FOOT DISORDERS IN THE NEWBORN

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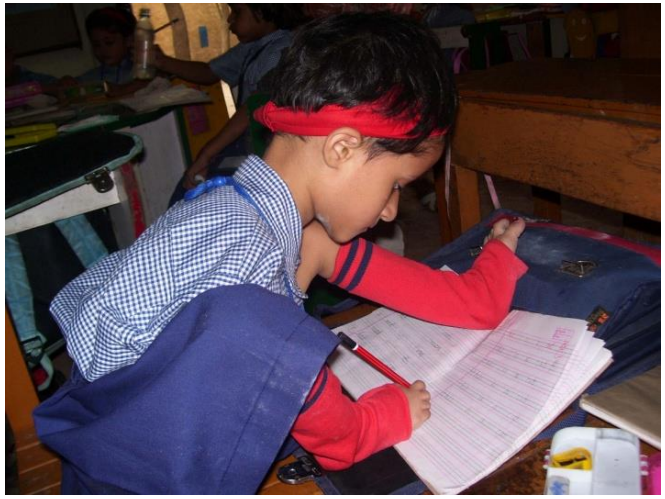
HUMAN FOOT ANATOMY

Complex biomechanical system

- bones, joints, ligaments, tendons, and plantar cushioning

Capabilities

- Support and acceleration of body weight
- Shock absorption
- Adaptation to uneven terrain
- Prehensile function



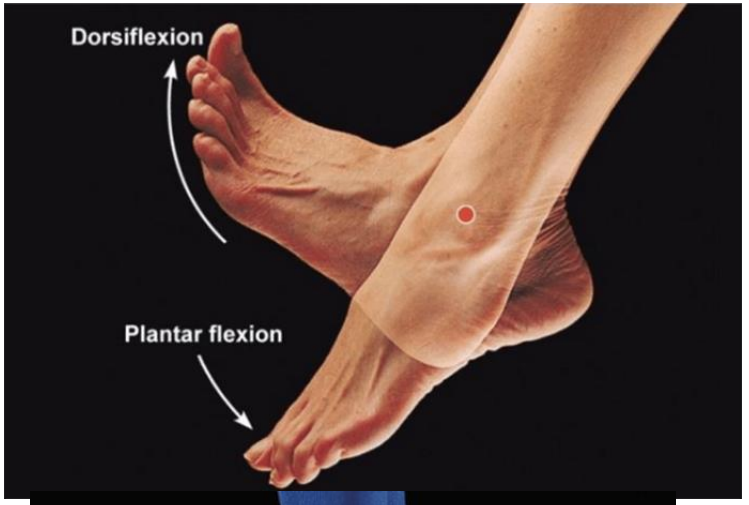
ANATOMY: FOOT MOTION

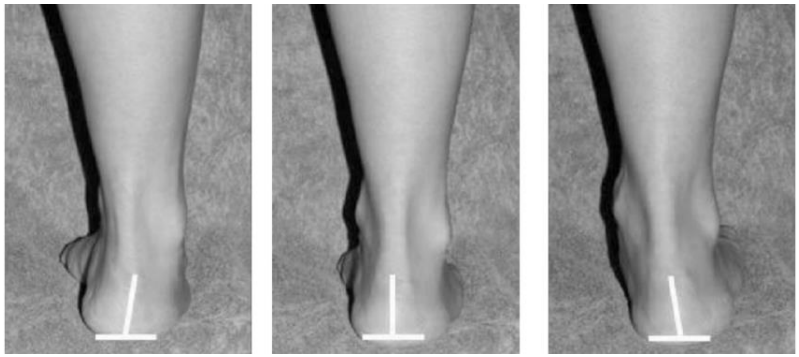
Foot and ankle motion critical to function

Movement terms confusing and overlapping

Hindfoot:

- Dorsiflexion and plantar flexion at ankle mortise
- Inversion and Eversion at subtalar joint

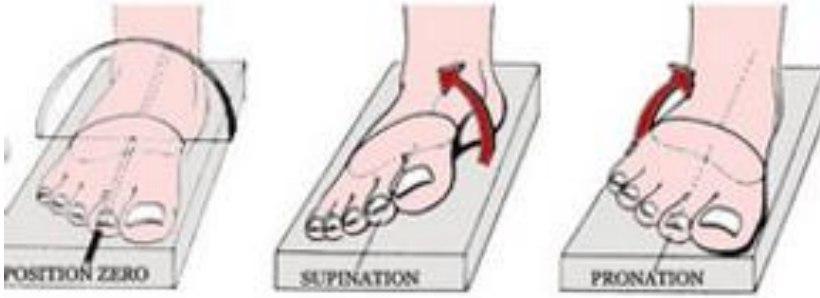


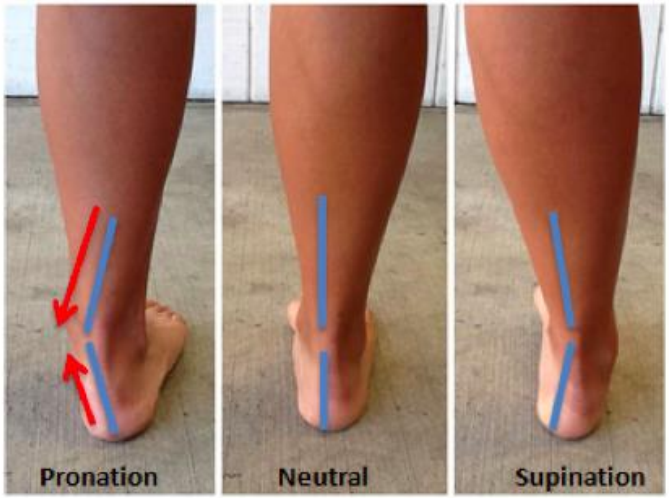


ANATOMY: FOOT MOTION

Midfoot/forefoot:

- Supination and Pronation (role plantar surface inward and outward)
  - Supination: dorsiflexion first MT → flatter arch
  - Pronation: plantarflexion first MT → higher arch
  - Confusing: applied to the subtalar joint

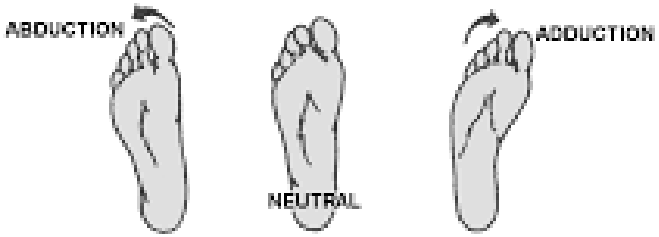


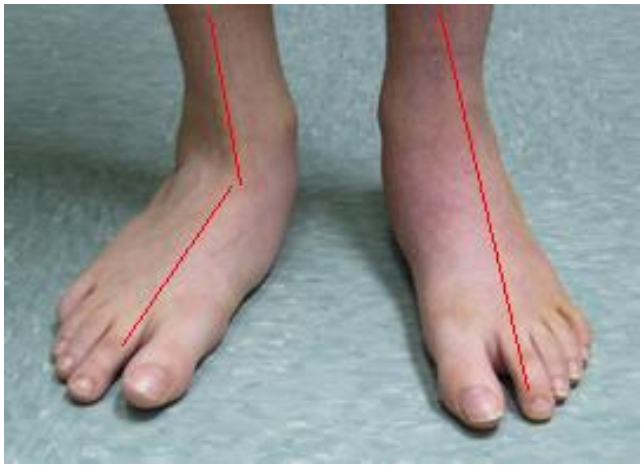


ANATOMY: FOOT MOTION

Midfoot/forefoot:

- Adduction and Abduction (internal and external rotation relative to tibia)
- Plantar flexion and dorsiflexion

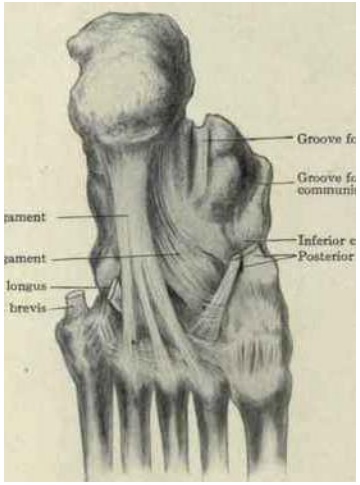


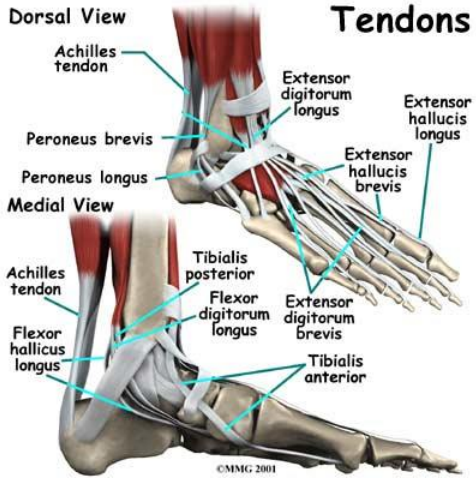


FOOT ANATOMY: STRUCTURE

Longitudinal arch

- Transfers forces to appropriate skin locations
- Formed by bony structure
- Maintained by strong ligaments
  - Flexibility main determinant of height
- Supported and altered by muscles
  - peroneous longus, intrinsics, post tib → increase arch
  - Tibialis anterior, peroneous brevis/tertius →decrease arch





DEFORMITIES

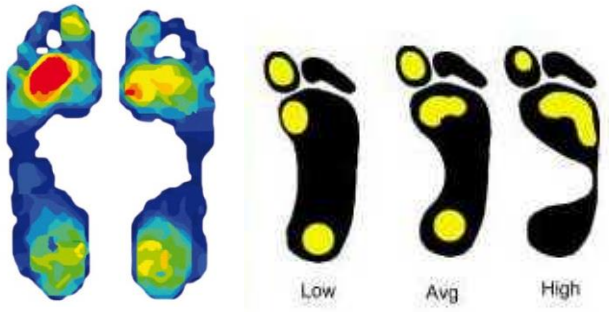
Hindfoot

- Equinus → plantarflexion
- Calcaneus → dorsiflexion
- Valgus → eversion/apex medial
- Varus → inversion/apex lateral

Midfoot/forefoot

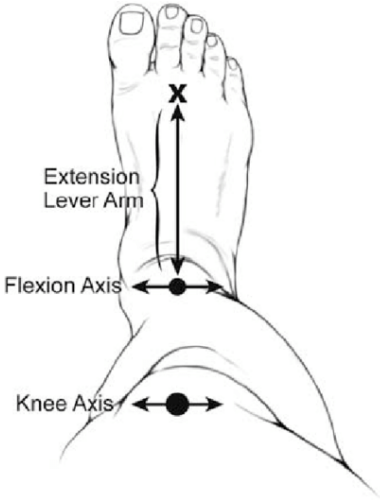
- Adductus → internal rotation relative to tibia
- Abductus → external rotation relative to tibia
- Cavus →higher arch (pronation of forefoot, first metatarsal down)
- Planus →lower arch (supination of the forefoot, first metarsal up)

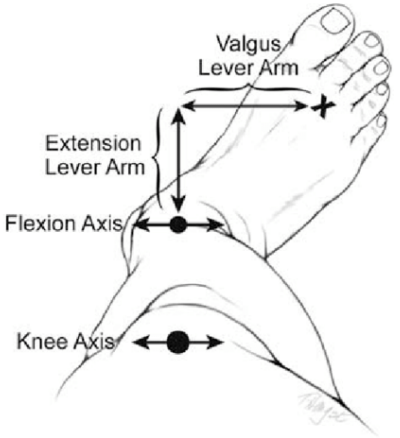
EFFECTS OF DEFORMITY



Altered weight bearing

- Concentration of weight over smaller area
- Weight bearing in an abnormal area
- Callous, pain, skin breakdown, stress fracture





Loss of stability

- Difficulty adapting to uneven surfaces
- Giving way, sprains

Altered kinematics

- Eccentric joint loading → arthritis
- Lever arm dysfunction → decreased energy efficiency

EVALUATION

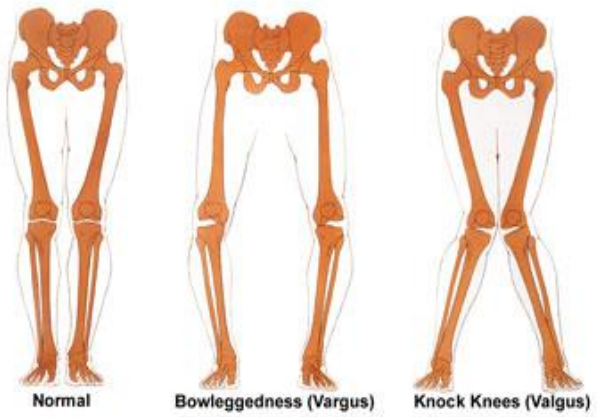
Foot deformity can be initial sign of underlying condition!

- Especially if:
  - Unilateral
  - Progressive
  - Cavovarus

Conditions presenting with foot deformity

- Spinal dysraphism/tethered cord
- Neuromuscular disease
  - Charcot-Marie-Tooth
  - Muscular Dystrophy
  - Cerebral palsy
- Arthrogryposis, Larsen syndrome (clubfoot, CVT)

EVALUATION



Examine remainder of limb

Appearance of foot deformity can be complicated by proximal deformity

- Knee or ankle valgus → apparent hindfoot valgus, abnormal shoe wear
- Rotational deformity → apparent flatfoot or cavovarus deformity

TREATMENT

Initial conservative treatment rule

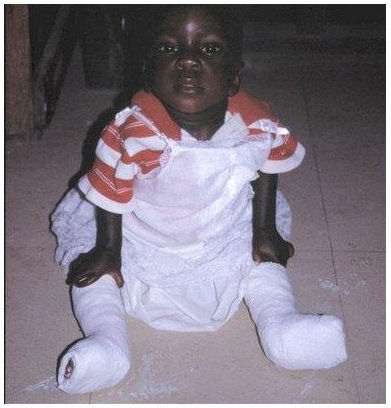
- Observation
- Shoe modification
- Bracing
- Casting/stretching

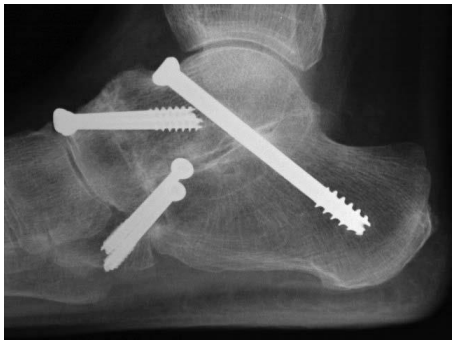
Operative treatment

- intractable symptoms unresponsive to non-operative treatment
- disorders with poor natural history (clubfoot, congenital vertical talus, progressive cavovarus)

Joint preserving surgery

- Fusions/talectomy last resort
- Maintain ROM, function on uneven surfaces
- Prevent adjacent arthritis





TREATMENT

Best treatment of many foot deformities remains controversial

- Wide spectrum of severity
  - Different populations in different studies
- Difficult to quantify results of treatment
- Follow-up into adult life necessary
  - Children with foot deformity typically do not complain and function well
  - Relapses occur years after initial treatment
  - Pain and functional problems do not develop until adolescence or adulthood

FOOT DEFORMITIES IN THE NEWBORN

Calcaneovalgus foot

Congenital vertical talus

Metatarsus adductus

Idiopathic clubfoot/talipes equinocavovarus

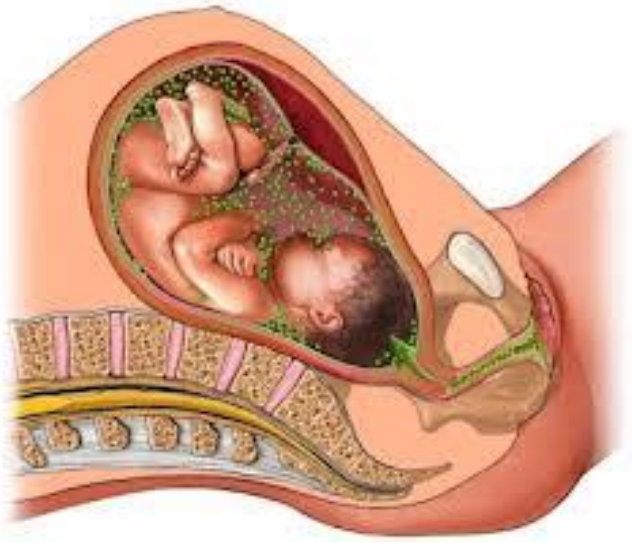
Hallux Varus

Syndactyly

Curly toe

Varus 5th toe

CALCANEOVALGUS FOOT



Talipes Calcaneovalgus

Most common foot deformity noted at birth

Incidence depends on definition

- 5-50% hyperflexible ankle
- 1/1000 stiff, obvious deformity

"Packaging" disorder

- Uterine wall forces foot into dorsiflexion

CALCANEOVALGUS FOOT

Foot hyper-dorsiflexed against leg

- Heel is in valgus,
- Forefoot abducted
- Low arch

Flexible

- Initially there is a contracture of dorsal joints and tendons
- Correctable to neutral
- Flexibility improves with age
- CVT: stiff deformity that does not improve with age

CALCANEOVALGUS FOOT

Ankle and calcaneus are dorsiflexed

CVT: Ankle plantarflexed, foot dorsiflexed → rocker bottom deformity

CALCANEOVALGUS FOOT

Associations

- Posteromedial bowing of tibia
  - Remodels but leg length discrepancy
- Developmental hip dysplasia
  - Opposite foot metarsus adductus “wind blown feet”
- External rotation contracture of hip

B

CALCANEOVALGUS FOOT

Radiographs

- Not necessary
- Differentiate from CVT (no vertical talus)

Natural history

- Excellent in short term
- Foot position “normalizes” in majority
  - 3-6 months
- Clinical experience has suggested association with symptomatic flexible flatfoot

CALCANEOVALGUS FOOT

Treatment

- Vast majority: observation or gentle stretching by parents
  - Stretching: no difference in outcome
- Marked stiffness of plantarflexion and inversion: consider serial casting
- Surgery not indicated

CONGENITAL VERTICAL TALUS

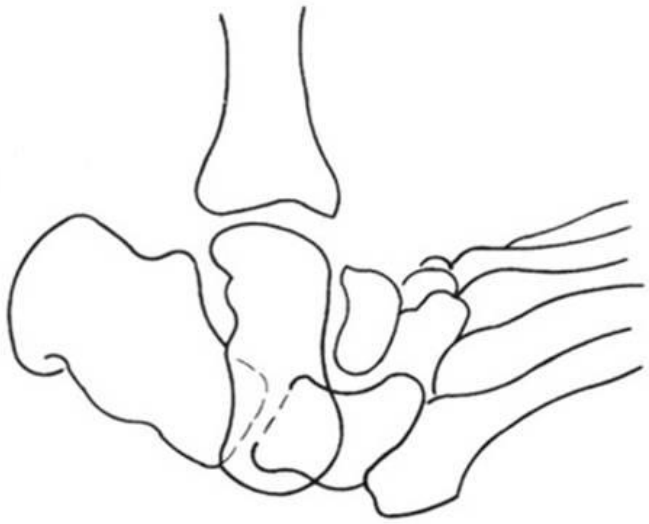
Teratologic dorsolateral dislocation of the navicular on the talar head

Rare (1/10000)

Cause unknown

Isolated congenital deformity or associated with neuromuscular disease (50/50)

- Arthrogryposis
- Myelomeningocele
- Many others



CONGENITAL VERTICAL TALUS

Classic presentation: rocker-bottom foot

- Convex plantar surface
- Apex at talar head: palpable in sole of foot

Calcaneus and talus are fixed in plantar flexion

- Achilles contracture

Heel valgus

Classically: Stiff deformity

- Variable flexibility
- Correctable: congenital oblique talus

NATURAL HISTORY

Very poor

Weight bearing on talar head, not heel pad or metarsals

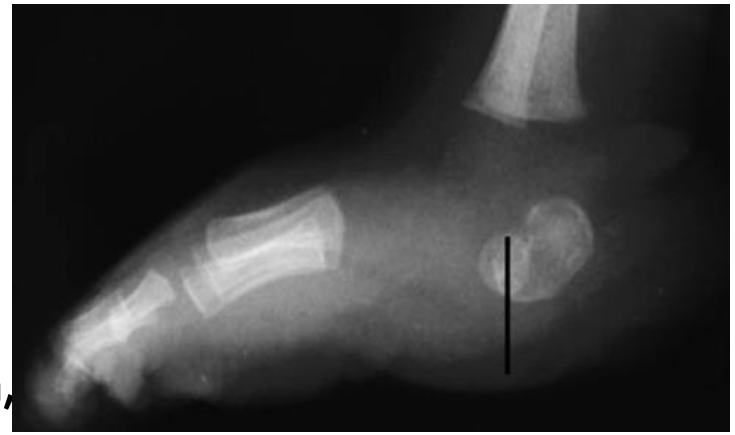
Severe lever arm dysfunction

Difficult shoe fitting

DIFFERENTIAL

- Calcaneovalgus foot
- Congenital oblique talus – can be corrected, navicular reduces on talar head
  - More benign natural history → flexible flatfoot
- Flexible flat foot

RADIOGRAPHS



Lateral radiograph in "neutral," plantar flexion, and dorsiflexion

Problem: immature ossification

- Navicular: 18-36 months

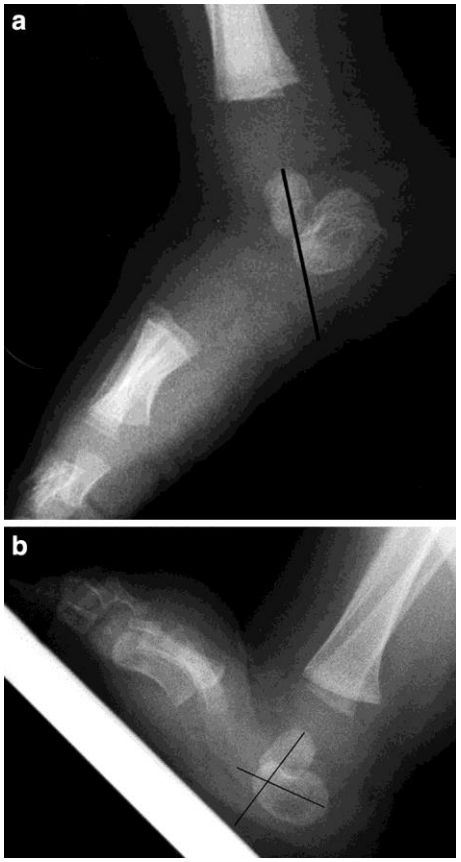
Plantar flexed talus

- "vertical"

Metatarsals point toward dorsal talus

Dorsiflexion view: Talus remains plantar flexed

Plantarflexion view: Deformity does not fully reduce



TREATMENT

Serial manipulation and casting to stretch tight dorsal structures

- Incomplete correction and recurrence

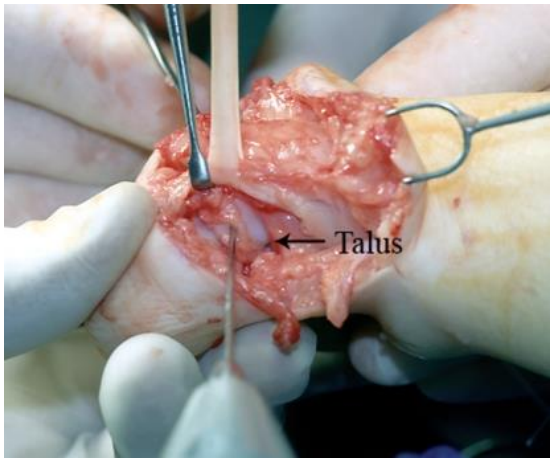
Surgery is usually required

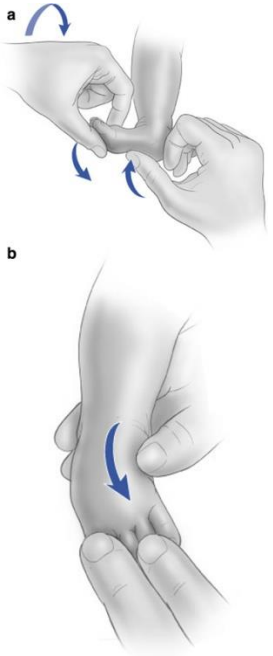
Traditional treatment: extensive surgical release, tendon lengthening and pinning of talonavicular joint at 1 year of age

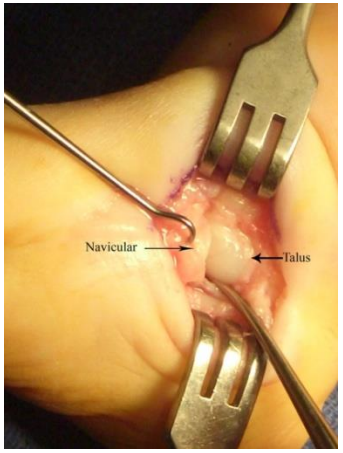
Trend toward less invasive treatment

Dobbs technique: similar to Ponseti treatment of clubfoot

- Reverse Ponseti casting
- Closed vs. open reduction and pinning of talonavicular joint and heel cord tenotomy
- Bracing







METATARSUS ADDUCTUS

Medial deviation of forefoot relative to the hindfoot

Incidence app. 1% (.1-12%)

Cause unknown

- Considered packaging disorder
  - Associated with hip dysplasia and torticollis
- Some patients develop after birth
- Multifactorial

METATARSUS ADDUCTUS

Clinical features

- Typically noted at birth
- Bean shaped foot with curved lateral border
- Varus great toe
- Forefoot cavus
- Flexible ankle and subtalar joint
- Intoeing often primary complaint in older children

METATARSUS ADDUCTUS

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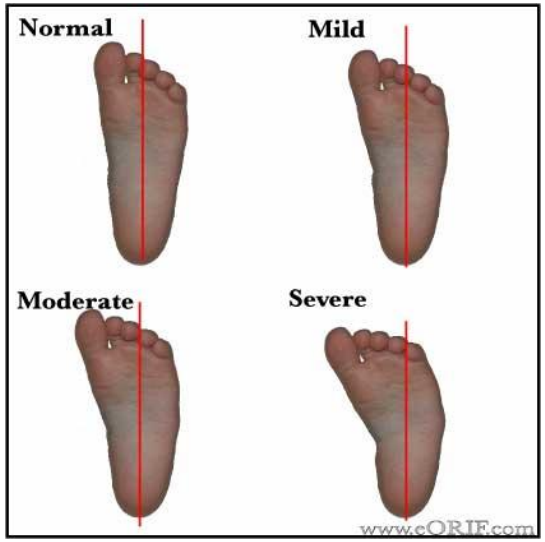
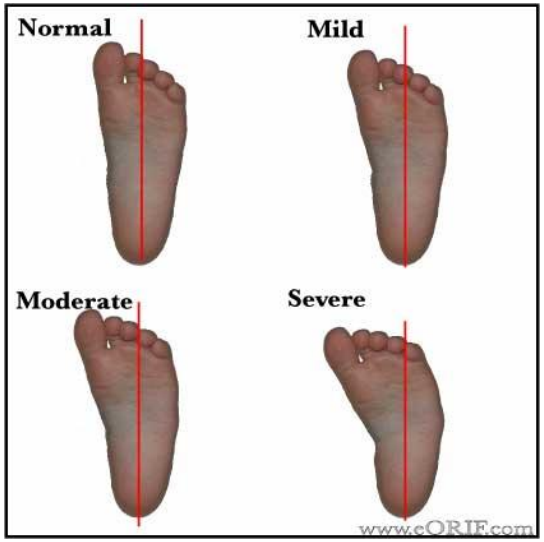


METATARSUS ADDUCTUS

Clinical features

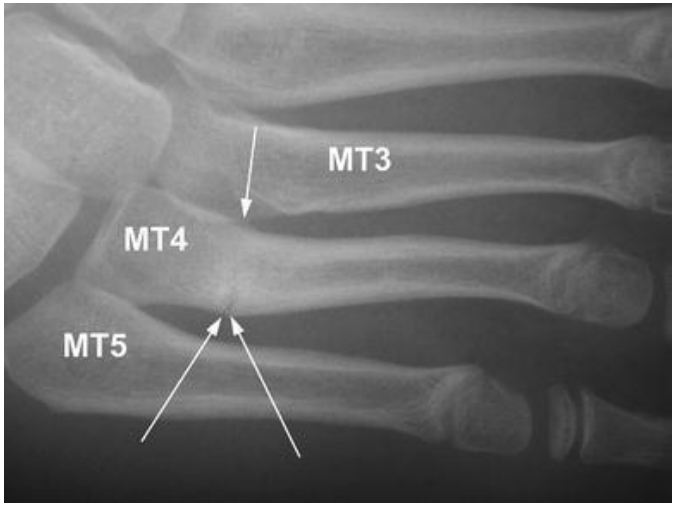
- Variable severity
  - Dynamic → Muscle pulls foot into adductus, especially with weight bearing
    - Variable deformity at rest,
    - Actively corrects with stroking lateral border of foot
  - Passively correctable
  - Rigid → medial foot crease



METATARSUS ADDUCTUS

Risks/Natural history

- Foot is plantigrade and functions well
- Intoeing
- Difficulty with shoewear
- Midfoot pain
- Lateral metatarsal stress fracture



METATARSUS ADDUCTUS

Treatment

- Dynamic Deformity → Observation
  - Parent stretching: abduction of forefoot relative to heel
    - Efficacy of parent stretching alone unproven
  - Steady improvement with growth in most patients
  - Often appears worse when patients begin walking

METATARSUS ADDUCTUS

Treatment

- Stiff deformities (not correctable) → Treatment
  - Numerous treatment options described
    - Good results with most options
    - Reverse last shoe may cause hallux valgus
  - No studies comparing treatment to observation or placebo
  - Studies comparing treatments show equivalent results
- Serial manipulation and casting
  - Plantar flex foot to lock subtalar joint
  - Abduct the forefoot relative to calcaneus
- Taping/strapping
- Bracing
  - Bebax shoe: small study shows equivalent results to casting
  - Wheaton brace

METATARSUS ADDUCTUS

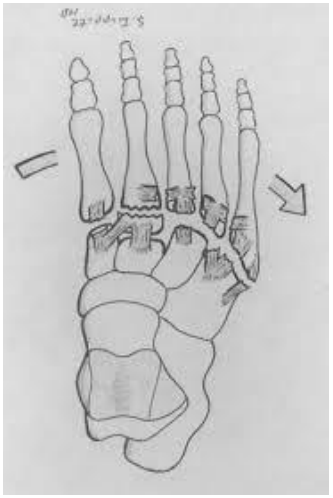
Treatment

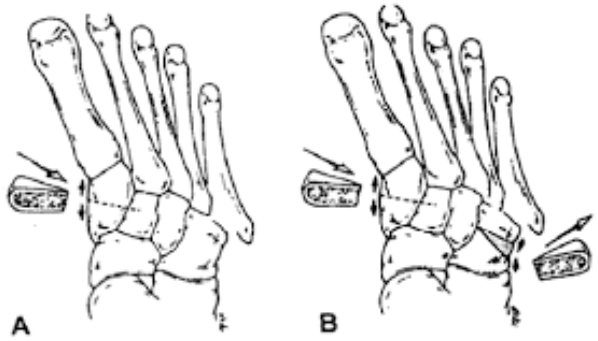
- Passively correctable foot → Observation or treatment?
- Rushforth: followed 83 children to age 7
  - 84% resolved/had mild residual deformity
  - 10% had moderate flexible deformity
  - 4% had stiff deformity
  - Difficult to predict which would not resolve until age 3
- Casting most effective before age 9-12 months
- Benefit of casting flexible foot?
- Observe until age 6-9 months and cast if not improving or becoming stiff

METATARSUS ADDUCTUS

Surgical treatment

- Symptomatic or severe deformity later in childhood or adulthood
- Soft tissue release
  - Abductor and 1st TMT,
  - Cast or pinning
  - Poor outcomes
- Corrective osteotomy
  - Medial cuneiform opening wedge osteotomy
  - Cuboid closing wedge osteotomy
  - Metatarsal osteotomies





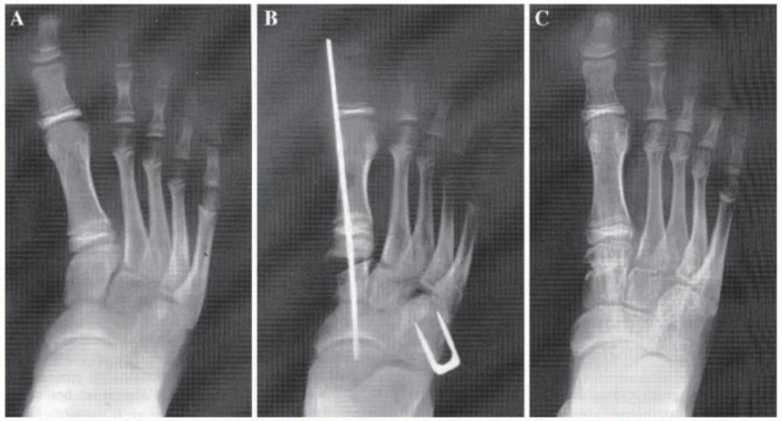


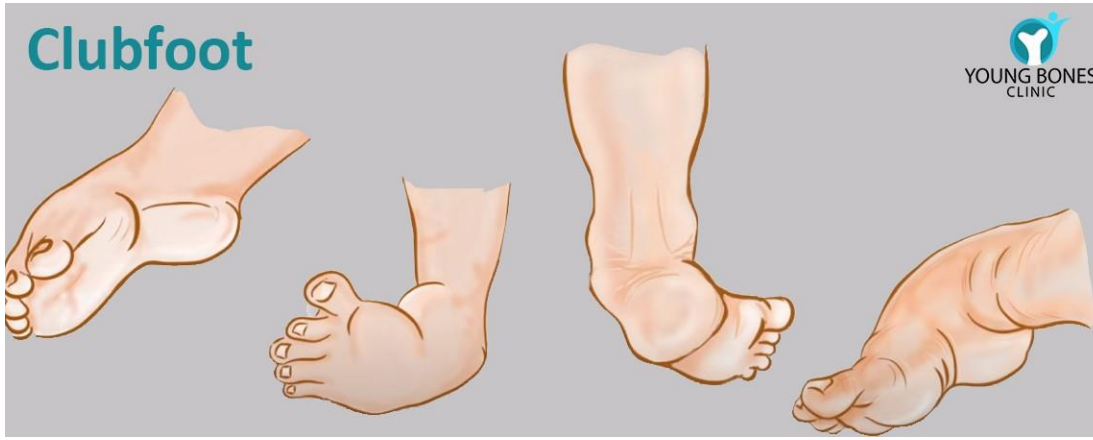
Figure 6: (Boy DEL..Ste'phane) (a): At 12 years old, the patient had a Z-shaped foot grade 4 with no initial treatment. He has metatarsus adductus and lateral deviation of the anterior tarse, with deformities of the first cuneiform and the cuboid. (b): we performed a closing wedge osteotomy of the cuboid and opening wedge osteotomy of the first cuneiform allowing good alignment of the first ray. The pins are removed after 2 months, the cast after 3 months (c). After one-year follow-up, the clinical correction and radiological aspect remained excellent. This procedure is recommended for the treatment of the Z-shaped foot after the age of 4–6 years. Jawish et al[28].

CLUBFOOT

Congenital foot deformity characterized by equinus and varus of the hindfoot with cavus and adduction of the midfoot/forefoot

Talipes Equinovarus

"Idiopathic clubfoot" – deformity occurring in otherwise healthy children



CLUBFOOT

Incidence 1/1000

Male to female: 2.5:1

50% bilateral

20% associated with syndrome or other congenital anomalies

- Myelomeningocele
- Arthrogryposis
- Constriction bands/Streeter dysplasia
- Prune belly
- Tibial hemimella
- Mobius syndrome
- Freeman-Sheldon syndrome (whistling face)
- Diastrophic dwarfism
- Larsen syndrome
- Pierre Robin syndrome

CLUBFOOT

Etiology: unknown

4 characteristic deformities:

- Cavus (midfoot/forefoot)
- Adductus (midfoot)
- Varus (subtalar)
- Equinus (ankle)

Limb discrepancies

- Foot smaller
- Affected limbs have smaller thigh and calf girths
- Mild limb length discrepancy
- Persist into adulthood

CLUBFOOT

Wide spectrum of severity

"Positional" clubfoot

- Clubfoot appearance at birth
- Deformity is completely correctable
- Multiple heel creases (normal)
- Intrauterine molding
- Corrects spontaneously or with very short period of casting
- Metatarsus adductus may persist

CLUBFOOT

True clubfoot

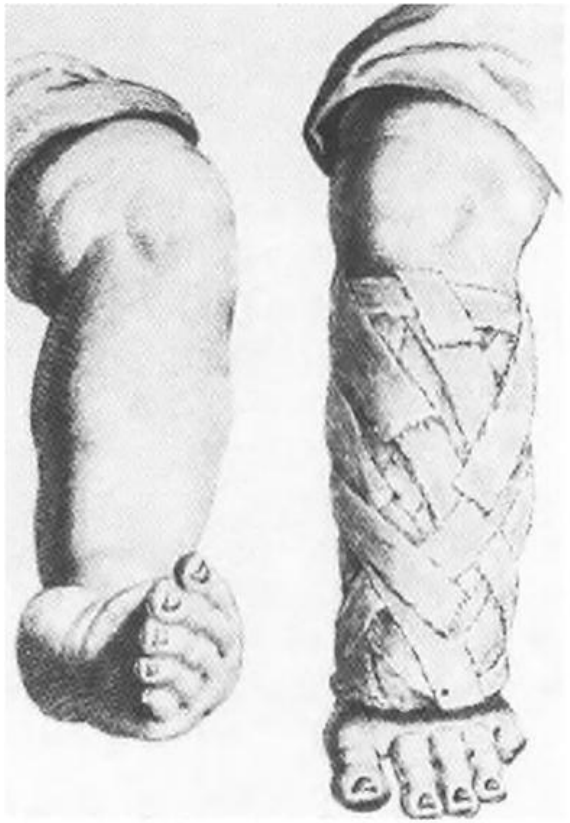
- Not fully passively correctable
- Variable stiffness

Radiographs not helpful

Poor natural history

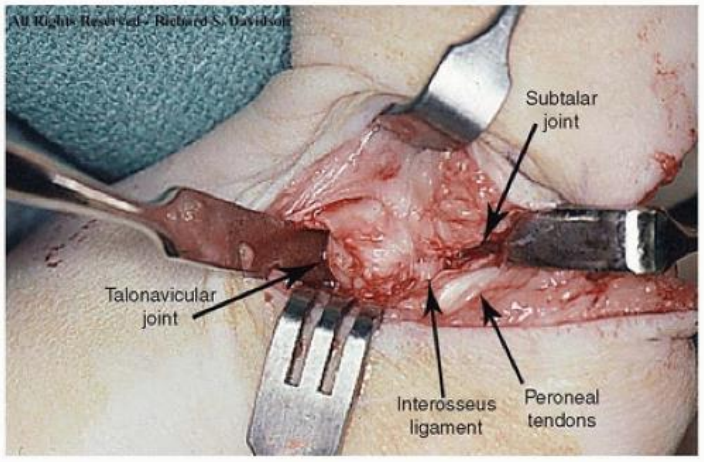
- Deformity becomes stiffer over time
- Weight bearing on lateral and dorsal foot

CLUBFOOT



Treatment

- Hippocrates described manipulation and bandage application followed by shoe in 400 BC
- Plaster of Paris cast introduced in 1830
- Poor success rate with casting techniques → large surgical releases
  - "More predictable correction"
  - High rate of overcorrection, undercorrection
  - Stiffness

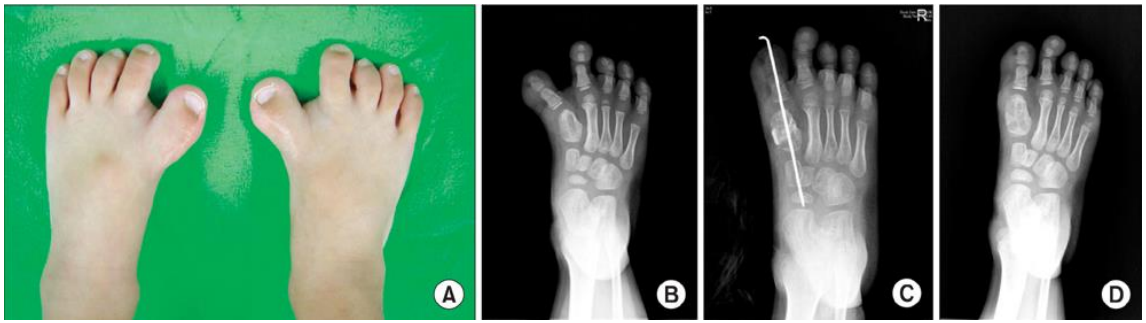


CLUBFOOT

Treatment

- Ponseti method of manipulation and casting developed 1940s
  - Results published in 1980 and1995
  - Successful correction of deformity in greater than 90% cases
  - More flexible foot, fewer complications
  - Achilles tenotomy and anterior tibial tendon transfer often required
  - Primary risk: recurrence
  - Foot abduction orthosis

HALLUX VARUS



Rare

Cause unknown

- Skeletal dysplasia
- Fibrous band along medial toe
- Longitudinal bracket epiphysis → short first metatarsal

Poor natural history

- Poor cosmesis
- Inabilty to wear shoes

Treatment

- No effective conservative treatment
- Excision of bracket epiphysis if present (age 6 months to 1 year)
- Abductor and medial MTP release, pinning, possible syndactylization to 2nd toe.

SYNDACTYLY OF TOES

Common malformation

Typically partial simple syndactyly of 2nd and 3rd toes

- Partial syndactyly extremely common
- Complete syndactyly 1/2000

Familial

Bilateral

Usually "simple:" soft tissue only

- Failure of apoptosis of intervening skin

SYNDACTYLY OF TOES

Asymptomatic, cosmetic concern

- No functional consequences
  - Toes function together
- Plastic surgeons: “associated with significant psychological morbidity”

No conservative treatment option?

Reconstruction

- Skin graft
- Cosmetic improvement?
- Scar contracture or sensitivity
- Web creep: recurrence over time

Recommend no treatment

- Big toe?
- polydactyly, deformity

CURLY TOE

Very common deformity

- Most 5th toes?
- 3rd toe most common in severe cases

Flexion and medial rotation (supination) of lesser toe

- overlap with medial toe

Caused by tight flexor tendons

Resolves in 25%, persists in 75%

Non-operative treatment not successful

Release flexor tendons if symptomatic

THANK YOU

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