Foot and Ankle Biomechanics for Sports Performance

American Osteopathic Academy of Sports Medicine
Philadelphia, Pa
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

Knock-kneed = Genu valgum

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></td>
<td>High Arch</td>
<td>Combo</td>
<td>Low Arch (Flatfoot)</td>
</tr>
</tbody>
</table>

- **High Arch**: The arch is high and not flat.
- **Low Arch**: The arch is low and almost flat.
- **High**: The arch is high and not flat.
- **Low**: The arch is low and almost flat.
- **Combo**: Indicates a combination of high and low arches.
These are abnormal foot types...a normal or neutral foot type is a happy medium between the high and low arch feet.
Normal Gait Cycle
Weight Transfer
Abnormal Gait Cycle
Weight Transfer
Common Forefoot Abnormalities

• Forefoot Supinatus
• Equinus Foot Type
• Pronates in Midstance
Other forefoot Abnormalities

• Forefoot Valgus
• Plantar Flexed 1st Ray Deformity
• Forefoot Elevated
• Pronate in Propulsion
The Cohen Index

Quick way to assess the lower extremity in athletes to help determine the likelihood of developing an overuse injury. It permits you to determine if the athlete’s biomechanics are preventing them from maximum performance.
Based on 20 factors, each is given a point for an abnormal finding.

1. Limb length discrepancy
2. Core Strength
3. Hip Rotation
4. Quads
5. Hamstring
6. Glute Max
7. Hip Flexor
8. TFL
9. Calf
10. Ankle Dorisflexion
11. Posterior Tib
12. 1st MPJ ROM
13. Knee Alignment
14. Heel Alignment
15. Foot Alignment
16. Foot Type
17. Forefoot Type
18. Single Leg Stance
19. Squat
20. Gait
Biomechanical Sports Summary of Podiatric Exam

1. Supinator or Pronator
   - Mild
   - Moderate
   - Severe

2. Gait Impression
   - Pronator
     - Heel Strike
     - Mild Stance
     - Propulsion
   - Supinator

3. Running Impression
   - Pronation
     - Heel Strike
     - Mild Stance
     - Propulsion

4. Balance Issues (Core Related)
   - Yes
   - No
Biomechanical Sports
Summary of Podiatric Exam

5. Orthotic Needs
   Minimum Control
   Moderate Control
   Max Control
   Minimum Shock Absorption
   Moderate Shock Absorption
   Max Shock Absorption

6. Shoe Needs
   Max Cushion
   Cushion
   Max Stability
   Mild Stability

7. Shoe Wear Evaluation
   Forefoot wear Pattern
   Rearfoot wear Pattern
GOALS

Goals of Orthotic Therapy

1. Raise the Arches to stabilize midfoot at midstance
2. Forefoot parallel to rearfoot – no abnormal influence of the rearfoot into the forefoot.
3. 60% of force under the 1\textsuperscript{st} Metatarsal
4. 1\textsuperscript{st} MPJ free to move 65% dorsiflexion
How Poor Biomechanics Contribute to these following entities...
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:
  - Forefoot Supinatus
  - Forefoot Varus
  - Flexible plantar flex 1st ray
  - Forefoot valgus
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
  - dyasaesthetic/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 Dysfuction

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 gastroc equinus
  - Compensated transverse plane deformity
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:

- 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

![](image.png)

- Plantar fascia is the thick band of tissue that covers the bones on the bottom of the foot.
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**

- 2\textsuperscript{nd} and 3\textsuperscript{rd} metatarsals are the most common sites for these to occur.
- Usually due to hypermobile or dorsiflexed 1\textsuperscript{st} ray segment—which places ↑ pressure on these sites.
DO WHAT I SAY!