PES Planovalgus & PES Cavovarus: The Brainy Muddy Portion of F &A Learning

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Disclosure:

Nothing related to the topics presented today.
MCQ:

• What is the most appropriate surgical treatment for patients with PTTD with rigidity of hindfoot arthritis?
Answer:

- Triple Arthrodesis.
- NONE of the procedures for extraarticular reconstruction for flexible deformity are applicable in this situation.
MCQs:

Flexible Stage 2 PTTD is best treated conservatively with what device?
Answer:

• Best Options:
• Early stage: Medial Post Orthotic
• UCBL for significant valgus with subfibular impingement
• AFO is a wrong answer: foot flexible so not necessary
A patient with foot pain is noted to have a cavovarus foot. The heel corrects to slight valgus on Coleman block testing. This finding indicates that the deformity should correct with which of the following procedures?
Forefoot Driven Hind Foot Varus

Dorsiflexion first MT osteotomy
MCQs

• A cavovarus foot reconstruction is planned. Which of the following *tendon transfers* will decrease the plantar flexion forces being applied to the first metatarsal head?
Answer:

- PL to PB transfer

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<thead>
<tr>
<th>Simple Deformities</th>
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<tbody>
<tr>
<td><strong>Deformity</strong></td>
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<tr>
<td>equinus</td>
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<td>cavus</td>
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<td>varus</td>
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<tr>
<td>supination</td>
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<td>flatfoot</td>
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<table>
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<tr>
<th>Complex Deformities</th>
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<tbody>
<tr>
<td><strong>Deformity</strong></td>
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<tr>
<td>equinovarus + supination</td>
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<tr>
<td>equinovalgus</td>
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<td>calcaneovalgus</td>
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MCQs

Mostly asked relationships of agonist vs antagonist relationship in foot.
Muscle Balancing in foot: Agonist - Antagonist

• Inversion-Eversion: PT vs PB, AT vs PL
• DF vs PF: AT vs Gastroc-Soleus
• Toe deformity: Intrinsic vs Extrinsic
MCQ:

• The **Coleman block test** is used to evaluate the cavovarus foot. What is the most important information obtained from this test?
Answer: Hindfoot flexibility

- Right hindfoot varus
- Forefoot-driven varus
  - Forefoot rigid
  - Hindfoot mobile
  - Hindfoot varus moves to valgus
- Hindfoot-driven varus
  - Forefoot mobile
  - Hindfoot rigid
  - Hindfoot remains in varus
Adult Acquired Flatfoot (AAFD or PTTD?)

• The PTT Anatomy:
  • Origin: Post Tib, fib and IOM
  • Insertion: 3 limbs
    a. Anterior limb: navicular tuberosity
    b. Middle limb: 2, 3 Cuneiform, cuboid, 2 to 5 MT
    c. Posterior limb: sustentaculum tali
Describe Flat Foot:

- Loss of Longitudinal medial arch (???) + segmental deformities
- Forefoot Supination
- Midfoot Abduction (dorsal lateral peritalar subluxation)
- Hindfoot Valgus
- Ankle Equines
Why ???
Fig. 4. Lateral views of wire-mesh models of the talus and first metatarsal from the weight-bearing CT scans of a normal patient (top) and a patient with a painful fallen arch (bottom). Note the difference in the talus-first metatarsal angle.

Fig. 5. AP views of wire-mesh models of the talus and first metatarsal from the same weight-bearing CT scans of a normal patient (left) and one with acquired flat foot deformity (right). Note the difference in the talus-first metatarsal angle.

Biomechanics and pathophysiology of flat foot
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AAFD = PTTD ???

- Other causes:
  - Lisfranc
  - RA
  - Tarsal coalition
  - Accessary navicular
How PTT function?

• INVERT HINDFOOT
• ADDUCT AND SUPINATE FOREFOOT
• LOCK TRANSVERSE TARSAL JOINT TO TOE OFF
• ACTIVE IN STANCE PHASE
• CONTROL BY TIBIAL NERVE
More facts:

- Antagonist by PB: PT weak PB get dominant and Spring lig fail and talar head sunk
- Watershed zone at 40mm proximal to insertion or 2 cm distal to MM
PTT is a Medial Arch Stabilizer

- Dynamic stabilizer
- Static stabilizer: spring ligament SM portion is mainly affected
- Failure of PTT ultimately leads to failure of Spring ligament and then foot flat
- Gastrocnemius Contracture: chicken or egg? (Silverskoid test)
- 2cm limited excursion of PTT
Acetabulum Pedis & Windlass:

Windlass mechanism of the plantar fascia

- As the toes are dorsiflexed plantar fascia is under constant traction as it is pulled distally around the metatarsal heads (drum of the windlass).
- This tightening elevates the longitudinal arch, inverts the hind foot and externally rotates the leg. This mechanism is passive and depends entirely on bony and ligamentous instability.
Arch Height Natural History:
More Understanding:
40% more stiffness:
Ideal Condition:
However, need some space for wiring.

Tuck in & Not Compromise Sturdiness:
- wires safe & structure stable
Alternative Designs:
Structure Unstable & Wire not safe
Transition: need supporting structures longitudinal & transverse
Clinically:

- Medial hindfoot pain progress to subfibular impingement
- Weak resisted hindfoot inversion
- Too many toe signs ????
What We Need to Care About?

- Flat foot is one type of normal shape of foot (especially in pediatrics) until it becomes painful.
- Progressive collapsing and pain: need Intervention
- PTT is associated but not always the cause of flat foot
Work ups:

- WB Xray & WBCT
- Talar head coverage
- Lateral Meary angle
- Deltoid insufficiency
- MRI vs US
Stages Made Easy:

I: pain PTT no deformity

IIA: flexible deformity + medial pain

IIB: flexible deformity + medial pain + lateral pain

III: rigid deformity

IV: Ankle busted
What are the conservative managements?

- Orthotics & Bracing:
- Medial Wedge and Medial Posting
- UCBL
- Arizona Brace
- AFOs
Surgery Options:

Stage 1: NO deformity on tenosynovitis. Synovectomy debridement if over PT 6 mos fails
Surgical Options:

- Stage 2: Yes for deformity but Flexible
- IN Phase FDL transfer
- 2A: medial pain with valgus
- Add MDCO: adding power and protect transfer
- 2B: abducted forefoot
- Add lateral column lengthening (Evans)
- 2C: forefoot supination
- Stable: Add Cotton
- Unstable: Add medial column fusion
Surgical Options:

• Stage 3: rigid fixed deformity w/ arthritis in hind foot
• Triple arthrodesis & correct deformity
• Triple for 3
Stage 4 Options:

- Deltoid fails
- Deltoid recon if flexible
- TTC if rigid
All stages:

Gastrocneums

Contracture

- Silfverskoid:
- Strayer vs Achilles lengthening
Cavovarus foot:

- Medial Arch Elevation
- Forefoot equines
- Forefoot pronation

- Neurological or Trauma: muscle imbalance

- Problems: instability, stress fx, loss of motion
What to look for?

- Unilateral Cavovarus:
  - Spina bifida tethering cord
  - Compartment syndrome sequela
  - Talar neck malunion
  - Polio
- Bilateral:
  - Hereditary Sensory Motor Neuropathy: CMT most common with imbalance of muscle powers
MCCs: Neuro, trauma, congenital, idiopathic

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<tr>
<th>Causes of Adult Cavovarus Foot</th>
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<tr>
<td>Congenital</td>
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<tr>
<td>Arthrogryposis</td>
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<tr>
<td>Talipes equinovarus (clubfoot)</td>
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<tr>
<td>Idiopathic</td>
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<tr>
<td>Neurologic</td>
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<tr>
<td>Cerebral palsy</td>
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<tr>
<td>Cerebrovascular accident (stroke)</td>
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<tr>
<td>Charcot-Marie-Tooth disease (hereditary motor sensory neuropathy)</td>
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<td>Friedreich ataxia</td>
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<td>Poliomyelitis</td>
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<tr>
<td>Spinal cord lesion (e.g., myelomeningocele, syringomyelia, tumor)</td>
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<td>Spinal muscular atrophy</td>
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<tr>
<td>Traumatic</td>
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<tr>
<td>Burn injury</td>
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<tr>
<td>Compartment syndrome</td>
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<tr>
<td>Crush injury</td>
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<tr>
<td>Peroneal nerve injury</td>
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<tr>
<td>Peroneal tendon insufficiency, severe chronic ankle instability</td>
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<tr>
<td>Talus fracture nonunion</td>
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</tbody>
</table>

CMT 1

PMP 22 gene
Tug of War:

• Initial forefoot driven hindfoot varus: over power of PL and PT over the **PB and AT** *(PROBABLY BAD AND AINT TOUGH)*

• Then Calc varus on sue

• Windlass tightens

• Intrinsic overpowered by extrinsics: claw toes

• AT weak and over powered by Gastroc: equines

• Order: intrinsic, PB the AT due to the length of the nerve
So: What to expect?

- Lateral instability and overload
- Stress fx
- Metatarsalgia due to fat pad migration and PF first ray
- DJD
What to look for in clinic:

• Coleman block
• Meaning: forefoot driven hindfoot varus and flexibility
• Peekaboo heel
Work ups:

- WB xray or WBCT: stacking of MT
- Increased Medial Cuneiform height
- Hump back appearance
- Medial shift heel bone
- Hight calc pitch
NonOp Options:

• Medial Arch support: WRONG ANSWER
• Latera posting: YES
Surgeries:

• Plantar Fasicia Release: Windlass mechanism aiding MT DF
• PL to PB
• PTT transfer to dorsum foot through IOM
• Cautions in TAL: weakness
• Flexor to Extensor for claw toes
• First MT DF osteotomy for forefoot driven hindfoot varus
• Add LDCO if NOT the case
• Triple arthrodesis if: rigid and arthritic
Test Questions:

• During gait evaluation of a 25-year-old patient who had polio at age 5, it is noted that the right foot slaps the floor at heel strike, and the toes extend during the swing phase. Examination reveals a flexible cavus foot, claw toes, and an equinus deformity. The patient has tried various orthoses and would like surgical correction if possible. What is the most appropriate treatment?
• Calcaneal Osteotomy, Achilles tendon lengthening, metatarsal osteotomies
• Calcaneal Osteotomy, Achilles tendon lengthening, EHL transfer to the first MT neck, FDL to EDL transfer of the lessor toes
• Calcaneal Osteotomy, plantar fascia release, Achilles tendon lengthening, tibialis posterior transfer to dorsum of foot, FDL to EDL transfer of the lessor toes
• Triple Arthrodesis, Achilles tendon lengthening, EHL transfer to the first MT neck, FDL to EDL transfer of the lessor toes
• plantar fascia release, Achilles tendon lengthening, tibialis posterior transfer to dorsum of foot, FDL to EDL transfer of the lessor toes
Correct Answer:

• Calcaneal Osteotomy, Achilles tendon lengthening, metatarsal osteotomies
• Calcaneal Osteotomy, Achilles tendon lengthening, EHL transfer to the first MT neck, FDL to EDL transfer of the lesser toes
• Calcaneal Osteotomy, plantar fascia release, Achilles tendon lengthening, tibialis posterior transfer to dorsum of foot, FDL to EDL transfer of the lesser toes
• Triple Arthrodesis, Achilles tendon lengthening, EHL transfer to the first MT neck, FDL to EDL transfer of the lesser toes
• plantar fascia release, Achilles tendon lengthening, tibialis posterior transfer to dorsum of foot, FDL to EDL transfer of the lesser toes
Test Questions:

• A 38-year-old man with a congenital pes cavus deformity reports lateral foot pain that has become increasingly debilitating. He has calluses over the lateral column and 3/5 muscle strength of the lateral compartment muscles. Nonsurgical management has failed to provide relief. In surgery, he undergoes a plantar fascial release, peroneus longus to brevis transfer, dorsiflexion osteotomy of the first metatarsal, and a Dwyer osteotomy. He has a hyperextended deformity of the first metatarsophalangeal joint. What tendon transfer will help to address this deformity?
Answers:

• FHL
• EHL
• EHB
• EDL
• TA
Correct Answer:

- FHL
- EHL
- EHB
- EDL
- TA
Test Question:

• Figures 1 and 2 are the radiographs of a 56-year-old woman who reports medial foot and ankle pain and notes a progressive change in the shape of her foot over the past year. Her normal activities are limited by pain. Nonsurgical management has failed to provide relief. Pain is present from the navicular to the medial malleolus. Single leg heel rise is accompanied by correction of hindfoot valgus but is painful. What is the best course of treatment?
Figures:
Answers:

• Debridement of PTT
• Transfer of FDL to medial Navicular
• MDCO w Transfer of FDL to medial Navicular
• MDCO with lateral column lengthening and FDL transfer to medial Navicular
• Triple arthrodesis
Correct Answer:

- Debridement of PTT
- Transfer of FDL to medial Navicular
- MDCO w Transfer of FDL to medial Navicular
- MDCO with lateral column lengthening and FDL transfer to medial Navicular
- Triple arthrodesis
Test Question:

• A 15-year-old boy has a unilateral flatfoot that is preventing sporting activities. After nonsurgical management fails, he undergoes surgery to correct a calcaneonavicular coalition. What procedure will most likely allow him to return to sports?
Answers:

- Non op likely to return to sports most likely
- Subtalar fusion
- Arthroereisis
- Closed manipulation under anesthesia
- Bar resection with tissue interposition
Correct Answer:

- Non op likely to return to sports most likely
- Subtalar fusion
- Arthroereisis
- Closed manipulation under anesthesia
- Bar resection with tissue interposition
The foot orthosis/footwear prescription for correction of a flexible deformity typically seen in Charcot-Marie-Tooth disease includes which of the following components?
Answers:

- Lateral heel and forefoot posting
- Medial heel wedge with lateral forefoot posting
- Metatarsal pad for global MT head offloading
- 3/8” heel lift with firm heel counter
- SACH with medial flare
Correct Answer: Lateral Heel and forefoot posting
Test Questions:

- Figure 1 shows the CT scan of an 11-year-old boy who has had a 1-year history of worsening painful flatfeet. He reports pain associated with physical education at school, especially with running and jumping. Management consisting of activity restriction, anti-inflammatory drugs, and casting has failed to provide relief. Treatment should now consist of
Answers:

- Subtalar arthroereisis
- Triple arthrodesis
- Resection accessory navicular and advancement of PTT
- Resection of Talocalcaneal middle facet coalition in each foot
- Resection of the Calcaneonavicular coalition in both feet
Correct Answer:

- Subtalar arthrodereisis
- Triple arthrodesis
- Resection accessory navicular and advancement of PTT
- Resection of Talocalcaneal middle facet coalition in each foot
- Resection of the Calcaneonavicular coalition in both feet
Test Question:

• Which of the following are considered appropriate nonsurgical bracing/orthotic options for a supple adult-acquired flatfoot deformity with forefoot abduction, secondary to posterior tibial tendon insufficiency?
Answers:

- Rigid AFO with a lateral post
- Custom molded leather and polypropylene orthosis (Arizona Brace)
- UCBL with lateral posting
- One quarter inch lateral heel and sole wedge
- Three quarter heel lift
Correct Answer:

- Rigid AFO with a lateral post
- **Custom molded leather and polypropylene orthosis (Arizona Brace)**
- UCBL with lateral posting
- One quarter inch lateral heel and sole wedge
- Three quarter heel lift
Best Wishes & Happy Learning