Rehabilitation of Non-operative Hamstring Injuries

12th Annual Colorado University Sports Medicine Fall Symposium

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Thank you

- Dr. Eric McCarty
- CU Sports Medicine Conference Speaker Selection Committee
Financial Disclosures

I have no financial disclosures
Athletic Performance

- Speed is conferred predominately by an enhanced ability to generate and transmit muscular force to the ground.” Weyland J Appl Physiol 2000

- The fastest athletes spend the least amount of time on the ground (0.7 – 0.9 sec seconds at sprinting speed
  - The main determinant of achieving maximum sprint speed was in reducing the contact time during the stance phase! Mann 1998
GCT and Horizontal Velocity

By the 8th step GCT 0.1 sec and velocity is at 9.4 m/s
Hamstring injuries

• Injury rate of 12% - 16% of all injuries to athletes
  Ekstrand et al AJSM 2011
  Elliott et al AJSM 2011

• Re-injury rate reported as high as 22% - 34%
  Marcus et al AJSM 2011
Hamstring Injuries

- Modifiable and Non-modifiable risk factors
  
  **Modifiable**
  - Hamstring weakness  Orchard et al AJSM 1997
  - Poor flexibility  Fousekis et al Br J Sports Med 2011
  - Poor warm-up  Worrell Sports Med 1994
  - Poor core stability  Sherry JOSPT 2004
  
  **Non-modifiable**
  - Age
  - Ethnicity
    - *Most consistent risk factor
    - Increase risk reoccurrence 2 – 6 times
Hamstring Injury – Mechanism of Injury

• Terminal swing phase of sprinting
  – Eccentric contraction of lower limb
  – Absorb kinetic energy and slow the lower limb

• Early stance phase of sprinting
  – Muscles absorb high ground reaction forces
  – Higher forces in the concentric stance phase

Komi J Biomechanics 1990
Hamstring Injuries - Neuromuscular Factors

• Biceps Femoris
  – Dual innervation
  – Long head
    • Tibial branch of sciatic nerve
  – Short head
    • Common peroneal (fibular) branch of sciatic nerve
Hamstring Injuries – Neuromuscular Factors

- Maximum length of hamstring muscles noted at late swing phase of sprinting
- **Biceps Femoris** - Peak musculotendon length is synchronous with peak EMG activation
- **Semitendinosus Muscle** - Peak musculotendon length occurs significantly later than peak level EMG activation
- *These results suggest that the BF muscle is exposed to an instantaneous high tensile force during the late swing phase of sprinting, indicating a higher risk of muscle strain injury*

Higashihara et al Eur J sport Sci 2016
Hamstring Injuries – Neuromuscular Factors

- Hamstring muscle activation occurring at different running speeds of maximum velocity
  - Running speed of 85% to 95% max velocity
    - Increased activation of hamstring muscles during late swing
    - No change in lower extremity kinematics
  - 95% max running velocity
    - Significant different peak muscle activation time in BF vs. ST
      - P < 0.05 stance phase
      - P<0.01 swing phase
- Complex neuromuscular coordination patterns occur at maximal running velocities

Higashihara et al J Sport Sci 2010
Hamstring Injuries – Muscle Force Production

• Peak hamstring torque occurs at significantly shorter muscle lengths in injured hamstrings

• Potential weakness at longer (previous) muscle lengths

• Eccentric training in the lengthened state may shift the torque curve at the end ROM

Brockett el al Med Sci Sports Exerc 2004

The Hierarchy of Athletic Development

- Hall of Fame S&C Coach Al Vermeil’s Heirarchy of Athletic Development

Each physical quality is dependent upon it’s predecessor

Panariello et al  Oper Tech Sports Med 2016
Hamstring Injuries

• Strength
  – CORE
  – Hip musculature
  – Lower extremity musculature
Influence of Gravity and Elasticity

Fully Inflated Ball
- Greater vertical force production
- Less horizontal braking forces
- Less eccentric load on hamstring
- Longer lever on ground contact

Partially Inflated Ball
- Less vertical force production
- Greater horizontal braking forces
- Greater eccentric load on hamstring
- Shorter lever on ground contact

Courtesy Derek Hansen
**Proper Vertical hip height**
- Increases both flight time and a greater distance covered due to the “toe off” occurring closer to the body’s center of mass
- Reduces ground contact time (amortization) resulting in an optimal Stretch Shortening Cycle (SSC)

*Courtesy Derek Hansen*
Hamstring Rehabilitation

• Must include:
  • Strength training
    – CORE
    – Hips
    – Lower extremities
    – *Especially at terminal knee/hamstring muscle lengths*
  • Velocity training
    – Re-establish neuromuscular timing

Nordic hamstring exercise does not achieve terminal length strengthening
Hamstring Strengthening – Terminal Knee Extension
Velocity Training - Modified Running Progressions and Mach Drills

- “A”, “B”, and “C” running drill series developed by track & field coach Gerard Mach

- Clinical Progression
  - “A” walks/marches
  - “A” skips low
  - “A” skips (high)
  - “A” runs

- Running
  - 10 yard sprints
# Running Progressions

**Modified Mach Drills**

<table>
<thead>
<tr>
<th>Poor Strength Qualities</th>
<th>Fair/Good Strength Qualities</th>
<th>Good/Excellent Strength Qualities</th>
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<tbody>
<tr>
<td>Marching/Walking “A”’s</td>
<td>“A” Skips partial/full ROM</td>
<td>Running A’s perfect technique</td>
</tr>
<tr>
<td>Mirror Drills</td>
<td>Running “A”’s partial/full ROM</td>
<td>Bounding</td>
</tr>
<tr>
<td>Seated arm action activities</td>
<td></td>
<td>Sprinting</td>
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</tbody>
</table>
Modified Mach Drills
Mach Drills
10 Yard Sprints
“A” Marches/Walks
Low “A” Skips
“A” Skips
“A” Runs
10 Yard Sprints
Thank You

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