Overview of Adult Acquired Flat foot Deformity

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An Overview of Adult Acquired Flat Foot and Tibialis Posterior Pathology

Liza Dunkley
Senior Lecturer in Podiatry
Division of Podiatry and Clinical Sciences

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Aim

- Review anatomy and function
- Provide an overview of the presentation, aetiology, pathological features of AAFF and tibialis posterior pathology
- Assist in the recognition of staging the condition for improved clinical decision making
- Improve treatment outcomes through early recognition and appropriate management
Outline

• Define
• Overview of Anatomy
• Function
• Clinical Presentation
• Pathology
• Pathomechanics
• Clinical Assessment
Adult acquired flat foot deformity

- A progressive, painful deformity resulting from gradual stretch (attenuation) of the tibialis posterior tendon as well as the ligaments that support the arch of the foot.
- Classification of different stages of presentation increasing in severity and stiffness (Johnson and Strom 1989).
- Progressive weakness, ligament disruption and subluxation of the rear foot.
- Management of each stage with different treatment regimes.

Why the confusion?

Does PTT pathology cause a flat foot deformity or do flat feet cause PTT pathology and late sequale AAFF?
Literature

- tendon loss, tendon dysfunction
- AAF secondary to TP pathology
- MRI studies - Spring ligament, deltoid, interosseous TC lig
- 70% unilateral TP pathology subjects had contralateral asymptomatic flat foot but xray same
- Revisions of classifications

Inter related conditions

- Abnormal biomechanics of foot could result in dysfunction of muscle
- Release of the tendon alone does not reproduce a flat foot.
- Spring lig, plantar aponeurosis, deltotid, talo-calcaneal, long and short plantar need to be released
- TP tendon cannot restore alignment if the ligaments are damaged in experimental conditions

Risk Factors

- Women:men 4,3,2 : 1
- Middle to older age
- Predeposition to flat feet / pes planus (Dyal et al 1997)
- Obesity, Diabetes, steroid injection and RA, inflammatory arthropathies,
- Acute trauma - chronic progressive
- Hypermobility, inflammatory, DJD, muscle imbalance CP

Myerson et al 1989
Holmes and Mann 1992
Arch Support mechanisms

- Mobile adaptor/ Rigid lever
- Stabilisers
  - Plantar fascia
  - Spring Ligament
  - Medial TNJ Capsule
  - Interosseous talar calcaneal lig
  - Tibialis posterior tendon
- intrinsics
A common presentation

Patient presents with lowered arch profile and functions in a pronated position through gait

Pain in the medial ankle and foot region

MUSCULOSKELETAL DIAGNOSIS
### Anatomy - Tibialis Posterior

<table>
<thead>
<tr>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve Supply</th>
<th>Action</th>
<th>Function</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>stance</th>
<th>IC</th>
<th>FFC</th>
<th>HO</th>
<th>TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading Response</td>
<td>Mid stance</td>
<td>Terminal Stance</td>
<td>Concentric</td>
<td></td>
</tr>
<tr>
<td>Eccentric</td>
<td>No activity</td>
<td>???????</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Semple et al 2009

*Image showing the anatomical structure of the Tibialis Posterior muscle with semicolons indicating unclear text.*
Posterior Tibial Tendon

- Dynamic stabiliser MLA
- Plantarflexion TCJ
- Supination STJ
- Elevate medial long arch
- Increases efficiency of gastrocnemius
Stabiliser of MTJ - reverses leg rotation through STJ
re-supination – oblique axis
TP deficient Peroneus brevis is unapposed

- Pulley
- TP contraction pulls navicular posteriorally assists in carrying the load placed on spring ligament
- Fibrocartilagenous sesamoid to aid pressure absorbing and gliding

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Biomechanics

- Small lever for plantarflexion
- Main supinator of foot – dependant on STJ transverse axis position
Gait

- Kinematics TPD compared to normal individuals
- Significant alteration in position

**Loading response**
- Decrease in dorsiflexion and increase in eversion of the rearfoot

**Terminal Stance**
- Decrease in plantar flexion and increase in abduction shift
- Loss of varus thrust of forefoot limited motion of mid foot
- Decrease in ROM dorsiflexion at 1st MTPJ

Ness et al 2008
Ligaments

- Support the foot’s architecture
- If muscles are paralysed or weakened by disuse ligaments give way to stress when unprotected by muscular contraction.
- Deltoid
- Deltoid and interosseous
- Foot disconnected from leg
Deltoid

- Strengthens ankle joint
- Holds the calcaneus and navicular against the talus
- Fibrous joint capsule TNJ
Tibio-navicular
Tibio-calcaneal
Posterior tibio-talar

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Plantar calcaneo-navicular ligament (spring lig)

- Important role in stabilising the arch
- Completes the socket
- Prevents drifting apart
Calcaneo-cuboid (short plantar lig)

- Strengthens calcaneocuboid joint
Long plantar lig

- Maintain lateral longitudinal arch of foot
- Passes inferiorly to short ligament
- Larger attachment more proximal on the calcaneus

Interosseous talar calcaneal ligament

- Total loss of movement
Interosseous talar calcaneal
Total loss of movement hintermann 1998
Plantar aponeurosis

- Tie beam
- Slips curve over toe sides of flexors
- dorsally insert plantar lig mtpj and flexor sheath
- Pulls arch together when dorsiflex forms rigid structure for push off
Windlass

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Adult acquired flat foot deformity

- a progressive, painful deformity resulting from gradual stretch (attenuation) of the tibialis posterior tendon as well as the ligaments that support the arch of the foot.
- Can be a disabling condition
- Strong association with flat feet (Hirano et al 2009)
- Co-existing DJD, RA, neurological weakness
DDx – pathological flat foot

- CVT
- TC
- Trauma
- Tumour
Unilateral pathology - mechanical
Clinical Signs and Symptoms

**symptoms**
- Postero medial foot and ankle, heel and arch pain
- Medial ankle pain and swelling
- Tarsal Tunnel symptoms
- Lateral foot pain
- Worse with increased activity
- Insidious onset
- Fatigue
- Difficulty going up stairs

**signs**
- Plano valgus deformity
- Appropilsive
- Impaired function
- Pathological flat foot
- Excessive over pronation
- Weakness
- Difficulty rising onto toes
- Positive findings for tendinopathy / ligament
- Tenosynovitis
- Tear
Acute onset symptoms

- Decrease pain and oedema
- Early diagnosis
- Improve mobility and prevent deformity
Classification

Progression through stages (Myerson)

1. little structural change
2. Lowering of arch abduction of forefoot
3. Rigidity of the rearfoot
4. Severe valgus deformity

Truro

1. Little structural change
2. Fully correctable deformity
   a. varus < 15 degrees
   b. varus > 15 degrees
   c. forefoot rigid
3. Rigidity of the rf and ff with no correction
4. Rigidity of the rf and ff with no correction- talar tilt on Xray

Johnson and Strom 1989
<table>
<thead>
<tr>
<th>Stage</th>
<th>Presentation</th>
<th>Tendon</th>
<th>Joints</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minimal structural change</td>
<td>Inflammation Tendon still functional</td>
<td>flexible</td>
<td>Heel raise with resistance weaker endurance All tests -ve</td>
</tr>
<tr>
<td>2</td>
<td>Lowering of arch, abduction of forefoot</td>
<td>Tendonopathy Functionally impaired Incompetence</td>
<td>Correctable RF Too many toes sign</td>
<td>Difficult to perform single heel raise Positive sup lag positive 1st met rise Positive Hubscher manoeuvre</td>
</tr>
<tr>
<td>3</td>
<td>Rigidity of the rear foot</td>
<td>Tendon rupture Dysfunction tendon rupture</td>
<td>fixed Moderate DJD Posterior facet STJ Subchondral bone talar navic</td>
<td>unable to manipulate foot all tests -ve</td>
</tr>
<tr>
<td>4</td>
<td>Severe valgus deformity</td>
<td>Tendon rupture</td>
<td>DJD ankle / rearfoot joints # fibular malleolus</td>
<td>rigid deformity all tests +ve</td>
</tr>
</tbody>
</table>

Johnson and Strom, Myerson et al 1996, Richie
## Sub stages

<table>
<thead>
<tr>
<th>Sub stage</th>
<th>Deformity</th>
<th>Rearfoot</th>
<th>Forefoot Supination</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>2a</td>
<td>mild</td>
<td>mobile</td>
<td>&lt;15 degrees</td>
<td>mobile</td>
</tr>
<tr>
<td>2b</td>
<td>mod</td>
<td>mobile</td>
<td>&gt;15 degrees</td>
<td>mobile</td>
</tr>
<tr>
<td>2c</td>
<td>severe</td>
<td>mobile</td>
<td>severe</td>
<td>rigid</td>
</tr>
</tbody>
</table>

Parsons et al, 2009
Aetiology

- Multi-factorial
- Traumatic
- Mechanical
- Ischaemic
- Inflammatory
- Anatomical

Uchiyama et al 2006, Hirano 2009 friction
Abnormal flatfooted position creates resistance on PTT and increases friction

- INCREASED LOAD PTT
- DECREASES STRENGTH
- DIMINISHED CIRCULATORY SUPPLY
- INFLAMMATION AND OR DEGENERATION
- INCREASED FORCES
= LOSS OF ARCH STRUCTURE --->

Subluxation
Fig. 1-18. Loading response of the subtalar joint. A, Adduction of the talus with foot pronation.
B, The ankle axis (solid line) rotates medially (arrows) as the talus displaces with foot pronation.
C, The tibia internally rotates with the talus.
High gear / low gear propulsion
High gear / low gear propulsion
Pathogenesis – Degeneration/ Vascular

- Tendinosis rather than tendinitis – alignment of collagen fibres lost
- Zone of ischaemia – ff position increases gliding resistance of tendon
- Fibroblast hypercellularity, degeneration and neovascularisation by repeated microtrauma
- Thickening irregular structure
- Synovial effusion
- Overpronation – Mobile medial column
- Achilles tightness

Mosier 1998
Examination

• MSK assessment - diagnosis
• Lower leg frontal plane
• Calcaneal alignment / foot posture Index
• Regional assessment of media ankle – palpation observation
• Tip toe test – mid foot breech
• 10 unsupported heel rises on each leg
• Resisted manual muscle testing inversion and plantar flexion
• Reafoot Forefoot flexibility/stiffness
• Malleolar position
Foot Posture Index

Pronated (+2)

Pronated (+2)

Pronated (+2)

Pronated (+2)

Pronated foot (+2)

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Clinical Predictors

- Single heel raise
- Hubschner Manoeuvre
- Supination Lag
- 1\textsuperscript{st} metatarsal Rise

- Tests positive if ligaments not intact
Test for ligamentous stability

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Tip toe test

- Fatigues
- Persistent pronation
- Impossible
- Too painful

Fig. 4-1. A. Normal single heel rise test. B. Abnormal single heel rise test.
Compartment Syndrome

- Increased interstitial pressure within muscle compartment interferes with circulation and function
- Vascular and neural effects within the muscle compartment - ischaemia
- Chronic, exertional or acute
- Relationship + mass by + volume + pressure
- Aetiology – obstruction crush burns exercise drug overdose
- Increase in thickness and stiffness fascia
- Venous collapse – decreased tissue perfusion

FASCIOTOMY

(Garrett 1995, p.48)
Medial tibial stress syndrome

- Multi-factorial overuse
- Exercise induced in runners
- 35% incidence in 124 naval recruits 10 week training programme (Yates and White 2004)
- Diagnosis? Problematic
- Stress reaction/ stress fracture/ tendinopathy musculotendinous strain and compartment syndrome
- Anatomy, training, strength, footwear, mechanics
- Excessive tensile forces to fascia by eccentric soleus and flex longus
- Tib post?
- Fascitis/ periostitis changes in bone mineral density (Magnusson et al 2001)
Tibial Stress Reaction and Stress Fracture (Shin splints)

- Repetitive loading of bone
- Magnitude and frequency exceed ability for bone to remodel
- Stress fracture due to chronic loading
- Sudden increase in activity
Late stage prevention

- complex problems = bony impingement, sinus tarsi inflammation, peroneal tendinopathy equinus contracture, arthrosis
• "can be effectively treated with aggressive conservative management using molded ankle foot orthoses and UCB inserts."

• “67% of the subjects had results that were considered good to excellent based on pain, function, use of an assistive device, distance of ambulation and patient satisfaction.” (Chao et al. 1994)

• 87% (Nielson et al 2011)
Conclusions

- Complex Aetiology, presentation
- Recognising stage 1 and stage 2A and B
- Treat acute symptoms

- Effective staged education
- Absence of pain not necessarily absence of pathology
- Orthotic - restore arch and architecture


G.B. Holmes and R.A. Mann, (1992), Possible epidemiological factors associated with rupture of posterior tibial tendon. Foot Ankle, 13 pp. 70–79


