Hip Pain and Biomechanics of Running

_Evan Hansen PT, DPT_

Board Certified Orthopedic Specialist in Orthopedic Physical Therapy
Fellow for the American Academy of Orthopedic Manual Physical Therapists
Clinical Mentor, Creighton University Orthopedic Physical Therapy Residency

Objective & Format

At the end of this lecture, the participants should be able to:

• Assess adolescent hip pain and evaluate biomechanical factors of influence
Clinical Practice Guidelines

Nonarthritic Hip Joint Pain
Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability and Health From the Orthopaedic Section of the American Physical Therapy Association

Differential Diagnosis
Clinicians should consider diagnostic categories other than nonarthritic joint pain when the patient’s history, reported activity limitations, or impairments of body function and structure are not consistent with those presented in the Diagnosis/Classification section of this guideline or when the patient’s symptoms are not diminishing with interventions aimed at normalization of the impairments of body function.
Interventions

DIFFERENTIAL DIAGNOSIS
The Pathoanatomic Model

- The traditional model of western medicine
- Example: Gluteus medius tendinopathy, labral tear, etc.
- Relies on imaging as the gold-standard of diagnosis
- Clinically providers rely on special tests to theoretically confirm the presence of pathology


Limitations

- High cost of diagnostic imaging
- Does not explain prevalence of conditions in asymptomatic people
  - 42 asymptomatic elite soccer players
    - Prevalence of chondrolabral lesions was 57.6%
      - Labral lesions 33.8%
      - Femoroacetabular cartilage 13.8%
      - Chondrolabral lesions 10%
      - Cam-type impingement was the most common FAI (22.5%)
  - 63 asymptomatic volunteers
    - More than 1/3 exhibited at least one positive pincer-type MRI finding.
- Limited validity of special testing

Ludewig 2017, Márquez 2019, Bensler 2019, Reiman 2013

“There is limited evidence to support the use of HPE tests as standalone clinical tests for the diagnosis of hip related pathology.”
Other Limitations

- Treating symptoms
  - Physical therapy treatment?
- More than one pathology?
- Does it guide treatment?
  - “What are the best exercises for hip pain?”

**intervention for bursitis**
- rest
- ice
- anti-inflammatory medication
- anti-inflammatory modalities
- injection

What’s In A Name?

- Diagnostic labels are intended to:
  - Guide treatment
  - Facilitate communication between health professionals
  - Provide homogeneous patient groups in treatment outcome studies
- Greater Trochanteric Pain Syndrome, Gluteal Tendinopathy, Lateral Hip Pain, Hip Pain of Unknown Etiology
- What about naming movement impairments?
  - Physical therapists and trainers cannot change the shape of the acetabulum or femur, remove spurs, or change the integrity of the labrum
  - Considering the fact that impairments in the hip are often associated with specific provocative positions or movements, the focus of our diagnosis classification and treatment may be better focused on movement dysfunction

Ludewig 2017
Movement Matters

- Runners with ITB Syndrome demonstrate increased femoral adduction and medial rotation
- Persons with FAI demonstrate smaller amounts of posterior pelvic tilt excursion during squatting
- Increased anterior pelvic tilt has been shown to increase strain on the hamstring muscles

Ferber 2010, Bagwell 2019, Thelen 2006

Pathokinesiologic Model

- Described by Hislop
- Believes that pathoanatomical abnormalities are the cause of impairments which then lead to abnormal movement
- Example: Sprained ankle leads to limited ankle dorsiflexion which leads to increased foot external rotation during a squat

Sahrmann 2001
Kinesiopathologic Model

- Proposed by Shirley Sahrmann
- Believes that abnormal movements during daily activities can also cause impairments that lead to pathoanatomical abnormalities
- These abnormal movements begin as a result of sustained postures and repetitive movements that cause limitations in strength and flexibility

In Reality...

Narveson 2018
Subjective Interview

- Body chart first!
  - Anterior
  - Lateral
  - Buttock
- Aggravating/Easing factors
- Mechanism of injury
- Establish irritability
- Sport specific information
- Red flag screening
  - Female athlete triad
  - Age
- Create a ranked hypothesis list

Functional Testing

- Assessing quality & quantity of motion
- Evaluate dynamic stability
- Identify areas in need of further objective testing
- Looking for cause of the problem (regional interdependence)
Posture

• Spend time assessing posture!
• Helps identify shortened and lengthened muscles
• Prolonged posture can contribute to faulty movement patterns and repetitive microtrauma
• How do these compare to the patient’s location of pain?

Wilder 2014, Grimaldi 2011, Sahrmann 2001

Bilateral Squat

• Assess functional dorsiflexion as well as general screening for intra-articular pathology of hip & knee
• Look for valgus collapse
• Quad vs. Glute dominance

Wilder 2014
Single Leg Stance

• 30 seconds eyes open/30 seconds eyes closed
• Look for pelvic, core, and foot control
• Notice compensations – especially as they shift their weight

Wilder 2014, Reiman 2015

Single Leg Squat

6 Points Total Indicates
-1 Hands off Hips (Global Balance)
-1 Trunk Shift (Hip Abd/Core Weakness)
-1 Pelvic Drop (Hip Abd Weakness)
-1 Knee Medial to 2nd Toe (Hip Abd/ER Weakness)
-1 Elevation of 1st Ray (Decreased Foot Control)
-1 Loss of Balance (Decreased Foot Control)

5-6 = Good    4-3 = Fair    <2 = Poor

Wilder 2014
Step Down Test

6 Points Total
-1 Hands off Hips (Global Balance)
-1 Trunk Shift (Hip Abd/Core Weakness)
-1 Pelvic Drop (Hip Abd Weakness)
-1 Knee Medial to 2nd Toe (Hip Abd/ER Weakness)
-2 Knee Medial to Inside of Foot (Severe Abd/ER Weakness, Possible Foot Control)
-1 Loss of Balance (Decreased Foot Control)

5-6 = Good  4-3 = Fair  <2 = Poor

Wilder 2014

Swing Test

• Assesses
  • Stance Leg Stability
  • Swing Leg Mobility (Hip flexor and hamstring)
  • Lumbopelvic Stability

Increased anterior pelvic tilt is associated with hamstring and lumbar spine injuries

Wilder 2014
Bridge and March Test

- Test for transverse plane lumbopelvic stability
- Positive test is indicated by pelvic rotation toward side of leg lift

Site-Specific Objective Exam

- Use the information from the subjective history and functional testing to identify where to target your exam – it may be different from the patient’s site of pain!
- Why do they move the way they do?
- Regional Interdependence
- Upon completion should be able to identify:
  - Painful Structure
  - Underlying Movement Impairment
Common Injuries in the Young Runner

• Hip and Pelvis
  • **Apophysitis and Apophyseal Avulsions**
    • Ischial Tuberosity (Hamstring)
    • Anterior Inferior Iliac Spine (Rectus Femoris)
    • Anterior Superior Iliac Spine (Sartorius)
    • Iliac Crest (Obliques, transversus abdominis)
  • **Legg-Calve-Perthes Syndrome**
    • 3-12 years (5-7 most common)
    • Anterior groin, thigh, or knee pain
    • Limited IR ROM, with obligatory ABD and ER during passive flexion (Drehmann sign)
  • **Slipped Capital Femoral Epiphysis**
    • 10-13 years (girls), 12-15 years (boys)
    • Anterior groin and anterior knee pain
    • Limited IR ROM, with obligatory ABD and ER during passive flexion

Anterior Groin Pain Differential Diagnosis

• There are many causes of anterior groin pain that can be difficult to differential diagnose
• A simple test of **bilateral resisted isometric hip adduction** will help to narrow your initial hypothesis list considerably

### Possible Pain Generators for the Groin Region

<table>
<thead>
<tr>
<th>Conditions With Painful Resistive Hip Adduction</th>
<th>Conditions With Painless Resistive Hip Adduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute adductor tendinopathy</td>
<td>Herniation</td>
</tr>
<tr>
<td>Chronic adductor tendinopathy</td>
<td>Hip joint labrum</td>
</tr>
<tr>
<td>Rectus abdominis</td>
<td>Stress fracture</td>
</tr>
<tr>
<td>Obturator nerve</td>
<td>Psoas tendinopathy</td>
</tr>
<tr>
<td>Osteitis pubis</td>
<td>Psoas bursitis</td>
</tr>
<tr>
<td>Ossifying myositis</td>
<td>Nerve entrapment</td>
</tr>
<tr>
<td>Symphysitis</td>
<td>Incompetent abdominal wall</td>
</tr>
<tr>
<td>Sacroiliac joint dysfunction</td>
<td>Referred:</td>
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<tr>
<td></td>
<td>• Lumbar spine</td>
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<tr>
<td></td>
<td>• Lymphatic</td>
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<td></td>
<td>• Vascular</td>
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<td></td>
<td>• Gynecological</td>
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<td></td>
<td>• Urological</td>
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</tbody>
</table>

Femoral Acetabular Impingement Syndrome

McGalliard 2016 Wilder 2014

Reiman 2015

McGalliard 2016
Conditions with Painful Resisted Adduction

- Acute or Chronic Adductor Tendinopathy
  - Adductor longus and brevis – hip in neutral
  - Pectineus – hip in 90 degrees flexion
  - Gracilis – hip adduction and knee flexion painful
- Rectus Abdominis
  - Painful resisted trunk flexion
- Sportsman’s Hernia
  - Increased with valsalva and hip adduction
  - No pain with palpation of adductors
- Obturator Nerve
  - Obturator nerve test
  - Sensory changes in medial thigh
- Sacroiliac joint
  - Positive SIJ cluster testing, active SLR test
- Pubic Symphysys Dysfunction
  - Active Straight Leg Raise w/ Compression
  - Joint mobility assessment
- Osteitis Pubis
  - Severe pain presenting similar to pubic dysfunction
  - Diagnosed with T2 MRI

McGalliard 2016, Moore 2010

Conditions Without Painful Resisted Hip Adduction

- Urological, gynecological, and lymphatic pathology
  - Subjective history and lack of objective findings
- Stress Fracture of Femoral Head
  - Fulcrum Test
  - Pubic Percussion Test
- Rectus Femoris Tendinopathy
  - Pain with resisted knee extension (neutral hip) and hip flexion
- Psoas Tendinopathy
  - Pain with resisted hip flexion and external rotation
- Femoral Nerve Entrapment
  - Femoral nerve test
  - Weakness of quadriceps, tenderness of inguinal ligament

McGalliard 2016, Reiman 2015
**Labral Tears and Femoral Acetabular Impingement Syndrome (FAIS)**

- Movement disorder of the hip resulting in aberrant contact between the femur and acetabulum
- No conclusive diagnostic criteria
  - Anterior hip/groin pain
  - Positive FADIR test
  - Positive radiographic signs
  - Greater than 50% relief with intra-articular injection
- Can be traumatic or gradual onset
- Pain increased with sitting and stairs with frequent complaints of clicking, locking
- Can have secondary pathologies including psoas bursitis, psoas tendinopathy, labral tear, etc.
- Very little research on conservative management (most is focused on surgical management at the moment)
- Can cause cam, pincer, or mixed deformity
- Labral tears diagnosed with contrast MRI

_Narveson 2018, Cheatham 2016_

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**Lateral Hip Pain Differential Diagnosis**

- Lumbar (somatic referral)
  - Positive lumbar screen
  - Diffuse pain
- Lumbar radiculopathy
  - Positive lumbar screen
  - Positive neural mechanosensitivity
  - Possible sensation changes, myotomal weakness, reflex changes
  - Narrow band of symptoms
- Lateral femoral cutaneous nerve (LFCN) of the thigh
  - Neurodynamic test (hip extension with adduction)
- Greater trochanteric pain syndrome
  - Greater trochanteric pain syndrome
  - Gluteal bursitis
    - Pain with passive flexion/adduction with IR or ER
  - Gluteal tendinopathy/tear
    - Resisted external rotation derotation test
    - Pain reproduced with SL stance >30 seconds
- Coxaferomral joint
  - Scour test
- Sacroiliac joint

Buttock Pain Differential Diagnosis

- Sciatic nerve (piriformis syndrome)
  - Active piriformis test
- Sciatic nerve (hamstring syndrome/ischial tunnel syndrome)
  - Increased pain with sitting
  - Positive Ischial Tunnel Syndrome Testing
  - Painful with palpation over lateral ischial tuberosity
- Pudendal nerve
  - Symptoms medial to the ischium, perineum and anorectal regions
  - Worse with sitting (except toilet seat due to lack of compression)
  - Prolonged cycling can aggravate
- Lumbar disk radiculopathy
- Lumbar (somatic referral)
- Hamstring tendinopathy
- Ischial bursitis
- Sacroiliac joint

Martin 2017, McGalliard 2016, Bogduk 2009

Movement Impairments Affecting the Hip: Finding the Cause

- Lumbar Extension/Rotation Syndrome
- Hip Anterior Glide/Medial Rotation Syndrome
- Hip Adduction/Medial Rotation Syndrome

Sahrmann 2001
Lumbar Extension/Rotation Syndrome (ERS)

**Common associated diagnoses:** facet syndrome, spinal stenosis, spondylolisthesis, spinal instability, DJD, OA, herniated disk, hamstring syndrome, hamstring strain

**Presentation**
- Most common lumbar movement impairment
- Common in chronic low back pain, rotational sports
- Posture: Swayback posture, hips extended with medial rotation, knee hyperextension, decreased gluteal definition.
- **Functional Testing:**
  - Gait: Excessive lumbar extension with rotation (tail wagging the dog)
  - SL Stance: Hyperextension of knee, lumbar hyperextension
  - SL Squat and Lateral Step Down: Pelvic drop with femoral medial rotation, quad dominance
  - DL Squat: Quad dominance, lumbar hyperextension throughout or during hip extension

Sahrmann 2001

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**Forward Bending and Side Bending**

**Objective Testing:**
- **Forward Bending/Return**
  - Positive Test: Forward bending may relieve symptoms. Upon return from bending, patient will initiate with lumbar spine extension rather than hip extension. With cues for hip extension any symptoms should improve.
- **Side Bending**
  - Positive Test: A “hinge point” will be seen at one level. If symptomatic, PT stabilizes the patient’s spine just above the pelvis and re-tests to see if symptoms decrease.

Sahrmann 2001
Bent Knee Fall Out, March, & Clamshell

Bent Knee Fall Out
• Positive Test: Movement of pelvis toward the moving leg within the first 50% of the range of motion. Can retest with PT stabilizing pelvis to assess symptom response.

Clamshell
• Positive Test: Movement from lumbar spine instead of isolation to the hip joint.

March
• Positive Test: Movement of pelvis toward the moving leg within the first 50% of the range of motion. Can retest with PT stabilizing pelvis to assess symptom response.

Prone Knee Flexion & Hip Extension

Knee Flexion
• Positive Test: Lumbar extension/anterior pelvic tilt with knee flexion. If symptomatic, PT can stabilize pelvis to assess response.

Hip Extension w/ Knee Flexed
• Positive Test: Lumbar extension/anterior pelvic tilt. If symptomatic PT can place pillow under hips and stabilize pelvis to assess response.
Quadruped Rock-Back

- **Positive Test**: Patient may feel alleviation of symptoms when flexing lumbar spine. Rotation noted. When returning patient initiates with lumbar extension. Correct the movement to assess symptom response.
- **Remember to screen hip joints if asymmetrical**

Femoral Anterior Glide with Medial Rotation Syndrome (AGMR)

**Common associated diagnoses**: groin pain, iliopsoas tendinopathy, iliopsoas bursitis, hip bursitis, FAI, labral tears, OA. Can also drive pathology further down the chain such as PFPS, MCL/ACL injury, Achille’s tendinopathy

**Presentation**
- Often seen in runners and dancers
- Posture: hip extension and medial rotation, knee hyperextension, decreased gluteal definition

**Functional Testing**
- **Gait**: Medial rotation/hamstring dominance, pelvic drop
- **SL Stance**: Medial rotation of femur
- **SL Squat and Lateral Step Down**: Pelvic drop with femoral medial rotation
- **DL Squat**: Femoral internal rotation, quad dominance

*References*
- Sahrmann 2001
Femoral Anterior Glide/Medial Rotation Syndrome (AGMR)

Objective Testing:
- Seated active knee extension
  - Have patient actively extend knee
  - Positive: femoral medial rotation
- Hamstring dominance test
  - Have patient actively extend hip in prone position while palpating hamstring and gluteal musculature
  - Positive: hamstring activation prior to gluteal activation

Femoral Anterior Glide/Medial Rotation Syndrome (AGMR)

- Straight Leg Raise for AGMR
  - Can perform actively or passively
  - Positive Test: Greater trochanter glides anterior and medial with hip flexion
  - Negative Test: Greater trochanter appropriately posteriorly glides and remains relatively stationary
  - Can apply posterior pressure to femoral head to assess symptom response
Femoral Anterior Glide/Medial Rotation Syndrome (AGMR)

- Quadruped Rock-Back
  - Positive Test: Asymmetrical level of hips or reproduction of anterior hip pain alleviated with hip ER
  - Also screens lumbar movement impairments

Sahrmann 2001

Femoral Adduction with Medial Rotation Syndrome (ADDMR)

**Common associated diagnoses:** ITB syndrome, piriformis syndrome, sciatica, hamstring strain, hip bursitis, gluteal tendinopathy, snapping hip syndrome, adductor strain. Can also drive pathology further down the chain as a result of excessive pronation.

**Presentation**
- Pain usually with weight bearing activities
  - Can also occur from crossing legs or sleeping on side
- Posture: Habit of standing on one leg in hip adduction/medial rotation, increased ITB tone
- Functional Testing:
  - Gait: Hip ADDMR and pelvic drop during stance (crossover), hip ADDMR during swing phase
  - SL Stance: Pelvic drop/hip adduction
  - SL Squat and Lateral Step Down: Pelvic drop with ADDMR

Sahrmann 2001
Clinical Gait Analysis

- Equipment Needs
  - Treadmill
  - Video system (optional)
- Lateral and posterior views
- Camera frames per second – higher the better
- Use tripod for best results
- Software programs
  - Dartfish
  - Hudl
  - Others

Treadmill Basics

- Treadmill Type
  - Minimal Frame
  - Below-Belt Motor
  - Top Speed Depends on Type of Runners Treated
  - Clinic Space
- Warmup
  - No Consensus Yet
  - Depends on Runner’s Familiarity with Treadmill
- Speed Selection
  - May Video Race Pace or Easy Pace

Wilder 2014
Lateral (Sagittal Plane) View

• Moments of Importance
  • Initial Contact
  • Maximal and Minimal Vertical Height
  • Terminal Stance
• Knee Flexion Angle (15-20 degrees at initial contact)
• Foot Contact Position
  • Vertical Excursion (5-7cm)
  • Peak swing phase knee flexion (>90 degrees)
  • Trunk lean (10-12 degrees forward)
  • Hip extension (18-20 degrees)

Posterior (Frontal Plane) View

• Moments of Importance
  • Initial Contact
  • Mid Stance
  • Terminal Stance
• Pelvic Lateral Tilt
• Proximity of Knee Joints
• Medial-lateral Foot Placement (Crossover)
• Toe Out
• Trunk sway/lean
• Arm symmetry
• Landing and terminal stance positions
• Heel Whip

Wilder 2014
Cadence

https://vimeo.com/18627138

Gait Evaluation

Speed: _____ MPH

Trunk: Extended Normal Flexed Trunk Lean Rotation

Hip: Pelvic Drop Cross Micline Decreased Extension

Knee: Dynamic Valgus Femoral IR Varus Thrust Swing Phase Circumduction Decreased Swing Phase Knee Flexion

Foot/Ankle: ER IR Excessive / Uncontrolled Pronation Early Heel Rise Heel Whip Decreased Push-Off

Footstrike: Fore / Mid / Rear Foot Over Stride Knee Extended

Other: Vertical Displacement Decreased Stance Phase Arm Swing

Cadence: _____ steps/min
TREATMENT OVERVIEW
Manual Therapy Overview

- Lack of high-quality evidence as a sole intervention
- More effective in acute, uncomplicated patient populations
- May be best considered a tool to facilitate, “functionally appropriate, relatively pain-free movement,” within a multidimensional intervention
  - Manual therapy + exercise appears to afford better treatment outcomes
- Patient expectation plays a large role
- Should be applied with an honest explanation of its short-term hypoalgesic effects whilst challenging any associated biomedical beliefs

Exercise Prescription General Principles

- Prescribed exercises should always have a goal
  - Strengthen, stretch, retrain movement, improve bloodflow, etc.
- Number of sets, repetitions, and weight is influenced by tissue involved and goal of exercise
- Mobility restrictions should be addressed prior to stability dysfunctions
- Activation-Acquisition-Assimilation
- Exercises can be used for multiple diagnoses and body regions and serve multiple purposes
- Difficulty of exercise must be adjusted with patient
- Make exercises as functional as possible
- Home exercises will vary based on patient
- Be creative!
Lumbar Extension/Rotation Syndrome Treatment

Activity Modification
- **Standing Posture:** Contract abs for posterior pelvic tilt/back flat against wall
- **Stairs:** Contract abs when lifting leg, lean weight over foot and flex spine slightly when pushing up
- **Gait:** Walk slowly, minimize pelvic motion, use abdominals
- **Running:** Emphasize core activation and slight forward lean
- **Sports:** Emphasize hip and thoracic rotation (golf, tennis, etc.)

Exercise Overview
- **Lumbar neutral retraining**
  - Teach hip extension using glutes instead of hamstrings or lumbar spine
  - Posterior pelvic tilt progressions (heel slides, marching, bent knee fall out, etc.)
- **Functional tasks** emphasizing hip rotation and extension instead of lumbar

Anterior Glide/Medial Rotation Treatment

Activity Modification
- **Posture Correction:** Contract glutes slightly to keep knees forward, arches raised, knees unlocked
- **Sleeping:** Pillow between legs when sleeping to avoid medial rotation
- **Stairs:**
  - Watch pelvic drop and knee valgus during descent
  - Keep feet shoulder width to discourage medial rotation
- **Gait:** Contract gluteal muscles to keep knees forward
- **Running:** Knees pointed forward, avoid over-striding
- **Sports:** Watch knee position with cutting, squatting, jumping, etc.

Exercise Overview
- Gluteus medius vs. TFL strengthening
- Progressive psoas strengthening
- Progress to functional activities as soon as possible
- Correction of femoral medial rotation in all functional positions
  - TKE, stairs, SL squat, etc.
Retraining AGMR During Running

Abstract

STUDY DESIGN: Block randomized controlled trial.

OBJECTIVES: To investigate whether a strengthening and movement education program, targeting the hip abductors and hip external rotators, alters hip mechanics during running and during a single-leg squat.

BACKGROUND: Abnormal movement patterns during running and single-leg squatting have been associated with a number of running-related injuries in females. Therapeutic interventions for these aberrant movement patterns typically include hip strengthening. While these strengthening programs have been shown to improve symptoms, it is unknown if the underlying mechanics during functional movements is altered.

METHODS: Twenty healthy females with excessive hip adduction during running, as determined by instrumented gait analysis, were recruited. The runners were matched by age and running distance, and randomized to either a training group or a control group. The training group completed a hip strengthening and movement education program 3 times per week for 6 weeks in addition to single-leg squat training with neuromuscular readjustment consisting of mirror and verbal feedback on proper mechanics. The control group did not receive an intervention but maintained the current running distance. Using a handheld dynamometer and standard motion capture procedures, hip strength and running and single-leg squat mechanics were compared before and after the strengthening and movement education program.

RESULTS: While hip abductor and external rotation strength increased significantly (P<.005) in the training group, there were no significant changes in hip or knee mechanics during running. However, during the single-leg squat, hip adduction, hip internal rotation, and contralateral pelvic drop all decreased significantly (P=.005, P=.006, and P=.02, respectively). The control group exhibited no changes in hip strength, nor in the single-leg squat or running mechanics at the conclusion of the 6-week study.

CONCLUSION: A training program that included hip strengthening and movement training specific to single-leg squatting did not alter running mechanics but did improve single-leg squat mechanics. These results suggest that hip strengthening and movement training, when not specific to running, do not alter abnormal running mechanics.

LEVEL OF EVIDENCE: Therapy, level 2b.

PMID: 21789220 (PubMed - indexed for MEDLINE)
Variation response to mirror gait retraining of gluteus medius control, hip kinematics, pain, and function in 2 female runners with patellofemoral pain.


Abstract
STUDY DESIGN: Case report

BACKGROUND: The underlying mechanism of the changes in running mechanics after gait retraining is presently unknown. This case report assesses changes in muscle coordination and kinematics during treadmill running and step ascent in 2 female runners with patellofemoral pain after mirror gait retraining.

CASE DESCRIPTION: Two female runners with chronic patellofemoral pain underwent 8 sessions of mirror gait retraining during treadmill running. Subjective measures and hip abduction strength were recorded at baseline and after the retraining phase. Changes in hip mechanics and electromyography data of the gluteus medius during treadmill running and step ascent were also assessed.

OUTCOMES: Both runners reported improvements in pain and function that were maintained for at least 3 months. During running, peak contralateral pelvic drop (baseline-postretraining difference: runner 1, 2.6° less; runner 2, 1.7° less) and peak hip abduction (baseline-postretraining difference: runner 1, 5.2° less; runner 2, 6.3° less) were reduced after retraining. Kinematic reductions accompanied earlier activation of the gluteus medius relative to foot strike (baseline-postretraining difference: runner 1, 1.26 milliseconds earlier; runner 2, 3.73 milliseconds earlier) and longer duration of gluteus medius activity (runner 1, 55.9 milliseconds longer; runner 2, 44.4 milliseconds longer). Runner 1 had a reduced contralateral pelvic drop to step ascent, whereas runner 2 did not (contralateral pelvic drop baseline-postretraining difference: runner 1, 3.06° less; runner 2, 1.6° more; hip abduction baseline-postretraining difference: runner 1, 3.0° less; runner 2, 0.5° more). Both runners demonstrated earlier onset of gluteus medius activity during step ascent (baseline-postretraining difference: runner 1, 48.0 milliseconds earlier; runner 2, 28.3 milliseconds earlier), but only runner 1 demonstrated longer activation duration (runner 1, 25.0 milliseconds longer; runner 2, 29.4 milliseconds shorter).

DISCUSSION: While changes in hip mechanics and gluteus medius activity during running were consistent with those noted during step ascent for runner 1, runner 2 failed to demonstrate similar consistency between the tasks. Earlier onset and longer duration of gluteus medius activity may have been necessary to alter step mechanics for runner 2.

LEVEL OF EVIDENCE: Therapy, level 4

PMID: 24178611 [PubMed - indexed for MEDLINE]
AGMR Running Cues

• “Run with your knees apart with your kneecaps pointing straight ahead” and “squeeze your buttocks”

• Try external focus cues – “Imagine lasers shooting out from your knees - Don’t let lasers cross”

Femoral Adduction/Medial Rotation Treatment

Activity Modification

- **Posture Correction**: Do not stand on one leg in adduction with knee locked, stand with even weight, contract gluteals isometrically
- **Sitting**: Avoid crossing legs into adduction, medial rotation, and flexion
- **Sleeping**: Pillow between legs when side-lying to avoid femoral adduction
- **Gait**: Decrease crossover (wider base of support)
- **Stairs**: Avoid femoral adduction by keeping a wider base of support
- **Running**: Decrease crossover, look at increasing cadence
- **Sports**: Avoid femoral adduction during activities (cutting, running, etc.)

Exercise

- **Strengthen** lateral rotators and gluteal muscles
- **Minimize TFL** activation
- **Avoid ITB stretches** that cross leg into more ADD/MR
- Retrain closed chain position watching for pelvic drop, trunk lean, or femoral rotation

*Sahrmann 2010, Schubert 2014*
Effects of step rate manipulation on joint mechanics during running.

Heiderscheit BC¹, Chumanov ES, Michalski MP, Wille CM, Ryan MB.

Abstract

PURPOSE: The objective of this study was to characterize the biomechanical effects of step rate modification during running on the hip, knee, and ankle joints so as to evaluate a potential strategy to reduce lower extremity loading and risk for injury.

METHODS: Three-dimensional kinematics and kinetics were recorded from 45 healthy recreational runners during treadmill running at constant speed under various step rate conditions (preferred: ±5%, and ±10%). We tested our primary hypothesis that a reduction in energy absorption by the lower extremity joints during the loading response would occur, primarily at the knee, when step rate was increased.

RESULTS: Less mechanical energy was absorbed at the knee (P < 0.01) during the ±5% and ±10% step rate conditions, whereas the hip (P < 0.01) absorbed less energy during the ±10% condition only. All joints displayed substantially (P < 0.01) more energy absorption when preferred step rate was reduced by 10%. Step length (P < 0.01), center of mass vertical excursion (P < 0.01), braking impulse (P < 0.01), and peak knee flexion angle (P < 0.01) were observed to decrease with increasing step rate. When step rate was increased 10% above preferred, peak hip adduction angle (P < 0.01) and peak hip adduction (P < 0.01) and internal rotation (P < 0.01) moments were found to decrease.

CONCLUSION: We conclude that subtle increases in step rate can substantially reduce the loading to the hip and knee joints during running and may prove beneficial in the prevention and treatment of common running-related injuries.
Retraining Cadence

• Have runner run in time to a metronome alternating 1 minute on/off until runner can comfortably run at that pace and maintain without metronome
• Patient performs until new cadence becomes normal
• Ideally want 170-180 steps/min depending on skill
• Can also use music set at a specific BPM (Spotify)

Questions?
References

- Hansen, E. Evaluation and Treatment of Runners. Creighton University Orthopedic Residency Special Topic 2018