DREXEL UNIVERSITY
Department of Physical Therapy and Rehabilitation Sciences

DREXEL UNIVERSITY
Running Performance & Research Center
at Parkway Health & Wellness

Anatomy and Biomechanics of Running Injury: From Cadaver Dissection to Practical Interventions.

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Objectives

Upon completion of this session you will be able to:

1. Recognize and describe anatomical structures relevant to the most common running injuries.
2. Explain how faulty movement patterns place abnormal stress on anatomic structures and may cause injury.
3. Comprehend how modifications to movement patterns may assist in injury prevention and rehabilitation of injury.
4. Design and implement movement training techniques and exercises to change atypical movement patterns (including running specific-exercises, neuromuscular retraining, plyometrics and running drills).
5. Provide progressions and modifications for movement training techniques and exercises.

Running injury etiology is multifactorial.

The focus of this presentation will be anatomy and biomechanics of running injury with practical interventions.

Iliotibial band syndrome

Functional anatomy [1, 2]

Proximal and distal attachment sites

Relationship to gluteal muscles

Relationship to lateral femoral epicondyle and associated structures

Biomechanics of injury [1, 3]

Lateral knee pain in region of distal structures of iliotibial band (ITB)

Traditionally – friction as ITB rubs lateral epicondyle with knee flexion and extension leads to pain.

Current concept – compression of lateral structures of knee under ITB leads to pain

Focus on hip and knee biomechanics as contributing factors

- Large hip adduction angles/ medial collapse of hip
  - Control of frontal plane hip position by eccentric action of hip abductors during stance phase
    - Large hip adduction angle during running may be due to: weak hip abductors, poor activation/ neuromuscular control of hip, and/ or running technique.
- Large knee internal rotation angles
  - May also contribute to compression of lateral structures of knee
  - More difficult to measure/ modify

Patellofemoral pain syndrome

Functional Anatomy [4, 5]

- Relevant osteology
  - Femur
    - Medial and lateral femoral epicondyles
    - Patellar articular surface
  - Patella
    - Patellar facets
- Relevant soft tissues
  - Quadriceps tendon
  - Medial and lateral patellar retinaculum
  - Patellar ligament

Biomechanics of injury [6, 7]

Retropatellar pain attributed to aberrant joint contact stresses between patella and femur due to altered tracking of patella on femur.

Traditionally – alterations in knee biomechanics due to distal mechanism: subtalar joint motion linked to tibial rotation; quadriceps weakness or imbalance.

Current concept – proximal mechanism of injury: poor hip control changes relationship between femur and patella.

Reduced joint contact area leads to increased localized cartilage stress

Conservative treatment focuses on proximal mechanics – adduction, internal rotation

Large hip adduction and internal rotation angles during running may be due to: weak abductors/ external rotators, poor activation/ neuromuscular control of hip, and/ or running technique.

Achilles tendinopathy

Functional Anatomy [8]

Proximal and distal attachment sites

Relevant soft tissues

Paratenon

Retrocalcaneal bursa

Biomechanics of injury [9, 10]

Injury due to accumulation of damage resulting from abnormal loading on tendon.

Traditionally – large amounts of pronation, rearfoot eversion lead to injury

Current concept – focus on magnitude of load on Achilles tendon as primary risk factor

Greater vertical loading rate, braking forces, pronation velocity and maximum pronation angle associated with injury.

Biomechanical basis for interventions

Strength, neuromuscular control [11-14]

Mixed evidence for benefits of muscle strengthening exercises.

Direct focus on neuromuscular control of hip motion during running (gait retraining) successful, may require advanced technology

Step length/ Cadence[15-17]

Increasing cadence reduces step length at given running velocity. Shorter step length has secondary effects on key lower extremity biomechanical variables: notably reduced hip adduction angle, reduced vertical loading rate.

Increasing cadence may also reduce patellofemoral joint contact stress.

Step width[18,19]

Increasing step width has secondary effects on frontal plane biomechanics: notably decreased peak hip adduction angle, decreased peak rearfoot eversion angle.

Increasing step width may also reduce strain in the ITB.

Interventions for medial collapse

Assess potential causes of medial collapse [15-18, 20-22]

Structure (skeletal factors): Femoral neck-shaft angle, pelvis width to femur length ratio
Strength: Decreased strength of gluteal muscles identified in injured runners
Neuromuscular control: Contributions of muscular, skeletal and nervous systems.
Running technique: Step width and step length influence hip adduction angle during running

Identifying and quantifying medial collapse of hip [23-26]

Movement screening tests: Are they valid, reliable?
What are they testing? Strength and neuromuscular control components
3D motion analysis
2D clinical motion analysis

Strategies to correct modifiable factors related to medial collapse [11-14, 27-29]

Neuromuscular retraining strategy
- Strength is a component of the neuromuscular control system
- Effectiveness of neuromuscular training in modifying hip adduction during running
- Components of neuromuscular training
  - Influence of core on limb movement
  - External vs internal focus of attention
    - An external focus of attention has been shown to result in superior motor performance, increased automaticity and less energy expenditure
  - Plyometrics
    - Plyometric exercise can alter muscle activation patterns and cause changes in biomechanics during dynamic tasks
    - Progressions for plyometric programs specific to runners

Gait retraining strategy
- Laboratory based gait retraining
  - Real time feedback: 3D
- Clinically based gait retraining
  - Real time feedback: Mirror, verbal cues

Interventions for modifying step length and step width

Addressing biomechanical faults [15, 17-19, 30]

- Step length
  - Assessment of step length
  - How much change is needed?
  - Exercises
  - Drills
  - On the road

Tools: Cadence Training Apps
Music
Feedback
Protocols
Effectiveness

Step width [18,19]

Assessment of step width
How much change is needed?
Exercises
Drills
On the road
Tools: External cues
Lines
Video feedback
Internal Cues
Effectiveness

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