Rehabilitation of the Injured Runner: Addressing Running Mechanics

Jason B. Lunden, PT
Board Certified Specialist in Sports Physical Therapy
Excel Physical Therapy
Bozeman, MT

Objectives

• Review the basic biomechanics of running
• Describe examples of pathomechanics associated with running injuries
• Demonstrate how physical therapists address the pathomechanics of running and the treatment of the injured runner

Measures of the Running Gait Cycle

• Stride Length: the distance between foot contact points of the same foot
• Step Length: the distance between foot contact points between feet
• Cadence: the number of steps per minute

Rehabilitation of the Injured Runner

• Education
• Pain relieving modalities
• Taping/bracing/orthotics
• Manual Therapy
• Strengthening
• Neuromuscular control
• Gait Training

Phases of the Running Gait Cycle

• Impact: up to 3x BW
• first 50% of stance phase = greatest eccentric load
• 3 main strike patterns:
  – Heel
  – Midfoot
  – Forefoot

This Information is the property of Jason Lunden, PT, SCS and should not be copied or otherwise used without express written permission of the author.
Biomechanics Review

- **GRF**—the force of the ground on the foot

- **Joint Moment**—A directional force on the joint produce by the GRF. The antagonist muscle groups must work eccentrically to control the joint moment/movement.

Kinetics

- **Vertical GRF = Impact**

- **Anterior–Posterior GRF**
  - Braking Impulse: initial part of stance
    - eccentric
  - Propulsive Impulse: latter part of stance
    - concentric

Treadmill vs. Overground running

- Walking or running on a treadmill is mechanically equivalent to overground, as long as it is ensured that the treadmill speed does not fluctuate.

- "Treadmill-based analysis of running mechanics can be generalized to overground running mechanics, provided the treadmill surface is sufficiently stiff and belt speed is adequately regulated."
**Video Analysis**

- Human eye ~ 16 frames/second vs video camera: >60 frames/second
- Capture 3 angles (use tripod):
  - Rear --> Coronal plane
  - Side --> Sagittal plane
  - Front --> Coronal plane / Transverse?

**Fatigue**

- Hip adduction increases during prolonged run
  - Boksa et al. JOSPT. 2008; 38: 446-446
- LE mechanics change to increase shock absorption
- Peak leg impacts increase
  - Mountain S et al. CM poster. 2010
- Optimal extensor fatigue changes LE muscle activation, trunk and spine kinematics

**Injury Threshold**

- Structure
- Dosage
- Mechanics

**Mechanics**

- Loading
- Alignment

**Shock Absorption**

- Active Muscles
- Passive Bone/Ligaments/Cartilage
Pathomechanics

• Proximal vs Distal Factors:
  – In general distal pathologies have distal biomechanical factors and vice versa

Injury: the Big 6

Rates 20–90%

Knee injuries: 42%
  • PFPs: #1 injury (16%)
  • ITBFS: #2 injury (8%)

Lower leg/ankle/foot: 36%
  • Plantar Fascia: #3 injury
  • MTSS: #4 injury
  • Achilles: #5 injury

Stress Fx: up to 20%

Gait Analysis: Femoral IR

Transverse plane motion: Can not get a perpendicular reference.

So…
  – Look at coronal plane to get clues
    • Rear view: heel whip
    • Frontal view: dynamic valgus

This Information is the property of Jason Lunden, PT, SCS and should not be copied or otherwise used without express written permission of the author.
Gait Analysis: Femoral Adduction
Coronal Plane motion.

So...
– Look at rear/frontal views
  • Trendelenburg
  • Draw a vertical plumb line from L5/S1, leg/foot should not crossover

Abnormal Gait Mechanics

• increased hip IR for PFPS
  – decreased hip abd & ext strength

• increased hip add for ITBFS
  – decreased hip add strength

But what about other areas?

Achilles Tendonopathy:
  – 5% of running injuries (Taunton et al 2002)

  – Forefoot Strike Pattern?

  – Foot type:
    • Pes Cavus or Pes Planus ?!

Achilles Tendonopathy
Pathomechanics:
  – Decrease knee flexion ROM in 1st half of stance
  – Decreased rectus femoris and gluteus medius activity
  – Decreased tibialis anterior muscle activation just prior to heelstrike
Achilles Tendonopathy

Pathomechanics:
- Increased relative femoral IR during stance
- Increased tibial ER throughout stance
- Lower tibial ER moment
- IR moment of the tibia just after heel strike and just prior to toe-off

But what about pronation?!

Overpronation is defined as excessive pronation, pronation that occurs too quickly, or a prolonged duration or pronation during the stance phase.

But what about pronation?!

Tibialis posterior is the primary muscle responsible for controlling rearfoot pronation during loading…if it does not function properly the medial gastroc maybe forced to assist in eccentric control of tibia IR

Medial Tibial Stress Syndrome

- Poor cushioning
- High arches
- Out of Shape
- Training Errors: Running with fatigue, increased mileage, overstriding

But what about other areas?

Plantar Fasciosis:
- # 3 Running Injury (Taunton et al. 2002)
  - Conflicting evidence on overpronation
  - Increased loading rate
  - Increased impact

Stress Fractures:
- Up to 20% of running injuries (Matheson et al., AJSM 1987)
  - Overuse of Passive structures
  - High Impact/Loading

This Information is the property of Jason Lunden, PT, SCS and should not be copied or otherwise used without express written permission of the author.
Running Injuries

Knee injuries:
42% of all injuries
- PFPS: #1 injury (16%)
- ITBFS: #2 injury (8%)

Strength (weakness!)
- Injured athletes are likely to have hip abductor, flexor, and external rotator weakness
  - Ireland et al. JOSPT. 2003; 33:671-676
- Weak hip Abd associated with increased hip adduction during running (increased with fatigue) in athletes with PFPS
  - Dankers et al. JOSPT. 2008; 38: 448-446
- ITBFS sx resolution paralleled the return of hip Abd strength

Abnormal Gait Mechanics

- increased hip IR for PFPS
  - decreased hip Abd & ext strength
- increased hip add for ITBFS
  - decreased hip Abd strength

Gait (Re)Training
- Goal is to allow runners to train while injured
- Decrease stride length/increase knee flexion at contact
  - backwards running
  - barefoot running
  - uphill running
  - cadence manipulation
  - biofeedback

Gait (Re)Training: retro running
- Forefoot strike pattern
- decreased PFJ contact forces
  - Flynn TW et al. JOSPT. 1995
- decreased quad eccentric work
  - Flynn TW et al. JOSPT. 1995

Gait (Re)Training
- Pose Technique
  - midfoot strike pattern
    - emphasis on shoulder-hip-heel alignment
    - emphasis on flexed knee throughout gait cycle
  - decreased ground reaction forces
  - decreased knee eccentric work

This Information is the property of Jason Lunden, PT, SCS and should not be copied or otherwise used without express written permission of the author.
Rehabilitation of the Injured Runner
MNAPTA

5/21/2011

This Information is the property of Jason Lunden, PT, SCS and should not be copied or otherwise used without express written permission of the author.
Gait (Re)Training

- Cadence
  - low cadence = overstriding
  - increased stride length results in greater COM vertical displacement
  - increased stride length = greater impact shock
  - increased cadence = greater use of gluteal muscles and less on quadriceps
  (Heiderscheidt. Unpublished data. 2010)

Gait (Re)Training: Cadence

- 10% Increase
  - Increased knee flexion @ contact
  - Decreased peak knee flexion
  - Decreased hip adduction

Gait (Re)Training: Cadence

- 10% Increase
  - Decreased vGRF
  - Decreased braking impulse
  - Decreased impact at Knee & Hip

Gait (Re)Training

- Conclusion:
  - Decrease impacts/Braking impulse
  - Discourage heelstrike pattern
  - Promote use of gluteals
  - Decrease painful running

Summary

- Running injuries are associated with abnormal running mechanics
- Physical therapy can help to address abnormal mechanics and muscle imbalances
- Not all runners/injuries are the same