Foot and ankle biomechanics

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Barts and the London Basic Science Course
Take home messages

- Anatomical relations
- Subtalar / midtarsal mechanics
- Plantar fascia / windlass mechanism
- Pes cavus / Pes planus

- Flexible vs fixed deformity
Ankle biomechanics

- Axis of the ankle is oblique
- Movements therefore triplanar
- Everts (valgus) and abduction during dorsiflexion
- Inverts (varus) and adduction during plantarflexion
Ankle biomechanics

- Joint reaction force in stance is 4 times body weight
- At least 10 degrees of dorsiflexion is needed for normal gait
- 1mm of lateral talar shift decreases tibio/talar surface contact up to 40%
Talus

- Talus is an intercalated segment
- 60% articular surface
- No muscle or tendon insertions
- Blood supply
Calcaneus

- 3 facets
- Various angles
- Articulations with talus, fibular and cuboid
- Tarsal sinus / canal
Subtalar joint

- Allows eversion / inversion
- Hindfoot position locks and unlocks the midfoot
- 3 Facets
Heelstrike

- Tib ant contracts eccentrically
- STJ everts and aligns (unlocks) the midtarsal joints
- Allows foot to pronate and accommodate to absorb energy of heelstrike
- Tibia internally rotates

Toe-off

- Tib post inverts hindfoot and locks midfoot
- Foot more rigid for toe-off
- As toes dorsiflex, plantar aponeurosis tightens
Pes planus

- Valgus heel (STJ everted)
- Flattened medial arch
- Prominent navicular head
- Forefoot abducted and supinated (too many toes)
Pes planus - clinical assessment

- Diff dx
  - Soft tissue (Tib post or RA)
  - STJ pathology
- Tib post function
- STJ movement - Fixed or flexible
- Midtarsal movements and medial arch
Tib Post dysfunction

Johnson, modified by Myerson

- **Stage 1:**
  - Tenosynovitis, normal length - Non operative

- **Stage 2:**
  - No fixed deformity - Orthotic +/- tendon transfer

- **Stage 3:**
  - Fixed STJ deformity - Arthrodesis +/- triple

- **Stage 4:**
  - Ankle joint involved - Calcaneal osteotomy +/- fusion
Assessment of deformity

Fixed vs flexible governs management in foot surgery
‘Pes cavus’

An abnormally high arched foot
Aetiology

- Idiopathic pes cavus (20%)
- CMT
- Polio
- Spinal dysraphism, CP, arthrogryposis
- Severe clubfoot
- Post traumatic
  - Compartment syndrome
  - Hindfoot / midfoot fracture malunion
Pes cavus - aetiology

CMT /HSMN
- Paralysis of tib ant and P. brevis with relative overactive Peroneus longus
- Leads to a plantar-flexed 1st ray

Poliomyelitis
- Overactive tib ant pulls the midfoot up
- Lead to a calcaneus deformity
Polio
- Relatively overactive tib ant
- Calcaneus deformity
- Varus or valgus
- Sensation spared
CMT

- Adducted forefoot
- Plantarflexed 1st ray
- Equinus of the midfoot
- Varus of the heel
Fixed vs flexible

- Clawtoes correct with standing / passive elevation of MT heads
- Cavus improved by elevation of 1st ray
- Hindfoot corrected by Coleman’s block test
Summary

- Fixed vs flexible deformity
- Basic anatomy and blood supply
- Subtalar mechanics
- Cavus and planus
- Fixed vs flexible