Considerations for the Running Athlete

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Objectives

• Biomechanical review
• Screening / Rehabilitation considerations

Biomechanics

• Interactions between various anatomical segments as they relate to our ability to ambulate
• Classic description of movement are in single plane
• Physiologic motions are 3 dimensional (triplanar)

Pronation

<table>
<thead>
<tr>
<th>Joint</th>
<th>Sagittal</th>
<th>Frontal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>STJ</td>
<td>DF</td>
<td>Evert</td>
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Supination

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Closed Kinetic Chain Pronation/Supination

Ankle Joint axis
• Ankle: Dorsiflexion or Plantarflexion
  - 84° off Sagittal
  - 12° off transverse
Closed Kinetic Chain Pronation/Supination

Subtalar Joint axis
- Talus: Add/PF or Abd/DF
  - 16º off Sagittal
  - 42º off Transverse
- Calcaneus: Everts or Invert

Midtarsal Joint Axis
- Midtarsal:
  - Oblique axis – DF/Abd or PF/Add
    - 5º off Sagittal
    - 52º off Transverse
  - Longitudinal axis - Inver or Ever
    - 9º off Sagittal
    - 15º off Transverse

First Ray Joint Axis
- Dorsiflexion and Inversion or Plantarflexion and Eversion
  - 45º off Sagittal
  - 5º off Transverse
- Longitudinal and Transverse arches are lowered w/ pronation or raised w/ supination

Transverse Tarsal
- Axis parallel in Eversion – flexibility
- Non-parallel in Inversion – stability
- Heel Strike – eversion (flexible)
- Heel off – inversion (locks TT joints and arch)

Biomechanics
- Heel strike
  - IR, eversion, unlocks TT
- Foot Flat
  - ER, inversion, locks TT
- Windlass Mechanism
  - Assist in stabilizing longitudinal arch
  - DF of 1st MTP raises arch height

Gait Cycle
Gait Cycle

Foot Flat
- PTT fires to prevent over pronation
- Peroneals fire to stabilize as ankle DF

Peroneal Longus
- Power generated from cuboid “pulley”
- Disadvantaged when insertion lower than cuboid

Gait Cycle
• Heel off – Toe off
  - PTT initiates push off
  - Gastroc - Soleus powers heel off-toe off
  - Eccentric contraction of Gastroc - Soleus in midstance to slow ankle DF
• Swing
  - Anterior compartment brings ankle into DF

Common Foot Types
(Normal Foot)

Posterior View Neutral Position
Posterior View Relaxed

Normal Function
• Contact: begins supinated, quickly pronates
• Midstance: begins pronated, moving to supination
• Propulsion: supinated and then further supinates

Common Foot Types
(Compensated Rearfoot Varus)

Posterior View Subtalar Neutral
Posterior View Relaxed

Subtalar Varus
• Contact: supinated, then excessively pronates
• Midstance: stays excessively pronated
• Propulsion: poor midfoot stability
Common Foot Types
(Compensated Forefoot Varus)

- Contact: rearfoot normal
- Midstance: continues to pronate throughout
- Propulsion: stays pronated, poor stability

Common Foot Types
(Compensated Forefoot Valgus)

- Contact: relatively normal
- Midstance: 1st ray hits early, decreased pronation
- Propulsion: very early supination, callus 1st, 5th

Uncompensated Forefoot Varus

- Contact: begins normal, poor pronation
- Midstance: poor shock absorption, accommodation
- Propulsion: early supination, stays laterally

Forefoot Valgus

- Contact: rearfoot relatively normal
- Midstance: 1st ray hits early, decreased pronation
- Propulsion: very early supination, callus 1st, 5th

Rigid Forefoot Valgus
Shoe vs Barefoot Running

- Shod – RFS
- Heel strike to toe off
- Contact lateral heel – ankle slight DF
- Pronates through midstance-heel to toe

- Barefoot – FFS
- Toe strike to toe off
- Contact 4th-5th – ankle PF
- Pronates through midstance-toe to heel

- Shorter Stride length, higher cadence barefoot
- Late midstance to toe off very similar patterns
- Greater knee flexion during swing phase barefoot

Shoe vs Barefoot Running

- Ground Reaction Forces
  - Virtually equal (up to 3-5x BW)
- Transient Impact differences

Shoe vs Barefoot Running

- Ground Reaction Forces
  - Virtually equal
- Transient Impact differences

Shoe vs Barefoot Running

- Ground Reaction Forces
  - Virtually equal
- Transient Impact differences
- Rate of Loading
  - 7 times less in barefoot

FFS vs barefoot RFS
Screening the Runner

- Single Leg Squat
  - 60 deg knee angle
  - Tibial tubercle alignment
  - Pelvis alignment

- Single Leg Hop – distance
  - Males: 80-90% body height
  - Females: 70-80% body height

Screening the Runner

- Sitting on heels
  - DF toes/ankles

- Sitting on toes
  - Prayer stretch
  - PF toes/ankle

- Toe walking
  - Heel height/control
  - Varus heel
  - Gastroc/soleus contour
  - Forefoot position/WB

- Sitting on heels
  - Sitting on toes
  - Prayer stretch
  - Extensor strength
  - Hallux position

- Sitting on toes
  - Prayer stretch
  - PF toes/ankle

- Heel walking
  - Extensor strength
  - Hallux position
Screening the Runner

• Inclinometer
  – Multi-segmental
  – Tibial Tubercle
  – Hip/pelvis position
  – Knee position
    • 3-4 inches past knee

• Downward Dog (yoga)
  – Full body stretch
  – Gastroc/soleus stretch
  – Neuro stretch
  – Hold 5 breathes
  – Work is on the exhale

• Downward Dog (yoga) gastroc stretch
• Doorjam stretch
  – TMT position
  – Hallux
  – Plantar fascia
  – Achilles

Screening the Runner

• Stability dysfunction
  – Lacks stability
  – Strength
  – Static and dynamic

Screening the Runner

• Stability dysfunction

• Mobility dysfunction
  – Lacks mobility
  – Soft Tissue
  – Joint Capsule
  – Manual Techniques

Screening the Runner

Conclusion

– Triplanar motion at every joint
– Develop rehabilitation programs in conjunction with joint axis and the principals of the gait cycle
– Assess foot types and their gait influences as part of your rehabilitation program
– Barefoot running based upon foot types and function (jury is still undecided)
– Emphasize Stability or Mobility dysfunction
– Have purpose and fun with your rehabilitation
Thank you

Bibliography

- Green M. Lower Quarter Scissoring: Suggesting for Radiant Malalignment Hypothesis for Orthotics and Shoe wear. JOSPT, Volume 21, Number 6, June 1991.
- Running Barefoot: Biomechanics of Running. www.barefootrunning.fas.harvard.edu