Biomechanical Explanations for Selective Sport Injuries of the Lower Extremity

- DR. LEE S. COHEN
- Podiatric Consultant:
  - Philadelphia Eagles
  - Philadelphia 76ers
  - Philadelphia Wings
Understanding Normalcy

What is “Normal”?

Rearfoot/heel to leg in straight line

Perpendicular forefoot to rearfoot

Thighs and legs in straight line
Understanding Normalcy

**Inverted**

- Heel varus
- Forefoot varus or supinatus

**Normal/Neutral**

- Bow-legged = Genu varum
Understanding Normalcy

Everted

Heel valgus
Forefoot valgus

Normal/Neutral

Knock-kneed = Genu valgum
# The Arches of Your Feet

<table>
<thead>
<tr>
<th>Rear foot (Back foot)</th>
<th>High</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forefoot Arch (Front foot)</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Forefoot Arch (Front foot)</td>
<td>High Arch</td>
<td>Combo</td>
<td>Low Arch (Flatfoot)</td>
</tr>
</tbody>
</table>
Understanding Normalcy, cont.

These are abnormal foot types...a normal or neutral foot type is a happy medium between the high and low arch feet.

Pes planus = Flatfoot

Pes cavus = High arch foot

“High-Low” = Combo foot
Best Foot Forward

- A person who runs or walks **properly**:  
  - Lands on lateral heel  
  - Foot rolls to medial arch (prones) while turning inward to toe off great toe

- A person who runs or walks **flat footed**:  
  - Lands on lateral heel  
  - Foot rolls inward (pronates) excessively, which also causes the lower leg to turn inward excessively  
  - With NO direct toe off

- A person who runs or walks with a **high arch**:  
  - Lands hard on lateral heel  
  - Doesn’t pronate enough to allow the impact of running to be absorbed through the body  
  - The feet and outer part of knee and hip bear the brunt of each step
Iliotibial Band Syndrome

- Most common etiology of *lateral knee pain* in runners
- Seen as an isolated area of tenderness where the ITB passes over the lateral femoral epicondyle
Iliotibial Band Syndrome

- Pain due to **excess shock** transmitted through the knee joint during initial contact phase of running
- Additional beliefs
  - Excessive pronation causes excess internal tibial rotation which drags the distal ITB over the lateral femoral condyle
- LLD
- Weak hip abductors
Iliotibial Band Syndrome

- Foot types associated with ITB Syndrome:
  - Uncompensated Rearfoot Varus
  - Rigid Forefoot Valgus
  - Pes Cavus
  - Forefoot Supinatus
  - Forefoot varus
Piriformis Syndrome

- Caused by destabilization of the foot during the push-off phase of the gait cycle
  - Placing the piriformis at biomechanical disadvantage → non self-resolving inflammatory process
Piriformis Syndrome

- The sequellae of the overuse are:
  - Fibrosis & hypertrophic scarring of the piriformis
  - Dysaesthetic/nerve trunk neuropathic pain

- Foot types associated with Piriformis Syndrome:
  - Forefoot Supinatus
  - Pes Planus
  - Flexible forefoot valgus
  - Equinus
Patellofemoral Dysfunction

- Characterized by chronic symptoms in the peripatellar area, usually associated with activity
- Symptoms aggravated by:
  - Climbing stairs
  - Sitting for prolonged periods of time with a flexed knee position
Patellofemoral Dysfunction

Findings include:
- Weak vastus medialis
- Tight vastus lateralis
- Anatomic variations of the patella or femoral condyles
- Abnormal foot pronation
Patellofemoral Dysfunction

- **Foot types** associated with Patellofemoral Dysfunction:
  - Forefoot supinatus
  - Compensated forefoot varus
  - Flexible forefoot valgus
  - Compensated transverse plane deformity
**Medial Tibial Stress Syndrome**

- Newer name for medial-posterior shin splints

- **Symptoms:**
  - Pain/tenderness along the *distal medial border* of the tibia
  - Pain/tenderness along the *muscles posterior to the medial border* of the tibia
Medial Tibial Stress Syndrome

- **Etiology:**
  - Original thought:
    - Posterior tibial (PT) muscle is the main culprit
  - Excess pronation in all phases of gait
  - Physical attachment of PT muscle to distal tibia
  - Current thought:
    - Pain is the result of the abnormal pull of the deep posterior fascia on the proximal tibial insertion
Medial Tibial Stress Syndrome

- **Foot types** associated with MTSS:
  - Partially compensated/compensated forefoot varus
  - Forefoot supinatus
  - Compensated congenital gastrocnemius equinus
  - Compensated transverse plane deformity
Peroneal tendonitis

Symptoms:
- Pain along the inferior or posterior fibular border
- Pain within peroneus brevis (PB) and peroneus longus (PL)
Peroneal tendonitis

- PB is the most efficient pronator of the foot
- PL can also pronate the STJ, but due to its attachment, it functions to plantarflex the 1st ray which helps resist pronation of the foot
- Os peroneum may be present
- Tarsal coalition and PL spasm

Os peroneum
Peroneal tendonitis

- Etiology:
  - Certain foot types (see list below)
  - Tendency for lateral ankle instability
  - Improper training
  - Poor equipment

- Foot types associated with peroneal tendonitis:
  - Uncompensated/partially compensated/rearfoot varus
  - Flexible forefoot valgus
  - Rigid forefoot valgus
Anterior Tibial tendonitis

• Symptoms:
  - Pain in anterior and/or anterior-lateral aspect of leg, up to the fibular head level
Anterior Tibial tendonitis

- Etiology:
  - Compensation for overpronation as tibialis anterior assists in ↓ abnormal STJ pronation
  - Poor training
  - Overuse → → → →
    - Too much too soon
  - Poor equipment
Anterior Tibial tendonitis

- Foot types associated with anterior tib tendonitis:
  - Partially compensated/compensated forefoot varus
  - Forefoot supinatus
  - Flexible forefoot valgus
  - Compensated congenital gastroc equinus
  - Compensated transverse plane deformity
Achilles Tendonitis

- To understand Achilles tendon disorders, you must understand the unique morphology of tendon
- No sheath, 2 layers of connective tissue surround the tendon
Achilles Tendonitis: Peritendinitis

- **Peritendinitis** = Inflammation of peritendon
- Characterized by:
  - Tenderness of the length of the Achilles tendon
  - Palpate thickening of peritendon
  - Crepitus with rubbing along Achilles tendon
Achilles Tendonitis: Achilles Tendonosis

- **Achilles Tendonosis** = Disruption of Achilles tendon fibers
  - Some consider tendinosis biological death of fibers
- Dx can only be made by surgical or histological exam technically, but...MRI is “Gold Standard”
  - Diagnostic U/S can help
Achilles Tendonitis: Partial rupture

- Biomechanical factors
  - Excess pronation of the foot causes a rapid twisting and whipping movement of the Achilles
  - This may contribute to the ↓ in vascularity of the area ("wringing out")
Achilles Tendonitis

- **Foot types** associated with Achilles Tendon injuries:
  - Partially compensated/compensated forefoot varus
  - Forefoot supinatus
  - Flexible forefoot valgus
  - Compensated congenital gastroc equinus
  - Compensated transverse plane deformity
  - Pes Planus→→→→
Sinus Tarsi Syndrome

- Associated with compression of the lateral column of the foot
  - Compression caused by abnormal pronation and resulting calcaneal eversion
  - The more pronated the foot...the more likely STS will develop
- This is a common complication of inversion ankle sprains
Sinus Tarsi Syndrome

• Symptoms:
  - Localized pain on lateral side of foot
    • Mostly lateral to talar head and sometimes at the medial side of the sinus tarsi canal
    • Pain produced with direct palpation
  - Little or no edema is present clinically
  - No discoloration of skin is seen
Sinus Tarsi Syndrome

- **Foot types** associated with sinus tarsi syndrome:
  - Partially compensated forefoot varus
  - Compensated forefoot varus
  - Forefoot supinatus
  - Flexible forefoot valgus
  - Compensated congenital gastroc equinus
  - Compensated transverse plane deformity
Plantar Fasciitis

- **Plantar fasciitis** = Irritation of the plantar fascia, mostly the medial slip
  - Irritation is caused by an over-stressing of the fascia
  - Pain localized to medial calcaneal tubercle, but can run the entire length of the fascia
  - Heel spur may/may not be seen on X-ray
Plantar Fasciitis

- **Signs/Symptoms:**
  - Localized edema and erythema possible
  - Pain often present first thing in the morning or with rising after sitting for prolonged period of time
  - Dorsiflexion of great toe may ↑ pain
  - Usually exacerbated by excessive activity
  - Tight plantar fascia and Achilles/gastroc present
Plantar Fasciitis

- **Foot types** associated with plantar fascia:
  - Uncompensated/partially compensated rearfoot varus
  - Partially compensated/compensated forefoot varus
  - Forefoot supinatus
  - Flexible/rigid forefoot valgus
  - Compensated congenital gastroc equinus
  - Compensated transverse plane deformity
  - Basically ALL foot types!
Metatarsal Stress Fractures

- **Caused by:**
  - Excessive repetitive trauma
  - Faulty foot mechanics
  - Poor training techniques
  - Improper foot wear

- **Clinical symptoms:**
  - Pin point pain at site of fx, usually in bone shaft
  - Edema and erythema present
  - Pain ↑ with activity
Metatarsal Stress Fx

- **Diagnostic signs:**
  - Pain with vibratory testing
    - Tuning fork
  - Initial X-ray may be NEGATIVE
    - 50% of stress fx’s are never evident on plain films!
  - MRI/bone scan may be needed for dx
Metatarsal Stress Fx

- 2nd and 3rd metatarsals are the most common sites for these to occur
- Usually due to hypermobile or dorsiflexed 1st ray segment—which places ↑ pressure on these sites
Metatarsal Stress Fx

- **Foot types associated with met stress fx’s:**
  - Partially/fully compensated forefoot varus
  - Forefoot supinatus
  - Flexible forefoot valgus
  - Compensated congenital gastroc equinus
  - Compensated transverse plane deformity
When the Foot Hits the Ground, You’re to Late!!
Aberrant Gait Pattern, the sequella of Over Proation
Yeah baby! The End!

- Contact Info:
  - 642 East Chester Pike
    Ridley Park, PA 19078
    (610) 522-9200
  - 860 Lancaster Ave
    Devon, Pa 19333
  - 2005 RT 70 E
    Cherry Hill, NJ 08003

www.drleecohen.com