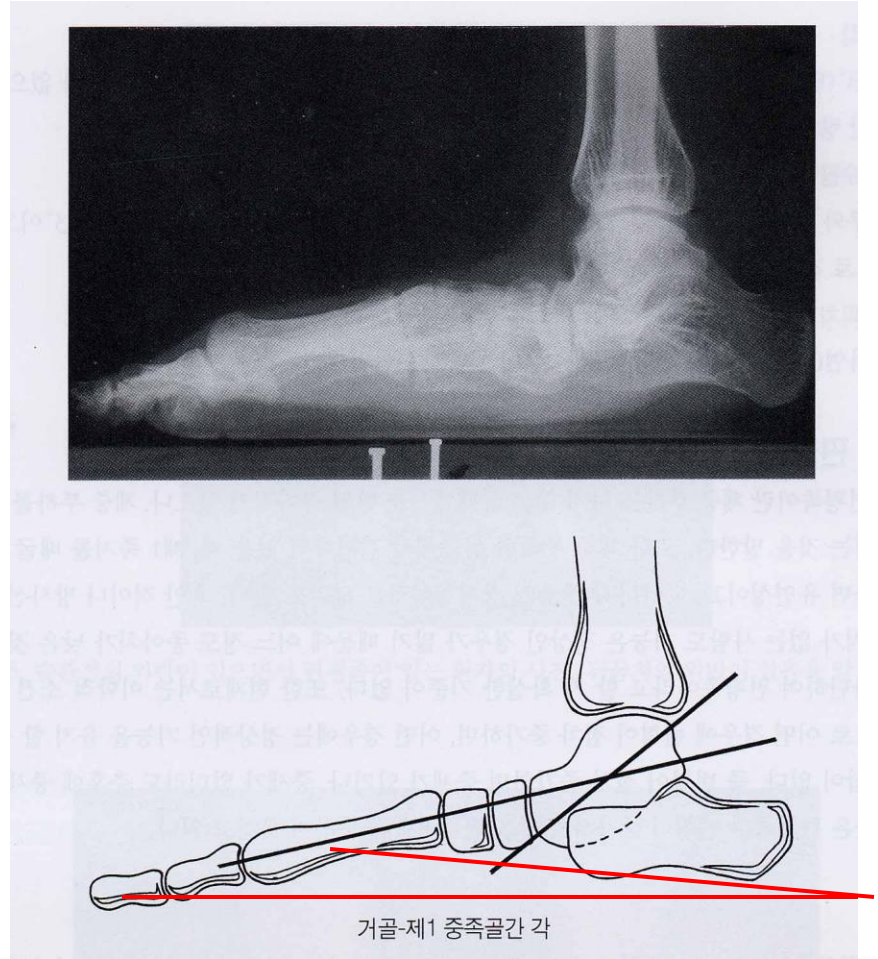
Foot & ankle lat.

Foot & ankle standing lat.

Ankle AP

Ankle mortise view

Axial Calcaneal view



Calcneal pitch

Radiographs

Measurement :

Talo-1st metatarsal angle : AP & Lat

Lat; 10-15도< : mild, 40도 < : severe

Talonavicular coverage angle

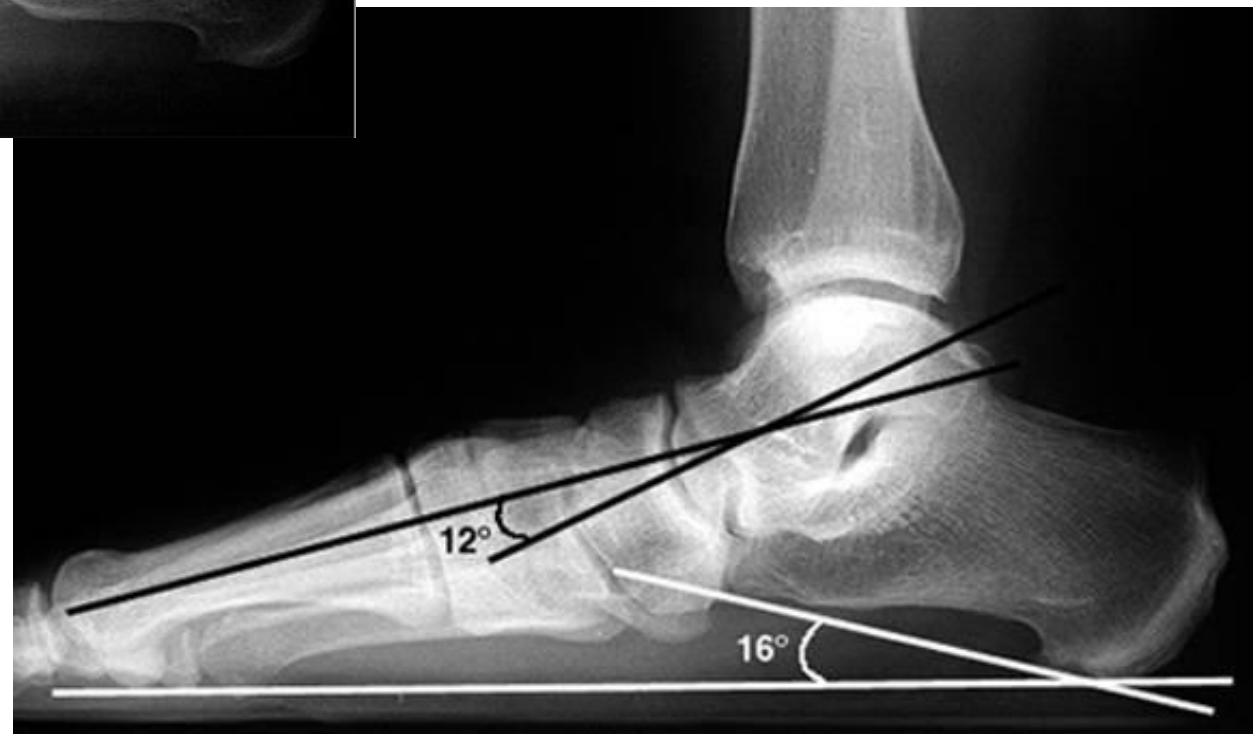
Talocalcaneal angle

Calcaneal pitch

AHR(arch height ratio)

Arch height


12°


12°
16°

Management

- Is treatment necessary?
- In many cases, pes planus (PP) does not require treatment:
- The arch may develop spontaneously in children under 10 years with flexible PP and no other relevant condition.
- In adults, a 'good' PP is one which has has been present a long time, is flexible, bilateral, painless, and not progressing.

Management

- Consider referral or treatment for PP if:
- PP is fixed, new, asymmetrical, progressing, there is foot pain, or if the patient has another disease which may be contributing (e.g. neuropathy or inflammatory arthritis).
- There is tibialis posterior dysfunction. This should be treated in its own right: treatment may involve rest, NSAIDs, orthotics or surgery.[4]

Conservative treatment

- Heel cord stretching is an important part of treatment, as a tight Achilles tendon tends to pronate the foot.[3] See box for details.
- Orthotics (inserts or insoles, often custom-made) may be used. These usually contain a heel wedge to correct calcaneovalgus deformity, and an arch support.
- Reduce contributing factors:[2]

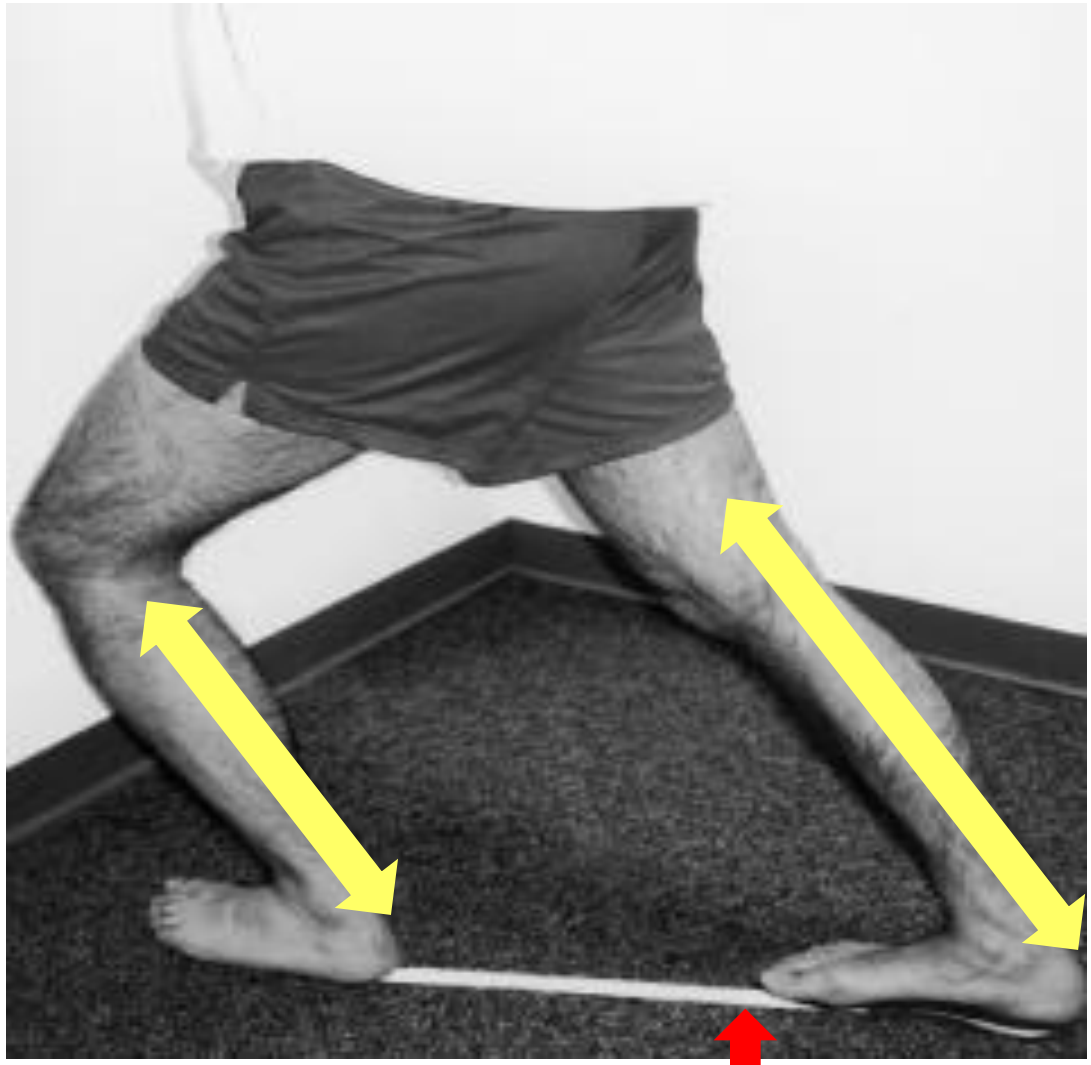
ARCH TYPE →	FOOT ALIGNMENT →	SHOE TYPE
 normal arch	 neutral	STABILITY SHOE
 high arch	 supinator	CUSHIONED SHOE
 flatfoot	 pronator	MOTION CONTROL SHOE

Fig. 3

The Exercises for the treatment

- Non-Weight Bearing (Sitting) ;
  - active foot rolling
  - trying to pick up a duster
  - alternative toe clawing
  - foot shortening
- Weight Bearing (Standing).
  - standing, walking
  - Correct heel and toe walking

Stretching of Achilles tendon



10sec
→30sec

2-3/day

3-5/week

Soleus stretching

GCM stretching

Surgery

- Common indications for surgery are:
  - Cerebral palsy with an equinovalgus foot, to prevent progression and breakdown of the midfoot.
  - Rigid and painful PP.
  - To prevent progression, e.g. with a Charcot joint.
  - Tibialis posterior dysfunction, where non-surgical tre atment is unsuccessful.

❖Possible surgical procedures include:

- Achilles tendon lengthening.
- Calcaneal osteotomy, to re-align the hindfoot.
- Reconstruction of the tibialis posterior tendon.
- For severe midfoot collapse of the arch, triple arthrodesis may be indicated.

Table 3. Comparison and Collation of the Three Existing Randomized Controlled Trials for Foot Orthoses and Pediatric Flatfoot

	Wenger et al,[11] 1989	Powell et al,[14] 2005	Whitford and Esterman,[12] 2007
Sample size (No.)	98	40	180
Subject age (years)	1–6	5–19	7–11
Condition or diagnosis	Flexible flatfoot	Juvenile idiopathic arthritis Foot pain for 1–24 mo	"Flexible excess pronation"
Groups	Shoe Helfet heel cups UCBL orthoses Control	Custom orthoses (n = 15) Neoprene inserts (n = 12) Athletic shoes (n = 13)	Generic orthoses Customized orthoses Control
Outcome measures	Radiographs of foot morphologic development	Pediatric pain questionnaire Timed walking Foot Function Index Pediatric QoL inventory (physical domain)	Motor skills Physical activity Self-perception
Findings	No significant differences among groups	Orthoses group showed significantly improved pain, function, and QoL	No significant differences between groups (approximately 50% had pain that, anecdotally, orthoses seemed to help)

Abbreviations: QoL, quality of life; UCBL, University of California Berkley Laboratory.

Note: The findings from the study by Powell et al[14] are applicable only for children with juvenile arthritis. There are notable differences between the studies by Wenger et al[11] and Whitford and Esterman,[12] eg, subject ages and outcome measures. The informal reports of improved foot/leg pain with orthoses apply only to symptomatic children and are preliminary findings.

Table 4. Subjective Features of Foot Posture that May Assist the Clinician in Monitoring Foot Morphologic Change over Time

	Foot Structure Attribute	Comment
Observe	Medial arch height	Normally increases with age
	Heel eversion	Reliability tested for RCSP
	Talar prominence	
	Lesions	
Assess	Ankle range	Manual testing with the knee extended is more reliable than with the knee flexed
	Forefoot/rearfoot	Reliability tested for forefoot/rearfoot
	Local tenderness	
	Gait (barefoot and shod)	Notice differences; footwear may be beneficial
Consider	Heel inversion with tip toe	Arch appears unless flatfoot is rigid
	Windlass effect	Dorsiflexion of hallux should raise arch via plantar fascia
	Obesity	Associated with increased flatfoot prevalence
	Muscle tone, ligament laxity	Can scale using Beighton's method
	Os tibiale externum	
	Tibial, knee positions	
	Tibial, femoral torsions versus positions	More proximal influences (often age related) that may affect foot posture
	Imaging	
	Blood tests	
	Sex	Males associated with flatfoot increased prevalence

Abbreviation: RCSP, resting calcaneal stance position.
Note: The reliability of these observations is largely unfounded.

Pes cavus

Synonyms for Cavus Foot

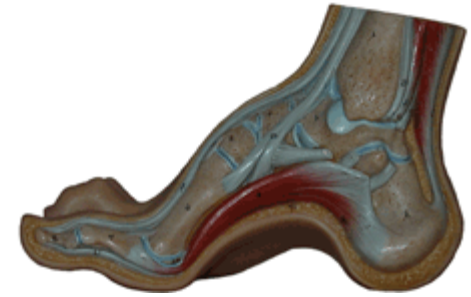
- Anterior Equinus
- Pes Cavo Varus
- Contracted Foot
- Talipes (Pes) Arcuatus
- Talipes Plantaris
- Schaffer Foot
- Lotus Flower Foot
- Bolt Foot
- Claw Foot
- Vault Foot
- Hollow Foot

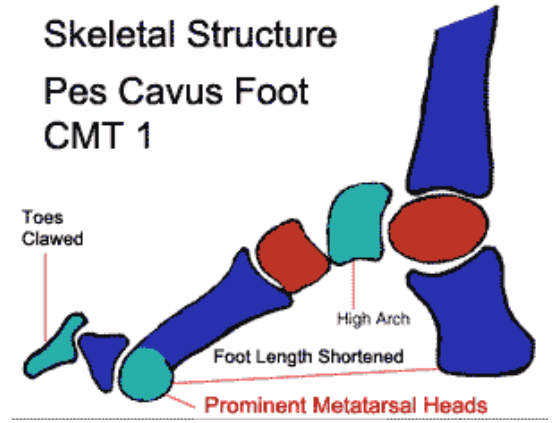
Pes cavus

- Extraordinarily high plantar longitudinal arch
  - Arch fails to flatten out with WB
- Forefoot is plantarflexed to rearfoot
- Primarily sagittal plane deformity

What's the problem?

- clawing of the toes, posterior hindfoot deformity (described as an increased calcaneal angle), contracture of the plantar fascia, and cock-up deformity of the great toe. weightbearing for metatarsal heads and associated metatarsalgia and callus.





Etiology of Pes Cavus

- Neurological
- Congenital
- Iatrogenic
- Infection
- Idiopathic

Etiology

- Neurological – mc cause; estimated at about 75%

  Charcot Marie Tooth disease

  Friedrich's Ataxia

  Roussy-Levy syndrome

  Poliomyelitis

  Cerebral Palsy

  Dejerine-Sottas's interstitial hypertrophic neuritis

Etiology

- Congenital
  - Spina Bifida
  - Talipes Equinovarus
  - Myelodysplasia
  - Clubfoot
- Iatrogenic
  - Post surgery or trauma
  - Peroneal nerve injury
  - Weak anterior muscles
  - Overpowering posterior muscles
- Infection
  - Syphillis
  - Poliomyelitis
- Idiopathic
  - Must be considered

Presenting Complaints

- Pain and/or weakness
  - Discomfort and fatigue of the foot
  - Pain related to callus formation at the “ball” of the foot
- Deformity
  - Trouble obtaining shoe gear
- Ankle Joint instability
- Lack of coordination

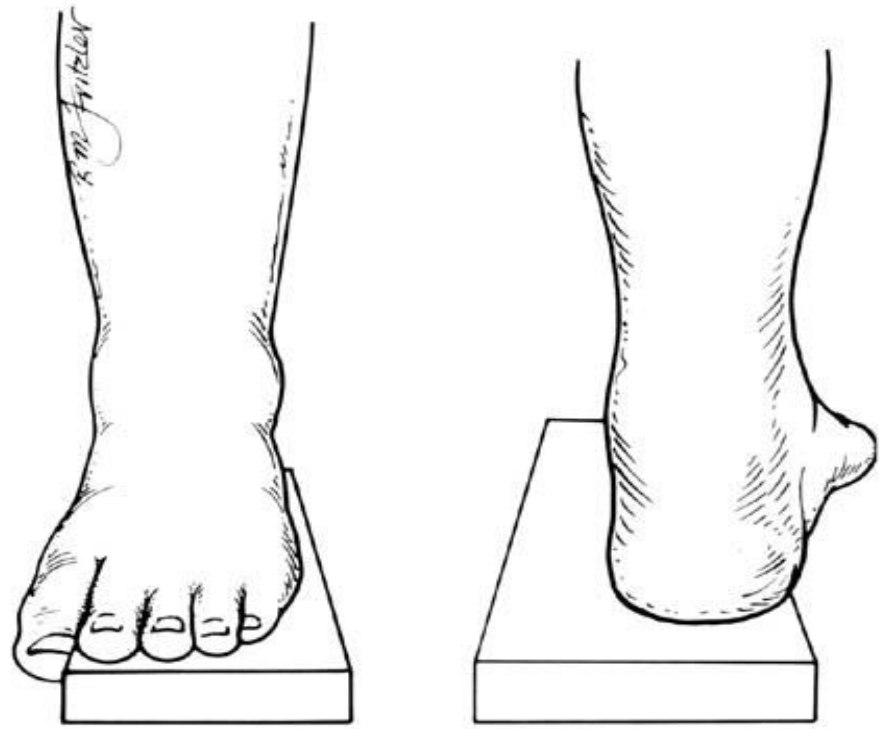
Evaluation

- Complete History
  - Include developmental, familial, and a good medical history
- Neurological Exam
  - Evaluate motor & sensory systems, assess reflexes and coordination tests.
- Musculoskeletal
  - check strength, ROM, DTR, rotational deformities (hips, knees, tibia, etc.)

Evaluation

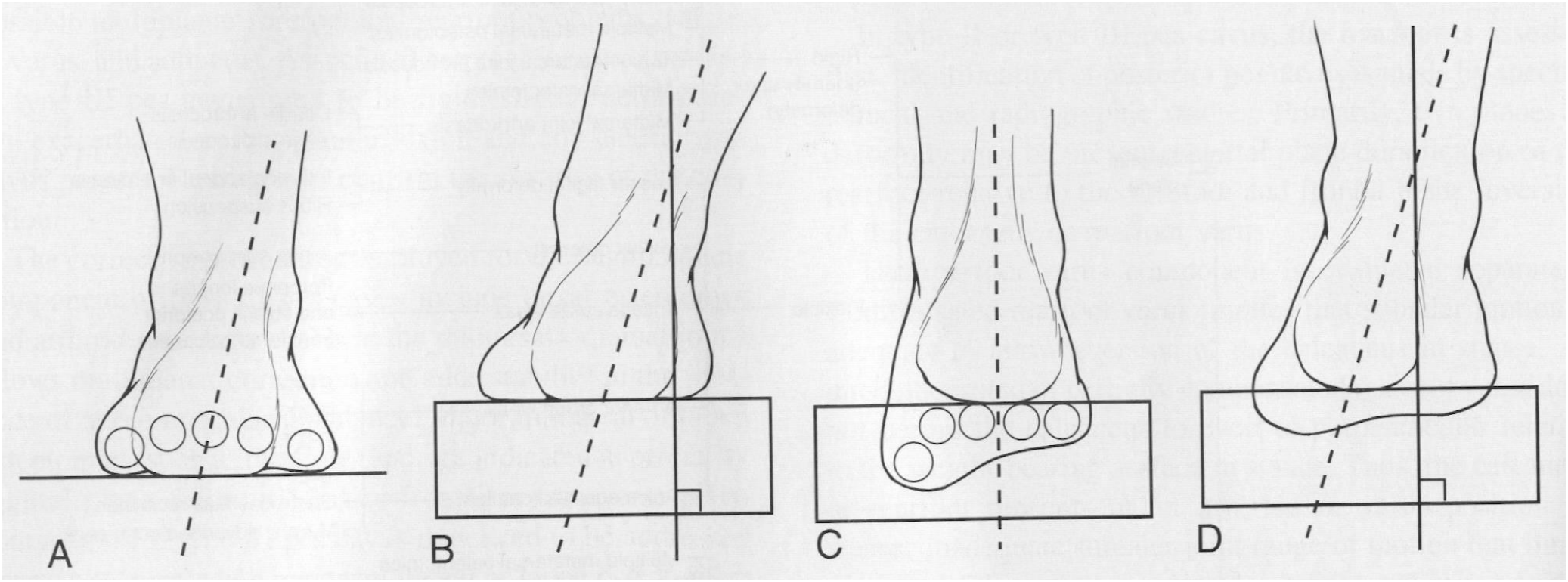
- Biomechanical Exam
  - Include gait analysis
  - Wide based gait with short steps ⇒ neurological
  - High stepping ⇒ weak AJ DF
  - Kelikian push-up test: test for flexible or rigid digital deformities
  - Coleman Block Test
  - Assess ankle equinus

Coleman Block Test



- Block Test
  - FF hanging off an edge
  - Bisected Calcaneus is vertical
    - STJ is Compensating
    - No rearfoot frontal plane component
  - Bisected Calcaneus is in varus
    - STJ is partially Compensated or uncompensated
    - Rearfoot frontal plane component

Biomechanics
Rearfoot Varus



Tibial Varum

Compensated

Partial or Uncompensated

Other Diagnostic Tests

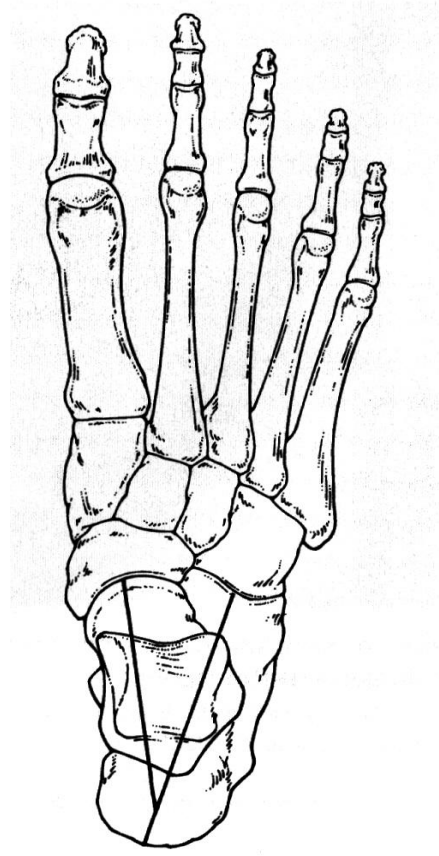
- Electromyography (EMG)
- Nerve conduction velocity
- Muscle biopsy
- Nerve biopsy
- Blood Tests
  - Blood smear shows acanthocytosis (Bassen-Kornzweig syndrome)

Radiographs

- AP
  - Evaluate transverse plane deformities
    - Metatarsus adductus
    - Kite's Angle
    - T-N articulation
- AP Ankle
  - deformity may not be at foot; ankle in varus

Talocalcaneal Angle (Kite's Angle)

- Is formed by the bisection of the longitudinal axis of the rearfoot and head and neck of the talus
- Normal is 15–30° and 75% of talus head articluates with the navicular
- Supination is 16° or less and greater than 75 % articulation



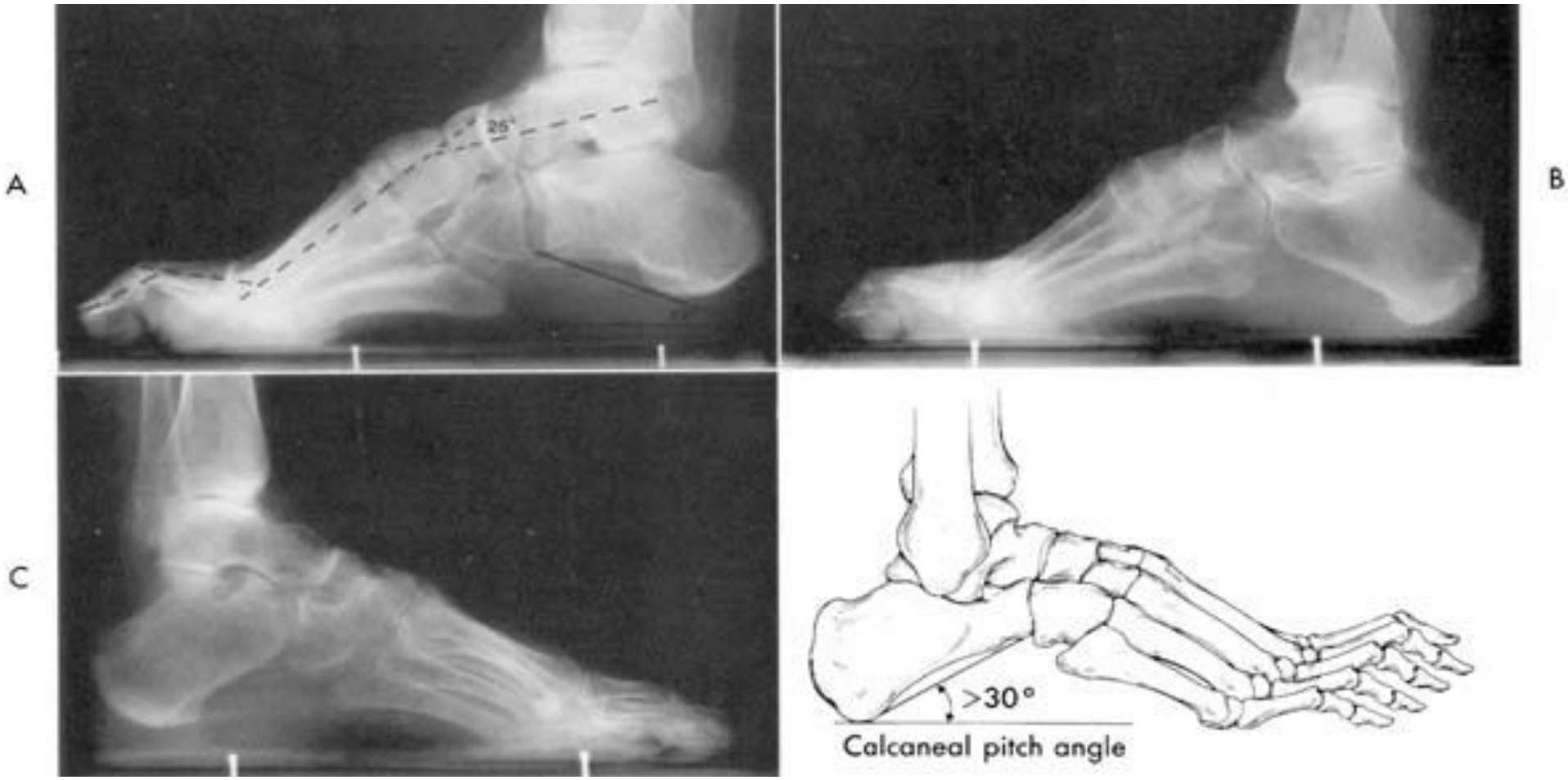
Radiographs

- Lateral
  - Evaluate:
    - Calcaneal inclination angle
    - Talar declination angle
    - Meary's angle
    - Hibb's angle
    - Metatarsal declination angle
    - Evaluate sinus tarsi and cyma line

Calcaneal Inclination Angle

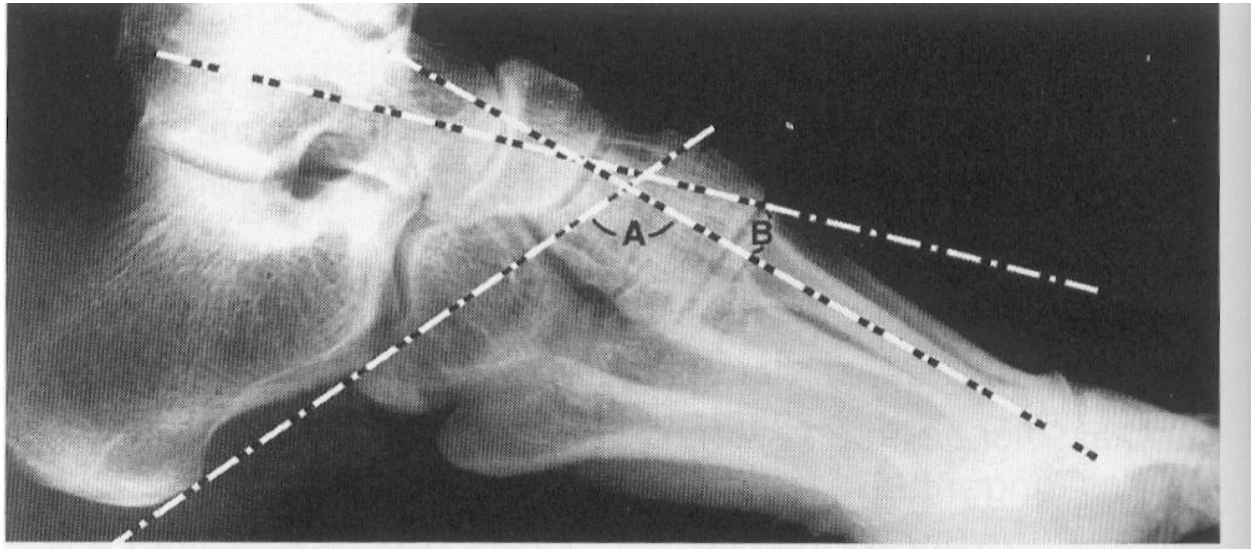
- Best angle – changes little with supination or pronation
- Inferior pitch of calcaneus to WB surface of calcaneus to 5th metatarsal head
  - Normal: 24.5°
  - Moderate pes cavus: 31°– 40°
  - Severe pes cavus : > 40°

Calcaneal Inclination Angle



Hibb's Angle

- long axis of calcaneus as it intersects with bisection of the 1st met.
- Intersects at apex of the deformity
- Represented by angle A



Anterior Cavus Foot

- Sagittal plane deformity
- Excessive PF of FF on RF

- Metatarsal Cavus (apex at Lisfranc's joint)
- Lesser Tarsal Cavus
- Forefoot Cavus (apex at Chopart's joint)
- Combined Cavus Foot (2 or more listed above)

Anterior Cavus Foot

- Local = PF of first ray only
- Global = entire FF is PF

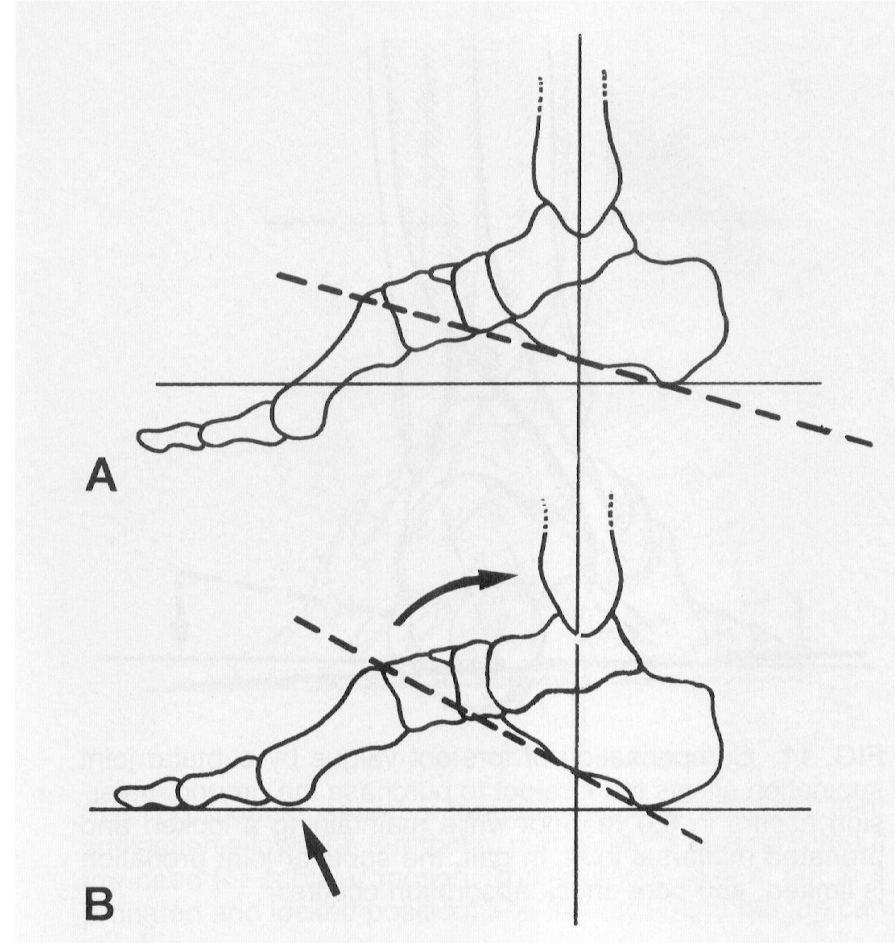
- Differentiating these two is important in determining proper surgical procedure

Anterior Cavus Foot

- C.I.A. < 30°
- Meary's angle > 10°
- Meary's angle intersects at base of 1st metatarsal or Lisfranc's joint

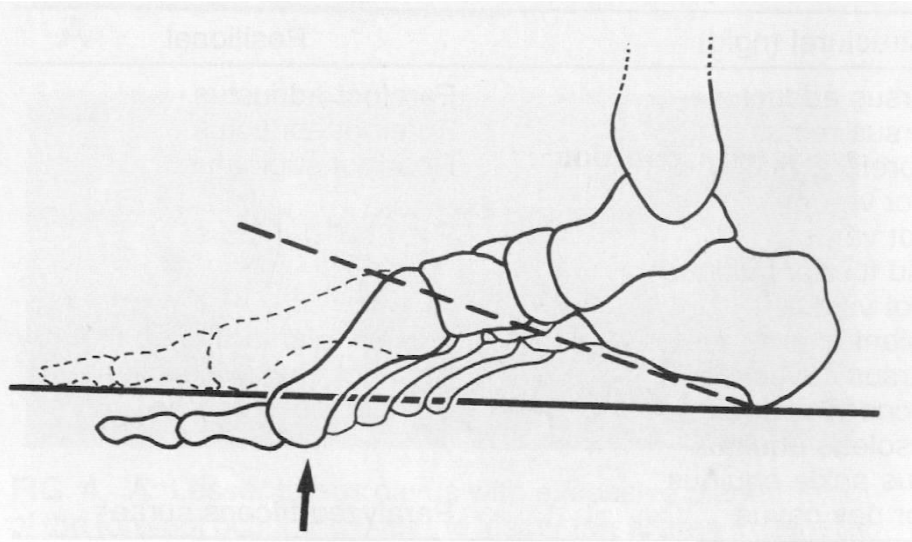
Rigid Anterior Cavus
Compensation

- Pseudoequinus
  - Functional limitation of AJ dorsiflexion caused by premature use of the AJ motion to compensate for pure sagittal plane anterior pes cavus deformity
  - No STJ compensation



Flexible Anterior Cavus
Compensation

- FF dorsiflexion at midfoot with WB forces
- Plantar buckling at MPJs
- Retraction of toes at MPJs



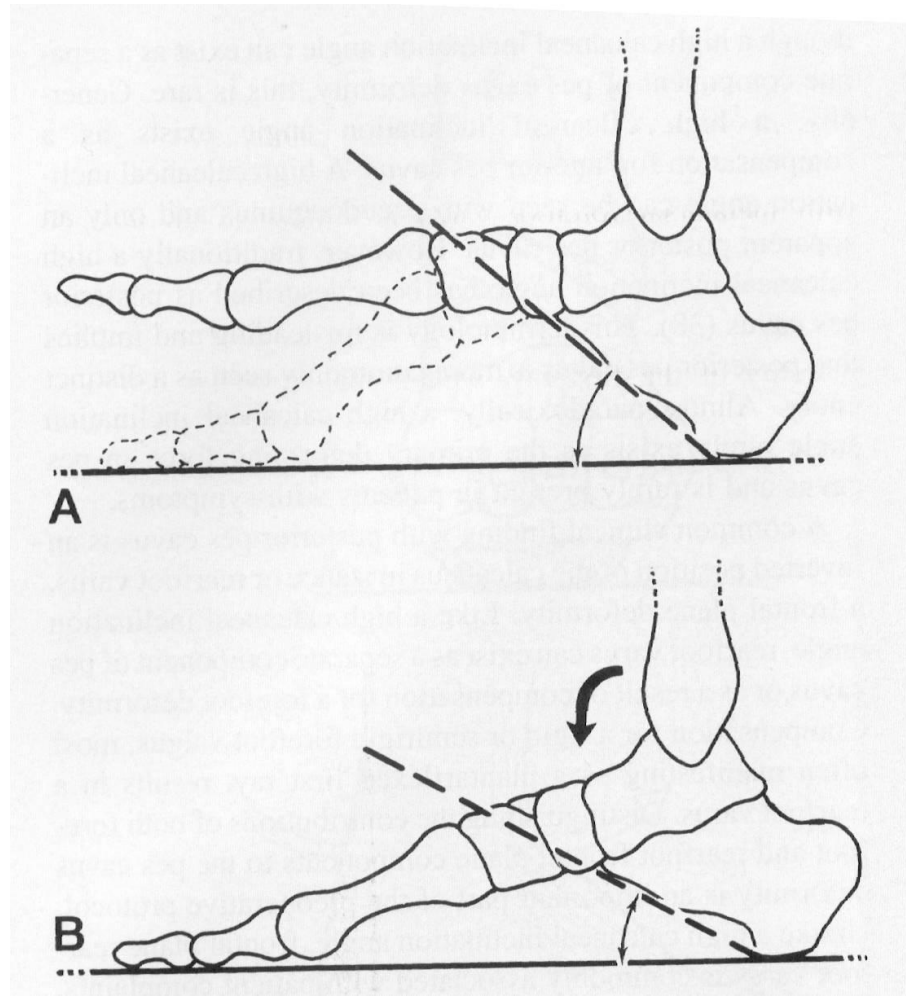
Posterior Cavus Foot

- Primarily STJ deformity
- Less common than anterior pes cavus

- C.I.A. > 30°
- Meary's angle < 10°
- Meary's angle intersects proximal to Chopart's joint

Posterior Cavus
Compensation

- Sagittal plane
  - A) Flexible:
    - Plantarflexion Comp.
    - No change in CIA
  - B) Rigid:
    - FF plantarflexion Comp.
    - Decreased CIA



Combined Cavus Foot

- Anterior and Posterior components
- ↑ C.I.A., talar declination angle, & met. declination angle

Combined Cavus Foot

- Primary Anterior
  - C.I.A. ~ 30°
  - Meary's angle intersects at N-C joint
- Primary Posterior
  - C.I.A. > 30°
  - Talar varus
  - Meary's angle intersects at Chopart's joint

Pes Cavus Rearfoot Varus

- Functional FF deformity with a rigid RF varus
- Coleman Block test used to determine if RF varus is 1° or 2° deformity

Treatment Goals

- Correct the deformity
- Relieve pain
- Maintain a balanced foot

Conservative Treatment

- Indications: mild pes cavus or when surgery is contraindicated
- Shoe modifications and inserts
  - build up shoe
  - AFO
- Physical Therapy
  - Stretching

Surgical Correction

- Soft tissue procedures
  - indicated for flexible deformities
  - often used in conjunction with osseous procedures
- Osseous procedures

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