- If you are viewing this course as a recorded course after the live webinar, you can use the scroll bar at the bottom of the player window to pause and navigate the course.

- This handout is for reference only. Non-essential images have been removed for your convenience. Any links included in the handout are current at the time of the live webinar, but are subject to change and may not be current at a later date.

Technical issues with the Recording?

- Clear browser cache using these instructions
- Switch to another browser
- Use a hardwired Internet connection
- Restart your computer/device

Still having issues?

- Call 866-782-6258 (M-F, 8 AM-8 PM ET)
- Email customerservice@PhysicalTherapy.com

Ortho & Sports Virtual Conference: Lower Extremity Athletic Injuries

Guest Editor: David Nolan, PT, DPT, MS, OCS, SCS, CSCS

- **10/1: Comprehensive Care of the Hip**
- Peter Draovitch, PT, MS, ATC, CSCS, SCS
- **10/2: ACL: From Prehab to Return to Play**
- Kristina Fleming, PT, DPT, SCS
- **10/12: Bone Stress Injuries**
- Adam Tenforde, MD
- **10/13: Running Related Injuries**
- David Nolan, PT, DPT, MS, OCS, SCS, CSCS
- **10/14**: **The Foot Core: Let's Think Differently About the Foot**
- Irene Davis, PhD, PT, FACSM, FAPTA, FASB

Running Related Injury: Getting the Runner Back on the Road

David Nolan, PT, DPT, MS, OCS, SCS, CSCS

2

3

Learning Outcomes

- Describe at least three factors related to running form that may contribute to injury.
- Identify the mechanisms of at least two common lower extremity overuse injuries in runners.
- List at least three effective and appropriate interventions for the injured runner utilizing current evidence.
- Identify at least three evidence-based measures to assist with return to run decision making.

Running Injuries

- **Extrinsic Factors /** Environmental
  - Training errors
    - "Terrible Too's"
      - *Too* much, *Too* soon, *Too* fast. With *Too* little rest.
  - Old shoes
  - Running surface
- **Intrinsic Factors / Person-Related**
  - Poor flexibility
  - Biomechanical faults
  - Previous injury
  - Running experience

Epidemiology of Running Injuries

- **Taunton JE et. al. *BJSM* 2002**
  - **Most Common Injuries**
    - Patellofemoral Pain Syndrome (16.5%)
    - Iliotibial Band Friction Syndrome (8.4%)
    - Plantar fasciitis (7.9%)
    - Gastroc-Soleus complex (6%)
    - Meniscal Injuries of knee (5%)
    - Tibial Stress Syndrome (4.9%)
- Van Gent RN et al. *BJSM*, 2007
  - **Systematic review of injury in distance runners**
  - **Knee was most common site of musculoskeletal injury**

Epidemiology of Running Injuries

- **Taunton JE et. al. *BJSM* 2003**

Location	Men	Women
Knee	36%	32%
Shin	17%	15%
Foot	14%	13%
Achilles / Calf	8%	10%
Ankle	10%	10%
Hip / Pelvis	7%	10%
Low Back	7%	5%
Hamstring	0%	3%
Thigh	0%	1%

Epidemiology of Running Injuries

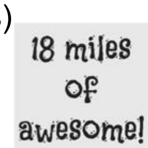
- **Buist, I et al *AJSM* 2010**
  - **532 novice runners (226 male, 306 female)**
  - **13 week training for 4 mile event**
  - **21% had at least one running-related injury**
  - **Male**
    - Higher BMI
      - Added physical stress on tissues
    - Previous injury in last year
    - Previous participation in sports without axial load
      - 2.1x higher risk
      - Ex. Cycling, swimming
  - **Female**
    - Navicular drop
      - Associated with greater foot pronation

Epidemiology of Running Injuries

- Nielsen RO et al. *Orthop J Sports Med*. 2013
  - **930 novice runners**
  - **27% sustained RRI**
    - Type B behavior (p=0.04)
    - Age 45-65 yo (p = 0.08)
    - Previous injury unrelated to running (p = 0.05)
    - Sex (p = 0.42)
    - Previous running related injury (p = 0.30)

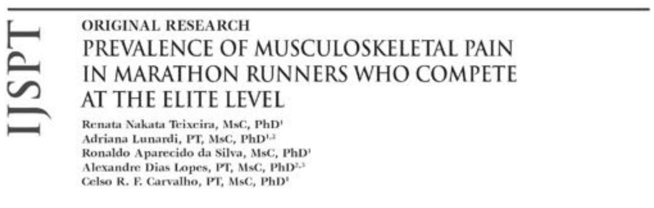
Epidemiology of Running Injuries

- Running Volume
  - **Rasmussen CH et al *IJSPT* 2013**
    - Retrospective study with marathon finishers
    - Self-Report RRI (↓ distance, speed, duration or frequency ≥ 14 days)
    - 10% reported RRI
    - 2x greater risk weekly volume <30K (18 miles)



continuED

Epidemiology of Running Injuries


IJSPT

ORIGINAL RESEARCH

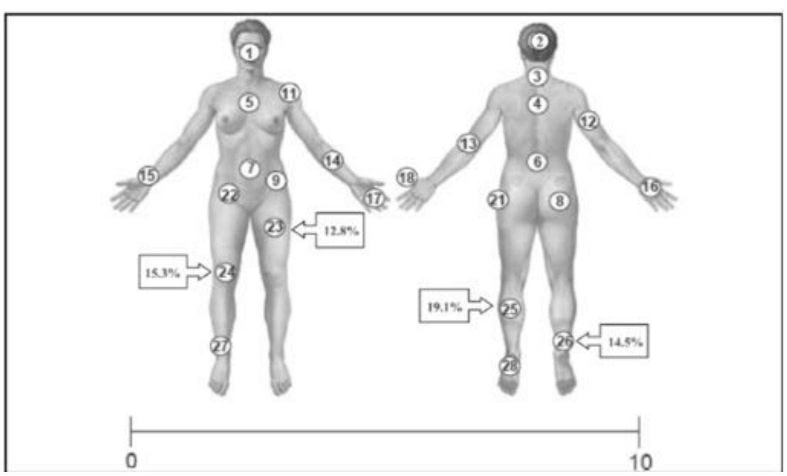
PREVALENCE OF MUSCULOSKELETAL PAIN IN MARATHON RUNNERS WHO COMPETE AT THE ELITE LEVEL

Renata Nakata Teixeira, MsC, PhD[1]
Adriana Lunardi, PT, MsC, PhD[1,2]
Ronaldo Aparecido da Silva, MsC, PhD[1]
Alexandre Dias Lopes, PT, MsC, PhD[2,3]
Celso R. F. Carvalho, PT, MsC, PhD[1]

- Teixeira RN et al. *IJSPT*. 2016
  - **199 elite marathoners interviewed**
  - **75% reported MSK pain**
  - **Independent of age, experience, running volume**

Epidemiology of Running Injuries

- Teixeira RN et al. *IJSPT*. 2016



Running Biomechanics

David Nolan, PT, DPT, MS, OCS, SCS, CSCS

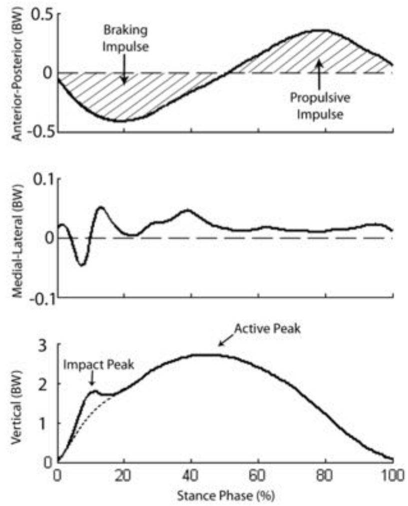
13

Ground Reaction Forces

- Force applied by the ground to the body in stance phase

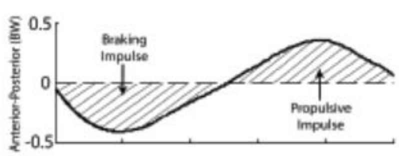
Ground Reaction Forces

- Anterior – Posterior
- Medial – Lateral
- Vertical



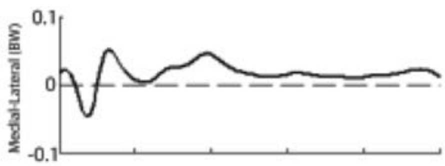
Ground Reaction Forces

- Anterior – Posterior
  - **Direction of Force**
    - Initial Contact to Midstance (1st half of stance)
      - Opposite of line of progression
      - Braking impulse
    - Midstance to toe-off (2nd half of stance)
      - Same direction as line of progression
      - Propulsive impulse



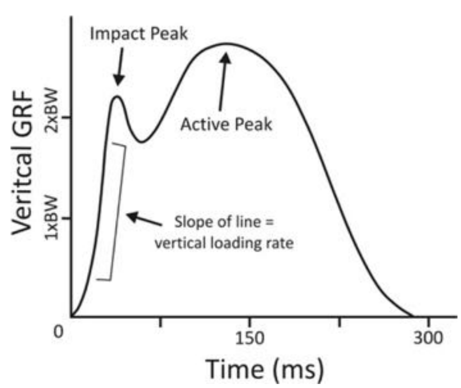
Ground Reaction Forces

- Medial – Lateral
  - **Smallest magnitude**
  - **Greatest variability**



Ground Reaction Forces

- Vertical
  - **Greatest magnitude**
  - **Active Peak (2.5BW)**
    - Midstance
  - **Impact Peak (1.5BW)**
    - 12% of gait cycle
    - Loading rate
      - ↑ with heel strike, slower cadence & downhill running

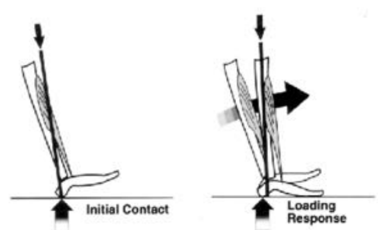


Ground Reaction Forces

- Its not just about the “Impact Peak”
  - **Resultant GRF increase until midstance**
    - Active peak of vertical GRF
      - Increases as COM moves downward
    - Braking force of A-P GRF
      - Increases as horizontal distance between COM and foot at initial contact increases

Kinetics & Kinematics

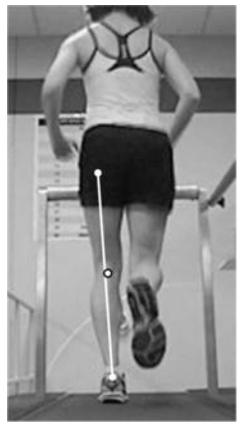
- Sagittal Plane Function
  - **Eccentric contractions**
    - Hip extensors
    - Knee extensors
    - Ankle plantar flexors
  - **Absorb mechanical energy**
  - **Hip Abductors key**
  - **Running style that ↑ GRF may ↑ demand**
    - Pelvic drop, dynamic knee valgus

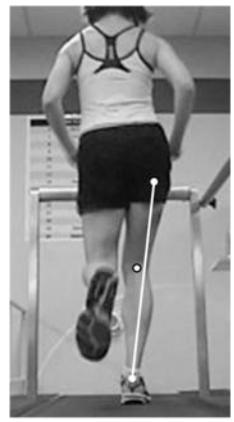


continuED

Running Assessment

- Frontal Plane
  - **Joint Center**
    - Hip – Ankle joint
    - Knee joint center
  - **Dynamic valgus**
  - **Dynamic Varus**



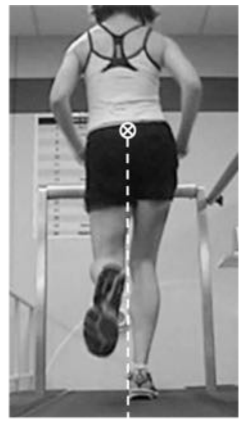


Running Assessment

- Frontal Plane
  - **Neutral Pelvis**
    - Lateral tilt / Pelvic drop
    - Women: 3°-5° > men
  - **Dynamic valgus**

Running Assessment

- Frontal Plane
  - **Foot Position**
    - Midline Crossover
      - ↑ lateral hip strain
    - Toe Out
      - Hip influence
        - » Capsule/Muscle/Bone
      - Knee influence
        - » Tibial torsion
        - » External malleolar torsion
      - Ankle influence
        - » Compensation for ↓ dorsiflexion



Running Assessment

- Sagittal Plane
  - **Foot Contact Angle**
    - Plantar aspect & running surface
    - Strike Pattern
      - Heel = >5°
      - Midfoot = ~ 0°
      - Forefoot = <-5°

Running Assessment

- Sagittal Plane
  - **A-P Foot Placement**
    - Horizontal distance of foot with Line Of Gravity (LOG)
    - ↑ Distance = ↑ Braking Impulse

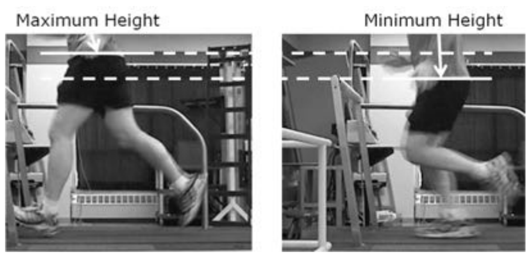
VS

Running Assessment

- Sagittal Plane
  - **Knee Flexion Angle**
    - Normal @ initial contact = 15° - 20°
    - Extended Knee : Overstride : Heel Strike Pattern
    - ↓ knee flexion angle = ↑ Impact peak force

Running Assessment

- Sagittal Plane
  - **Center of Mass (COM) Excursion**
    - Vertical displacement
    - Midstance (lowest) to midflight (highest)
    - ↑ Excursion = ↑ Active peak of vertical GRF
    - ↑ Excursion = ↑ Metabolic cost



Management of Common Running Related Injuries

David Nolan, PT, DPT, MS, OCS, SCS, CSCS

28

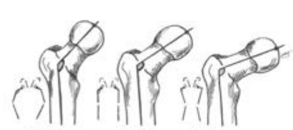
Common Running Related Injuries

- Anterior Knee Pain
- Achilles Tendinopathy
- Medial Tibial Stress Syndrome
- Heel Pain

Patellofemoral Syndrome

- **Risk Factors**
  - Excessive Foot Pronation
    - Tiberio D *JOSPT*, 1987
      - Tibial IR leads to femoral IR
      - Increases contact pressure on lateral facets of patella

  - Femoral Structure
    - Powers CM. *JOSPT*. 2003
      - Femoral Anteversion
      - Femoral Inclination (Coxa Valga)
        - » Reduced gluteus medius moment arm



  - Decreased Knee Flexion Angles
    - Crossley K et al. *J Orthop Res*. 2004
    - Decreased contact area of patella
      - Powers CM et al. *Clin Biomech*. 1999

Risk Factors

- Hip Muscle Imbalances
  - **Cichanowski HR. et al. *Med Sci Sports Exerc*, 2007**
  - **Bolga LA. et al. *JOSPT*, 2008**
  - **Robinson RL. & Nee RJ. *JOSPT*, 2007**
  - **Ireland et al. *JOSPT*, 2003**
    - 26% less hip abductor & 36% less hip ER strength in females
  - **Kendall et al. *J Athl Train*, 2007**
    - 90% of PFPS group ↓ hip ER, Abduction & flexor strength

Patellofemoral Syndrome

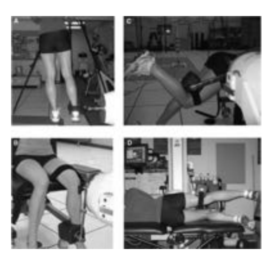
- Boling MC. et al. *AJSM* 2009
  - **1597 USNA Midshipmen**
  - **Risk factors for development of PFPS:**
    - Decreased knee flexion angle
    - Increased hip IR during jump-landing task
    - Decreased quad & hamstring strength
    - Increased hip ER strength
      - Possibly compensatory
    - Increased navicular drop
- Conclusion:
  - **Multiple modifiable risk factors for PFPS exist and should be addressed with prevention programs**

Patellofemoral Syndrome

- Dierks TA. et al. *JOSPT* 2008.
  - **20 runners with PFPS & 20 matched uninjured runners**
  - **Variables**
    - Hip abduction & ER strength pre/post run
    - Arch height index pre run
    - LE kinematic data beginning & end of run
  - **Results**
    - Both groups displayed diminished strength at end of run
    - PFPS group had significantly less hip abduction strength
    - Hip abduction weakness was associated with greater peak hip adduction angle
    - Arch height did not differ between groups
  - **Conclusion**
    - Runners with PFPS displayed weaker hip abductor muscles which became more pronounced at the end of a run

Patellofemoral Syndrome

- Souza RB. & Powers CM. *AJSM*, 2009
  - **19 females with PFPS & 19 pain-free controls**
  - **PFPS group**
    - ↑ Hip IR
      - (8.2° ± 6.6° vs. 0.3° ± 3.6°; $p<.001$)
    - ↓ Hip strength
      - 21% deficit in muscle performance overall
      - 49% less hip extension repetitions
      - 40% less pelvic drop repetitions
    - ↑ Femoral inclination
      - (132.8° ± 5.2° vs. 128.4° ± 5.0°; $p=.011$)

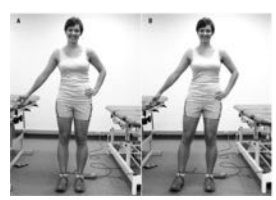


Patellofemoral Syndrome

- Noehren B et al. *Med Sci Sports Exerc* 2013
  - **Prospective study**
  - **3-D motion analysis of female runners**
  - **Followed for 2 years**
  - **Group that developed PFPS**
    - 4° more peak hip adduction compared to matched controls

Strengthening

- Khayambashi K et al. *JOSPT* 2012
  - **28 women with PFPS**
  - **Exercise or no exercise control group**
  - **B Hip Abductor & ER strength 3x/week for 8 weeks**
    - Decreased pain
    - Improved health status (WOMAC)
    - Increased B hip strength (HHD)



Patient Case
Patellofemoral Pain Syndrome

37

Case Study

- 15 year old female basketball player
- 4 teams
- Recent onset of B anterior knee pain
- Worse with basketball & stairs
- Father reports “worried about how she runs”

Barefoot Walk

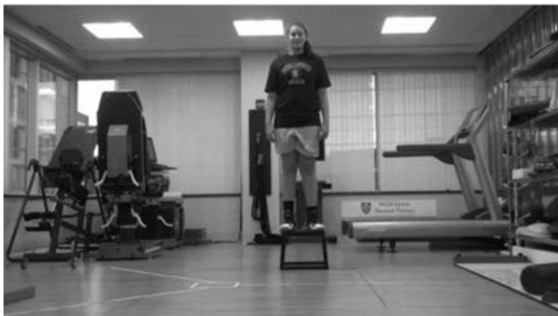
Case Study

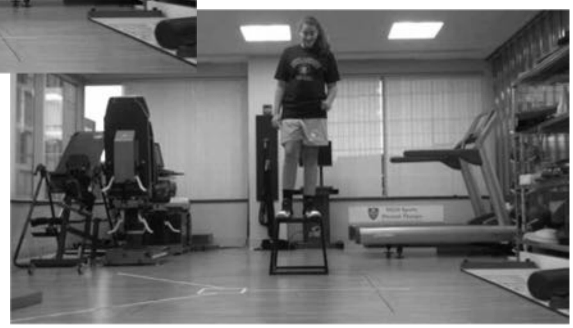
- Examination
  - **Limited muscle length**
    - Iliopsoas, quad, gastroc-soleus, hamstrings
  - **Limited strength**
    - Quad & hamstrings: 4/5 B
    - Gluteus medius & maximus: 3+/5 B

Shod Run

Shod Run Lateral

Drop Jump

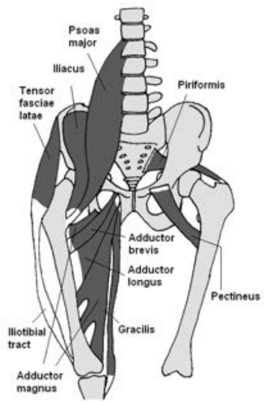




Case Study

- Treatment
  - **LE flexibility**
    - Hip flexors critical
  - **Gluteal activation exercises**
    - Significant compensation
    - HS for glut max
    - TFL for glut med
  - **Proprioception / Neuro Re-ed**
    - Static → Dynamic

Iliotibial Band Syndrome



Download for free at https://openstax.org/details/books/anatomy-and-physiology.

- Primary Functions
  - **Stabilize lateral hip & knee**
  - **Resist hip adduction & knee IR**
  - **Femoral & tibial attachments**
    - Atypical hip & foot mechanics potential causes of ITBS
- Common cause of lateral knee pain in runners & cyclists
  - **Hip Abductor & ER weakness**
    - Frederickson, M. et al. *Clin J Sports Med.* 2000
  - **Increased weekly mileage**
    - Messier, SP. *Med Sci Sports Exerc.* 1995

Iliotibial Band Syndrome

- **Distal Mechanism**
  - **Greater rearfoot inversion angle at heel strike**
    - Miller, RH. et al. *Gait Posture* 2007
  - **Greater tibial IR throughout stance phase**
    - Ferber R, et al. *JOSPT* 2010
  - **Increased peak rearfoot eversion**
    - Messier, SP. et al. *Med Sci Sports Exer*. 1995
  - **Decreased peak rearfoot eversion**
    - Noehren, B. et al. *Med Sci Sports Exer.* 2006
  - **Noehren, B. et al. *Clin Biomech*. 2007**
    - Decreased eversion in ITBS group as whole
    - Subgroup of subjects exhibited excessive eversion as well as high tibial and knee internal rotation

Iliotibial Band Syndrome

- **Noehren, B. et al. *Clin Biomech*. 2007**
  - Compared running mechanics of females with ITBS with healthy females
    - ITBS group exhibited significantly greater hip adduction & knee internal rotation
    - Result in increased ITB strain & compression against lateral femoral condyle
    - Treatment should focus on controlling secondary plane motions

- **Ferber, R et al. *JOSPT* 2010**
  - ITBS group significantly greater hip adduction angle & knee IR angle

Iliotibial Band Syndrome

- Mucha MD et al. *J Sci Med Sport*. 2017
  - **Systematic Review**
  - **1841 articles; 11 met inclusion criteria**
  - **ITBS, PFPS, MTSS, Tibial Stress Fx, AT**

  - **Hip Abduction weakness associated with ITBS**
    - 3/5 specific to ITBS

Patient Case
ITBS

49

Patient Case: ITBS

- 15 yo male HS runner competes in 20 races/year
  - 2 mile (track), 5K (XC)
- C/O B lateral hip and thigh pain extending to knee
- Pain has forced time off for 2 seasons
- Sx ↑ with running uphill, cutting, stairs

Patient Case: ITBS

- **Key Findings**
  - **Limited ankle DF**
    - Gastroc-Soleus length & Talocrural mobility
    - Early heel rise & compensatory pronation
      - Toe out on right with midfoot collapse
  - **Limited ROM**
    - ↓ B Extension, IR & ER
  - **Limited flexibility**
    - Iliopsoas, HS
  - **Limited gluteal strength**
    - Medius & Maximus

Barefoot Walk

Patient Case: ITBS

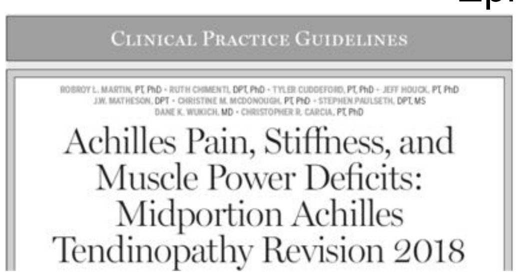
- **Key Findings**
  - **Limited gluteal strength**
    - Crossover: Inability of gluteus medius to eccentrically control limb

Shod Run

Achilles Tendinopathy

- Epidemiology (Carcia CR et a. *JOSPT*. 2010)
  - **7% - 9% of distance runners**
  - **Men > Women**
  - **More common in older athlete**
    - 30 – 50 year old

Epidemiology



CLINICAL PRACTICE GUIDELINES

ROBROY L. MARTIN, PT, PhD • RUTH CHIMENTI, DPT, PhD • TYLER CUDDEFORD, PT, PhD • JEFF HOUCK, PT, PhD
J.W. MATHESON, DPT • CHRISTINE M. MCDONOUGH, PT, PhD • STEPHEN PAULSETH, DPT, MS
DANE K. WUKICH, MD • CHRISTOPHER R. CARCIA, PT, PhD

Achilles Pain, Stiffness, and Muscle Power Deficits: Midportion Achilles Tendinopathy Revision 2018

- 7% of novice runners
  - Nielsen RO et al. *PLoS One*. 2014
- Running (6.2% - 9.5%); Ultramarathon (2.0% - 18.5%)
  - Lopes AD et al. *Sports Med*. 2012
- Most common in 40-59 yo
  - Yasui Y et al. *Biomed Res Int*. 2017

Achilles Tendinopathy

- Clinical Presentation
  - **Palpation**
    - Pain along distal 1/3 of tendon
    - Possible ↑ density
  - **Mobility**
    - Pain with passive dorsiflexion
  - **Muscle Performance**
    - Pain with resisted plantarflexion
  - **Activity**
    - Pain with running uphill
    - Pain with longer runs

Achilles Tendinopathy

"Itis"

- Inflammatory process
- Rare given chronic nature of most presentations
- Recover within 2 weeks

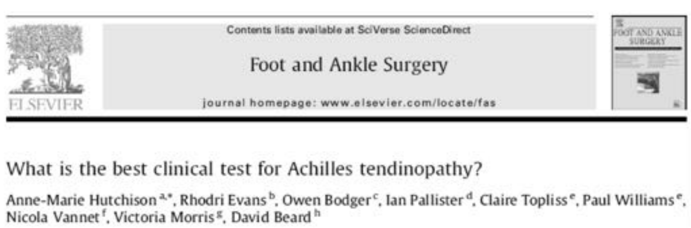
"Osis"

- Degeneration within the tendon
- Repetitive microtrauma
- Increase in vascularity
- Recovery may take several months
- Clinical Pearl
  - **Tendon enlargement will move with tendon; swelling will not**

Diagnosis

- **(+) Achilles tendon tenderness** (Carcia CR et a. *JOSPT*. 2010)
- **Arc Sign** (Carcia CR et a. *JOSPT*. 2010)
  - Patient is prone; observe area of thickening/swelling
  - Active PF/DF
  - Tendinopathy = density moves proximal/distal
- **Royal London Hospital Test** (Carcia CR et a. *JOSPT*. 2010)
  - Patient is prone; identify area of max pain on palpation
  - Active DF; Palpate same region
  - Tendinopathy = ↓ pain in DF

Diagnosis


Contents lists available at SciVerse ScienceDirect

Foot and Ankle Surgery

journal homepage: www.elsevier.com/locate/fas

What is the best clinical test for Achilles tendinopathy?

Anne-Marie Hutchison[a,*], Rhodri Evans[b], Owen Bodger[c], Ian Pallister[d], Claire Topliss[e], Paul Williams[e], Nicola Vannet[f], Victoria Morris[g], David Beard[h]

- Hutchison AM. Et al. *Foot Ankle Surg*. 2013
  - **Pain reported 2-6cm proximal to Achilles insertion extending to calcaneus**
    - Sensitivity = 84%; Specificity = 73%
  - **Pain with palpation midportion Achilles tendon**
    - Sensitivity = 78%; Specificity = 77%

Exam

[CLINICAL COMMENTARY]

JOY C. MACDERMID, PT, PhD · KARIN GRÄVARE SILBERNAGEL, PT, PhD, ATC

Outcome Evaluation in Tendinopathy: Foundations of Assessment and a Summary of Selected Measures

- MacDermid JC & Silbernagel KG. *JOSPT* 2015
  - **Hopping Tests: Continuous rhythmical jump**
    - Monitor contact & flight time
    - Monitor pain
  - **Heel rise endurance test**
    - SLS with knee extension & fingertip balance
    - Repeated PF → fatigue
    - Normal = 25 (range 6-70)

Exam: Outcome Measures

- Lower Extremity Functional Scale (LEFS)
  - Mehta SP et al. *J Orthop Sports Phys Ther*. 2016
  - Brinkley JM et al. *Phys Ther*. 1999
  - **20 items; 0-4 (max 80 points)**
  - **Test-retest reliability: *r*=0.87**
  - **MCID: 12** (McCormack J et a. *IJSPT*. 2015)
- Foot and Ankle Ability Measure (FAAM)
  - Shultz S et al. *Int J Sports Phys Ther*. 2013
  - Martin RL et al. *Foot Ankle Int*. 2005
  - **21 item ADL**
  - **8 item Sports**
  - **MCID: 8 (ADL), 9 (Sports)**
- VISA-A (Victorian Institute of Sport Assessment-Achilles)
  - **Assesses pain & stiffness**
  - **8 item questionnaire (max 100 points)**
  - **MCID: 6.5** (McCormack J et a. *IJSPT*. 2015)

Pathoanatomic Features

- Martin RL et al. *J Orthop Sports Phys Ther*. 2018
  - **Tendon thickening**
  - **Neovascularity**
  - **Collagen disorganization**
  - **Fat deposit**
  - **↓ Tendon stiffness & strength**
  - **Limited ability to transfer force**

Risk Factors

- Lower Extremity Intrinsic Factors (Carcia CR et a. *JOSPT*. 2010)
  - **Abnormal subtalar joint ROM**
  - **Limited ankle dorsiflexion**
  - **↓ plantarflexion strength**
  - **Foot pronation**
- Co-Morbidities (Carcia CR et a. *JOSPT*. 2010)
  - **HTN, DM, ↑ cholesterol**
  - **Obesity** (Franceschi F et al. *Int J Endocrinol*. 2014)
- Increased pronation (Ryan M et al. *Foot Ankle Int*, 2009)
  - **27 runners with mid portion achilles tendinopathy**
  - **↑ STJ eversion during mid-stance**
    - 13° ± 3° vs. 11° ± 3° (p = 0.04)

Risk Factors

- Magnan B et al. *Foot Ankle Surg*. 2014
  - **Systematic review; Intrinsic risk factors:**
    - ↑ Age, Male, ↑ body weight
    - ↓ Muscle strength, ↓ Flexibility

- Gluteal weakness
  - Habets B et al. *Phys Ther Sport*. 2017
  - Semciw A et al. *J Electromyogr Kinesiol*. 2016

- Family history of tendinopathy = 5x risk
  - Kraemer R et al. *Arch Orthop Trauma Surg*. 2012.

Caution with eccentric load…..

CLINICAL PRACTICE GUIDELINES

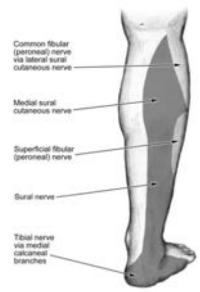
Achilles Pain, Stiffness, and Muscle Power Deficits: Midportion Achilles Tendinopathy Revision 2018

TABLE 2 SUMMARY OF EXCLUSION CRITERIA FROM STUDIES OF ECCENTRIC EXERCISES DUE TO PRESUMED FRAILTY OF THE PLANTAR FLEXOR MECHANISM AND LOCAL AREA

Exclusion	Example
Surgery	Tendon rupture repair
Connective tissue diseases	
Systemic diseases/disorders	Rheumatic diseases, diabetes
Genetic diseases	Marfan's syndrome
Medications	Local steroid injection, systemic fluoroquinolones
Pregnancy	
Age	Youths and adolescents
Fracture	
Other local disease states	Peripheral vascular disease

Differential Diagnosis

- Martin RL et al. *JOSPT*. 2018
  - **Os Trigonum**
  - **Posterior ankle impingement**
  - **Plantaris Tendon involvement**
  - **Retrocalcaneal Bursitis**
  - **Sural neuropathy**
  - **Radiculopathy**

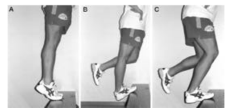


Achilles Tendinopathy

- Management
  - **Acute**
    - ↓ pain & effusion
    - Relative rest
      - Control load on healing tissue
    - Control dorsiflexion
      - Guided by pain
    - Possible heel lift: ↓ tensile load on tendon
      - Wulf M et al *J Orthop Sports Phys Ther*. 2016
  - **Sub-acute**
    - Progress to full ROM
    - Initiate strengthening / remodel tissue

Achilles Tendinopathy

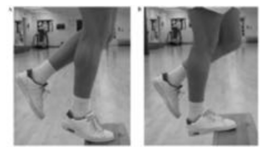
- Eccentric Calf Strengthening
  - **Alfredson H et al. *AJSM* 1998**
  - **15 recreational athletes Dx with Achilles tendinosis**
    - 12 men & 3 women (age 44.3 +/- 7 years)
  - **Training Program**
    - 2x/day for 12 weeks
    - 3 sets of 15 reps
      - Knee straight (gastroc) & Knee bent (soleus)
      - Body weight initially progressed to external load
  - **Results**
    - VAS decreased from 81.2 (+/- 18) to 4.8 (+/- 6.5)
    - All 15 subjects returned to pre-injury running level
    - 15 athletes received conservative treatment
      - All underwent surgical intervention



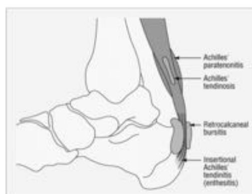
Achilles Tendinopathy

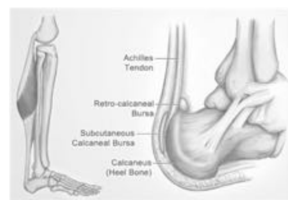
- Non-Operative Treatment
  - **Eccentric Training**
    - Knobloch K et al. *JOSPT* 2007
      - 12 week eccentric program performed daily
      - ↓ paratendinous capillary blood flow by 45%
      - ↓ pain level by 48%
    - Shalabi A et al. *AJSM* 2004
      - 3 months of eccentric calf strengthening
      - MRI evaluation revealed:
        - » 14% decrease in tendon volume
        - » 23% decrease in intratendinous signal
      - Results correlated with improved clinical outcome

Insertional Achilles Tendinopathy



- Fahlstrom M. et al. 2003
  - **32% patients with insertional Achilles tendinopathy successful with eccentric training into dorsiflexion**
    - Compressive forces in dorsiflexion
    - Impingement between tendon, bursa and bone





Insertional Achilles Tendinopathy

- Jonsson P. et al. *Br J Sports Med*. 2008
  - **27 subjects (20 unilateral & 7 bilateral)**
    - 12 men, 15 women, mean age = 53.4 yrs (25-77)
  - **Mean duration of symptoms = 26.5 months (6-96)**
  - **Eccentric exercise performed without dorsiflexion**
  - **3x15 reps, 2 x/day, 7 days/week for 12 weeks**
  - **Load increased to create pain during exercise**
  - **Results: 67% satisfied @ 4 month F/U**
    - 18 “satisfied”
      - VAS ↓ 69.9 to 21.0 ($p<0.001$)
    - 9 “not satisfied”
      - VAS ↓ 77.5 to 58.1 ($p<0.006$)

Eccentric Exercise

Physical therapies for Achilles tendinopathy: systematic review and meta-analysis

Samuel P Sussmilch-Leitch[1†], Natalie J Collins[1,2†], Andrea E Bialocerkowski[3†], Stuart J Warden[4†] and Kay M Crossley[1,2,5*†]

JOURNAL OF FOOT AND ANKLE RESEARCH

- Sussmilch-Leitch SP et al. *J Foot Ankle Res*. 2012
  - **Systematic Review of 9 RCTs**
  - **Supported eccentric exercise for midportion Achilles Tendinopathy**

Eccentric & Soft Tissue

- McCormack JR et al. *Sports Health* 2016
  - **Eccentric (n=9) vs Eccentric + ASTYM (n=7)**
  - **Treated over 12 weeks**
  - **F/U @ 4, 8, 12, 26, 52 weeks**

Eccentric & Soft Tissue

- McCormack JR et al. *Sports Health* 2016
  - **VISA-A**

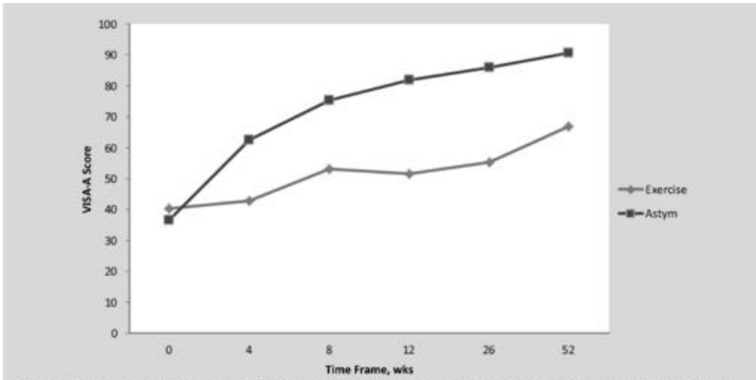


Figure 5. Mean Victorian Institute of Sport Assessment Achilles-Specific Questionnaire (VISA-A) scores at baseline and each follow-up period.

Eccentric & Soft Tissue

- McCormack JR et al. *Sports Health* 2016
  - **Pain Rating**

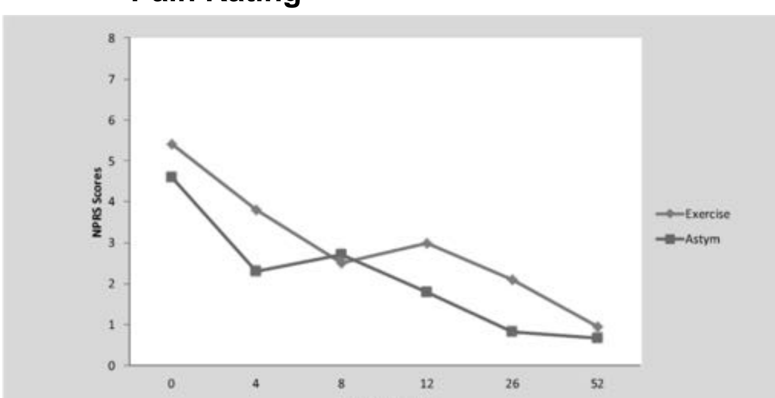


Figure 6. Mean numeric pain rating scale (NPRS) scores at baseline and each follow-up period.

Achilles Tendinopathy

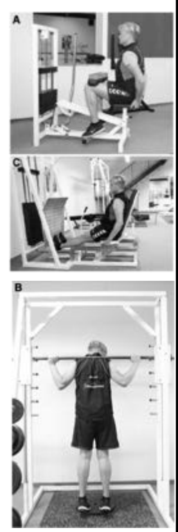
- More Than Just Eccentrics….
  - **Tibialis posterior strength**
    - Control transverse plane Williams DS et al *JOSPT* 2008
  - **Unstable surfaces**
    - Multi plane muscle balance
  - **Single leg hopping**
    - Control of ground reaction forces
  - **Manual Therapy**
    - Jayaseelan DL et al. *J Manual Manip Ther*. 2017






Heavy Load Slow Resistance

- Beyer R et al, *AJSM* 2015
  - **RCT Ecc vs HSR for 12 weeks:**
  - **Both groups improved; maintained at 1 yr F/U**
    - Self report measures
    - Decreased tendon thickness
    - Decreased neovascularization
  - **Patient satisfaction @ 12 weeks (*P* = .052)**
    - HSR 100%
    - ECC 80%
  - **Patient satisfaction @ 52 weeks (*P* = .10)**
    - HSR 96%
    - ECC 76%



Eccentric Program

[RESEARCH REPORT]

MARC STEVENS, PT, MSc[1] • CHEE-WEE TAN, PT, PhD[2]

Effectiveness of the Alfredson Protocol Compared With a Lower Repetition-Volume Protocol for Midportion Achilles Tendinopathy: A Randomized Controlled Trial

- Stevens M et al. *J Orthop Sports Phys Ther*. 2014
  - **Alfredson protocol: 180 eccentric reps/day**
  - **Standard (15) vs As tolerated (13)**
  - **6 week program**
    - No significant differences in VISA-A or VAS

Eccentric Program

CLINICAL PRACTICE GUIDELINES

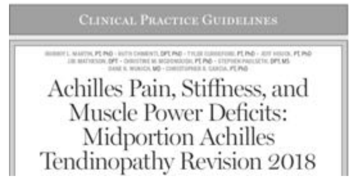
RobRoy L. Martin, PT, PhD • Ruth Chimenti, DPT, PhD • Tyler Cuddeford, PT, PhD • Jeff Houck, PT, PhD
J.W. Matheson, DPT • Christine M. McDonough, PT, PhD • Stephen Paulseth, DPT, MS
Dane K. Wukich, MD • Christopher R. Carcia, PT, PhD

Achilles Pain, Stiffness, and Muscle Power Deficits: Midportion Achilles Tendinopathy Revision 2018

2018 Recommendation

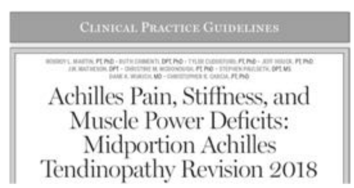
A Clinicians should use mechanical loading, which can be either in the form of eccentric or a heavy-load, slow-speed (concentric/eccentric) exercise program, to decrease pain and improve function for patients with midportion Achilles tendinopathy without presumed frailty of the tendon structure.

Updated Recommendations



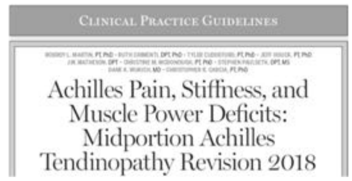
- Joint & Soft tissue mobilization
- Rigid taping
- Iontophoresis with Dexamethasone (acute)
- Extracorporeal Shockwave Therapy (with eccentrics)
- Dry needling (with eccentrics)
  - **Symptoms >3month & tendon thickness**

Updated Recommendations



- Night Splints
- Therapeutic elastic tape
- Platelet Rich Plasma Injection

Updated Recommendations


CLINICAL PRACTICE GUIDELINES

Achilles Pain, Stiffness, and Muscle Power Deficits: Midportion Achilles Tendinopathy Revision 2018

- Heel lifts
- Orthoses
- Low Level Laser Therapy

Patient Case
Achilles Tendinopathy

David Nolan, PT, DPT, MS, OCS, SCS, CSCS

84

Case Study: Achilles Tendinopathy

- 20 yo man C/O R>L midsubstance Achilles tendon pain (insidious onset)
  - R = 0=7/10
  - L = 0-5/10
- Collegiate runner (800m & 1500m)
- Typical training = 40+ miles/week
- Rigid foot orthoses with RF & FF posting

Barefoot Walk

Case Study: Achilles Tendinopathy

- **Key findings:**
  - Gluteal strength: R = 4-/5; L = 4/5
  - Limited flexibility: hip flexors and GS
  - Limited joint mobility: STJ & TCJ B
  - Biomechanical Exam: Neutral RF, Compensated FF varus, Hypermobile midfoot (Oblique axis)
  - Palpation: Mod pain & density R medial midsubstance Achilles tendon

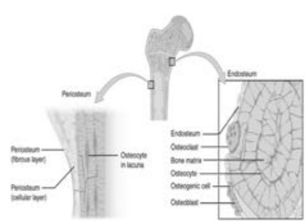
Shod Jog

Medial Tibial Stress Syndrome

- Shin Splints
  - **Stress Fractures**
  - **Myositis**
  - **Periostitis**
  - **Tendinitis**
  - **Compartment Syndrome**
  - **Fasciitis**
  - **Ischemic Disorders**
- MTSS
  - **Excludes stress fractures & posterior compartment syndrome**

Medial Tibial Stress Syndrome

- Pathogenesis (Tweed JL. et. al. *J Am Podiatr Med Assoc*. 2008)
  - **Periostitis**
    - Traction on muscular origins
      - Tibialis Posterior / Soleus
    - Strain on medial tibial fascia
  - **Periostalgia**
    - Chronic presentation: periosteum detached from bone
    - Adipose formation between periosteum & underlying bone
- Presentation
  - **Pain on palpation over distal 2/3 of posterior medial tibia**



By OpenStax College [CC BY 3.0 (https://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Medial Tibial Stress Syndrome

Risk Factors

- Sharma J et al. *Gait Posture*. 2011
  - **Most significant risk factor was "poor biomechanics" (9.2x)**
    - ↑ weight bearing on medial side of foot
    - ↑ medial pressure in forefoot
    - ↑ pressure in calcaneus at heel strike
    - ↑ foot pronation

Risk Factors

- Reinking MF et al. *Sports Health* 2017
  - **Female Sex**
  - **↑ weight**
  - **↑ navicular drop**
  - **Previous running injury**
  - **↑ Hip ER with hip in flexion**

Medial Tibial Stress Syndrome in Active Individuals: A Systematic Review and Meta-analysis of Risk Factors

Mark F. Reinking, PT, PhD, SCS, ATC,[*†] Tricia M. Austin, PT, PhD, ATC,[‡] Randy R. Richter, PT, PhD,[‡] and Mary M. Krieger, MLIS, RN[§]

Medial Tibial Stress Syndrome

- Prevention (Craig DI. *J Athl Train*. 2008)
  - **↑ strength & endurance of soleus**
  - **Control overpronation**
    - Alleviate stress along medial fascial attachment of soleus
  - **Promote adequate shock absorption**
    - New shoes, insoles
  - **1 day/week of cross training**
    - Non-impact activity

Medial Tibial Stress Syndrome

- Bennett JE. et al. *JOSPT* 2001
  - **125 HS X-Country runners**
  - **Variables Measured**
    - Tibiofibular varum
    - Resting calcaneal position
    - Gastrocnemius length
    - Navicular drop (after injury)
  - **Results**
    - 12% reported MTSS symptoms
      - 13 female & 2 male
    - Navicular drop (p = 0.003)
      - Injured: 6.8 mm (+/- 3.7)
      - Non-Injured: 3.6 mm (+/- 3.3)
  - **Conclusion**
    - Combination of being female and large navicular drop provides an accurate indication of those predisposed to MTSS

Medial Tibial Stress Syndrome

- Plisky, MS et al. *JOSPT* 2007
  - **105 HS X-Country runners followed for one season**
  - **Variables Measured**
    - Bilateral navicular drop
    - Foot length
  - **Questionnaire**
    - BMI, Injury history, Running experience, Orthotic & tape use
  - **Results**
    - 15.2% reported MTSS symptoms
    - Injury Rates: 2.8 / 1000 athletic exposures
      - Girls: 4.3 / 1000 AEs
      - Boys: 1.7 / 1000 AEs
    - Female gender and increased BMI were related to MTSS
      - Only BMI was significant when controlled for orthotic use
  - **Conclusion: Navicular drop was not an effective preseason screening tool for MTSS**

Medial Tibial Stress Syndrome

- Treatment
  - **Rest**
    - Complete or relative
  - **Address training errors**
    - Surface modification
  - **Muscle Imbalance**
    - Eccentric control of Tibialis Posterior
  - **Gastroc-Soleus complex flexibility**
    - Compensation for ankle equinus seen at midfoot which may increase load on Tibialis Posterior and Soleus
  - **Strengthening of plantar intrinsics**
    - Offer dynamic support to arches of foot and assist in pronation control

Medial Tibial Stress Syndrome

- Summary
  - **Literature does not offer a clear picture**
  - **Greater incidence in MTSS injury in women reported**
  - **Question the impact of hip mechanics on MTSS development**
  - **Future Research**
    - Include hip strength and motion as variables
    - Include all proposed theoretical contributing factors
      - Navicular drop
      - Calcaneal eversion
      - Tibiofibular varum
      - Others?
    - Increased number of variables present may be more related to developing MTSS rather than a single variable

Patient Case
Medial Tibial Stress Syndrome

97

Case Study 1

- 20 yo female collegiate runner
  - **XC & Track (distance)**
- Bilateral (L>R) shin pain began 3 years prior
- Pain has forced her to stop all running
- Radiographs and MRI (-)
- Treatment to date
  - **Physical Therapy x2**
  - **Chiropractic x2**
  - **Acupuncture**
  - **Podiatry**
    - Custom orthoses: unable to tolerate

Barefoot Fast Walk

Case Study 1

- Key Findings
  - **Limited ankle DF**
    - Gastroc-Soleus length & Talocrural mobility
    - Early heel rise & compensatory pronation
  - **Limited gluteal strength**
    - Medius & Maximus
    - Genu valgus and forced pronation
  - **Proximal & Distal factors contributing to overload of Tibialis Posterior & Soleus**

Shod Run

Biomechanical Risk Factors

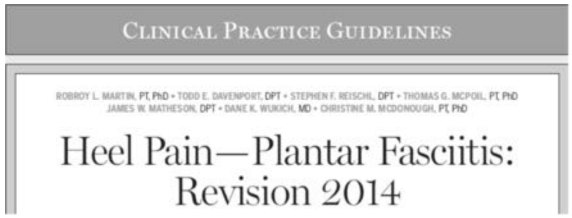
Biomechanical Factors Associated With Achilles Tendinopathy and Medial Tibial Stress Syndrome in Runners

James Becker,* PhD, Stanley James,† MD, Robert Wayner,‡ DPT, Louis Osternig,§ PhD, ATC, and Li-Shan Chou,§‖ PhD
Investigation performed at the Motion Analysis Laboratory, University of Oregon, Eugene, Oregon, USA

- Becker J et al. *Am J Sports Med*. 2017
  - **42 Runners (13 AT, 8 MTSS, 21 controls)**
  - **Injured Participants:**
    - ↑ tibial varus (8.67° vs 6.76°; $p = .002$)
    - ↓ ankle DF (6.14° vs 11.19°; $p = .002$)
    - ↑ duration of eversion in stance (86.02% vs 59.12%; $p < .001$)

Amount of rearfoot eversion ROM and velocity of eversion were **NOT** factors

Background


CLINICAL PRACTICE GUIDELINES

ROBROY L. MARTIN, PT, PhD • TODD E. DAVENPORT, DPT • STEPHEN F. REISCHL, DPT • THOMAS G. MCPOIL, PT, PhD
JAMES W. MATHESON, DPT • DANE K. WUKICH, MD • CHRISTINE M. MCDONOUGH, PT, PhD

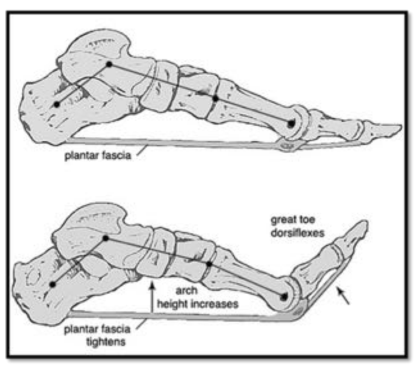
Heel Pain—Plantar Fasciitis: Revision 2014

- Most common foot condition treated by health care providers
- High prevalence in athletic & nonathletic populations

McPoil TG et al. *J Orthop Sports Phys Ther*. 2008
Martin RL et al. *J Orthop Sports Phys Ther*. 2014

Plantar Fasciopathy

- **Fasciitis or Fasciosis?**
  - Degenerative process *without* inflammation (Lemont H et al. JAPMA 2003)
- **Epidemiology**
  - Peak incidence 40-60 y.o. (Riddle DL & Schappert SM. *Foot Ankle Int*. 2004) Gender studies are conflicting
- **Anatomic Risk Factors**
  - Excessive femoral anteversion
  - External malleolar torsion
  - Pes planus or cavus foot
  - Excessive pronation
- **Biomechanical Risk Factors**
  - Limited flexibility (gastroc-soleus)
  - BMI > 30
  - Poor footwear



Plantar Fasciopathy

- **Risk Factors**
  - Running
    - Lopes AD et al. *Sports Med* 2012
    - Sobhani S et al. *Scand J Med Sci Sports* 2013
    - Tenforde AS. Et al. *PMR* 2011
  - High Arch
    - DiCaprio F et al. *J Sports Sci Med*. 2010
  - High BMI
    - Klein SE et al. *Foot Ankle Int.* 2012
    - Riddle DL et al. *J Bone Joint Surg*. 2003
  - Decreased ankle DF
    - Patel A & DiGiovanni B. *Foot Ankle Int*. 2011
    - Riddle DL et al. *J Bone Joint Surg*. 2003

Diagnosis

- **Patient Presentation** (Martin RL et al. *JOSPT*. 2014)
  - Pain on palpation medial calcaneal tubercle
  - 1st step pain in AM & after sitting
  - ↓ pain with movement
  - Limited ankle dorsiflexion
  - (+) Windlass test & (-) Tarsal Tunnel test
  - ↑ BMI in nonathletic individuals

By Kosi Gramatikoff User:Kosigrim [CC0], via Wikimedia Commons

Exam: Outcome Measures

- Lower Extremity Functional Scale (LEFS)
  - Mehta SP et al. *J Orthop Sports Phys Ther*. 2016
  - Brinkley JM et al. *Phys Ther*. 1999
  - **20 items; 0-4 (max 80 points)**
  - **Test-retest reliability: *r*=0.87**
  - **MCID: 9**
- Foot and Ankle Ability Measure (FAAM)
  - Shultz S et al. *Int J Sports Phys Ther*. 2013
  - Martin RL et al. *Foot Ankle Int*. 2005
  - **21 item ADL**
  - **8 item Sports**
  - **MCID: 8 (ADL), 9 (Sports)**

Exam: Outcome Measures

- Foot Function Index (FFI)
  - **17 items; 0-10 (max 170 points)**
- Foot Health Status Questionnaire (FHSQ)
  - Martin RL & Irrgang JJ *J Orthop Sports Phys Ther*. 2007
  - **MCID** (Landorf KB et al. *J Foot Ankle Res*. 2010)
    - Pain subscale: 13 points
    - Function subscale: 7 points
    - Footwear domain: 2 points

Plantar Fasciopathy

- Differential Diagnosis (McPoil TG et al. *JOSPT*. 2008 / Martin RL et al. *JOSPT*. 2014)
  - Calcaneal stress fracture
    - Squeeze test: medial/lateral pressure
  - Bone bruise
  - Fat pad atrophy (Yi TL et al. *Ann Rehabil Med*. 2011)
    - (-) 1st step pain
  - Tarsal tunnel syndrome
    - Burning/tingling in foot
    - No pain with dorsiflexion of toes
  - Sever disease
  - S1 radiculopathy

Plantar Fasciopathy

- **Martin RL et al. *JOSPT* 2014**
  - **Modalities** (Conflicting evidence)
    - Electrotherapeutic modalities not supported
    - May or may not use iontophoresis with dexamethasone or acetic acid to provide short-term (2-4 weeks) pain relief and improved function
    - Low-Level Laser Therapy: Conflicting Evidence
    - Ultrasound: Not recommended
  - **Dry Needling**
    - Not recommended
    - Emerging literature
  - **Footwear**
    - Consider rocker-bottom shoe

continued

Dry Needling

Effectiveness of Trigger Point Dry Needling for Plantar Heel Pain: A Randomized Controlled Trial

Matthew P. Cotchett, Shannon E. Munteanu, Karl B. Landorf

- Cotchett MP et al. *Phys Ther*. 2014
  - **Dry needling vs sham dry needling**
  - **Rx 1x/week for 6 weeks**
  - **12 week F/U**
  - **Effects favored dry needling**
    - Between group difference lower than minimal important difference
  - **Frequent (minor) transitory adverse events**

Plantar Fasciopathy

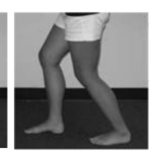
- **Martin RL et al. *JOSPT* 2014**
  - **Stretching** (Strong evidence)
    - Plantar-Fascia specific and gastroc-soleus stretching to provide short-term (1 week to 4 months) pain relief
  - **Taping** (Strong evidence)
    - Antipronation taping for immediate (up to 3 weeks) pain reduction and increased function
    - Elastic therapeutic tape applied to gastrocnemius and plantar fascia for short-term (1 week) pain reduction

Plantar Fasciopathy

- **Martin RL et al. *JOSPT* 2014**
  - **Night Splints** (Strong evidence)
    - Prescribe a 1-3 month program of night splints for individuals who consistently have pain with first step in morning
  - **Orthotic Devices** (Strong evidence)
    - Pre-fabricated or custom devices to support the medial longitudinal arch and cushion the heel to reduce pain and improve function for short (2weeks) to long term (1 year) especially in those who respond to antipronation taping techniques
  - **Manual Therapy** (Strong evidence)
    - Joint and soft tissue mobilization procedures to treat relevant lower extremity joint mobility and calf flexibility deficits

Plantar Fasciopathy

- Cleland JA et al. *JOSPT*, 2009
  - **Electrophysical Agents & Exercise (EPAX)**
    - Ultrasound
      - 3 MHz, 1.5 w/cm2, 20%, 5 minutes
    - Iontophoreses
      - Dexamethasone 40 mA-Min
    - Stretching
      - Gastroc, Soleus, Plantar Fascia
    - Ice x 15 min

  - **Manual Physical Therapy & Exercise (MTEX)**
    - STM of triceps surae & plantar fascia insertion
    - Rearfoot Eversion Mobilization
    - Manual therapy (hip, knee, ankle & foot)
    - Self-mobilization (ankle eversion)
    - Self massage
    - Stretching to gastroc, soleus & plantar fascia


Plantar Fasciopathy

- Cleland JA et al. *JOSPT*, 2009
  - **MTEX compared to EPAX**
  - **LEFS**
    - +13.5 @ 4 weeks; +9.9 @ 6 months
  - **FAAM**
    - + 13.3 % @ 4 weeks; +13.6 @ 6 months
  - **NPRS**
    - -1.5 @ 4 weeks; No difference @ 6 months

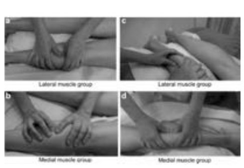
"The combined treatment approach, consisting of manual physical therapy and exercise, provides greater clinical benefits in terms of function than an approach using electrophysical agents and common exercise in managing patients with plantar heel pain"

Plantar Fasciopathy

Deep massage to posterior calf muscles in combination with neural mobilization exercises as a treatment for heel pain: A pilot randomized clinical trial

Bernice Saban[a,*], Daniel Deutscher[b], Tomer Ziv[c]

- Saban B et al. *Man Ther*. 2014
  - **Deep tissue massage posterior calf, neural mobilization & self stretch vs.**
  - **Ultrasound & self stretch**
  - **Deep Massage significantly more effective than US & self stretching**



Manual Therapy

Does manual therapy improve pain and function in patients with plantar fasciitis? A systematic review

John J. Fraser[a,b], Revay Corbett[a], Chris Donner[c] and Jay Hertel[a]

[a]Department of Kinesiology, University of Virginia, Charlottesville, VA, USA; [b]US Navy Medicine Professional Development Center, Bethesda, MD, USA; [c]Athletics Program, Lindsey Wilson College, Columbia, KY, USA

- Fraser JJ et al. *J Manual Manip Ther*. 2018
  - **Systematic review of 7 RCTs**
  - **Inclusion of MT = ↑ improvement in function in 6/7**

Recommendation:
Consider joint and soft tissue mobilization techniques in conjunction with stretching and strengthening

Patient Case
Plantar Heel Pain

David Nolan, PT, DPT, MS, OCS, SCS, CSCS

118

Case Study: Plantar Heel Pain

- 24 yo woman
- Elite Runner (800m)
- C/O right medial ankle pain (0-8/10)
- Typical training = 40+ miles/week
- Currently pool running only

Barefoot Fast Walk

Case Study: Plantar Heel Pain

- Key findings:
  - **Gluteal and core weakness**
  - **Limited flexibility: hip flexors, ITB and GS**
  - **Limited joint mobility: STJ**
  - **Hypermobile midfoot**
  - **Poor control with step down and single leg squat**

Shod Run

Shod Run Lateral

Therapeutic Exercise: Proximal Considerations

David Nolan, PT, DPT, MS, OCS, SCS, CSCS

The Name Game

- Lumbar stabilization
- Lumbopelvic stabilization
- Abdominal bracing
- Dynamic stabilization
- Neuromuscular training
- Neutral spine control
- Trunk stabilization
- Butt & Gutt

Prerequisite for Sports

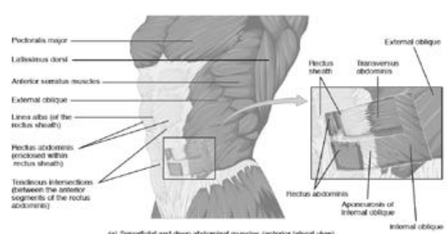
[Athletic Training] CEU

Core Stability Training for Injury Prevention

Kellie C. Huxel Bliven, PhD, AT,*† and Barton E. Anderson, MS, ATC, AT†

Huxel Bliven KC & Anderson BE. *Sports Health* 2013

- Strong and stable core
  - **Transmit forces through the kinetic chain**
  - **Propel body and/or objects using extremities**



Download for free at https://openstax.org/details/books/anatomy-and-physiology

Core Function

- Proximal stability before distal mobility
  - **Transfer of energy**
  - **Sagittal, frontal & transverse planes**



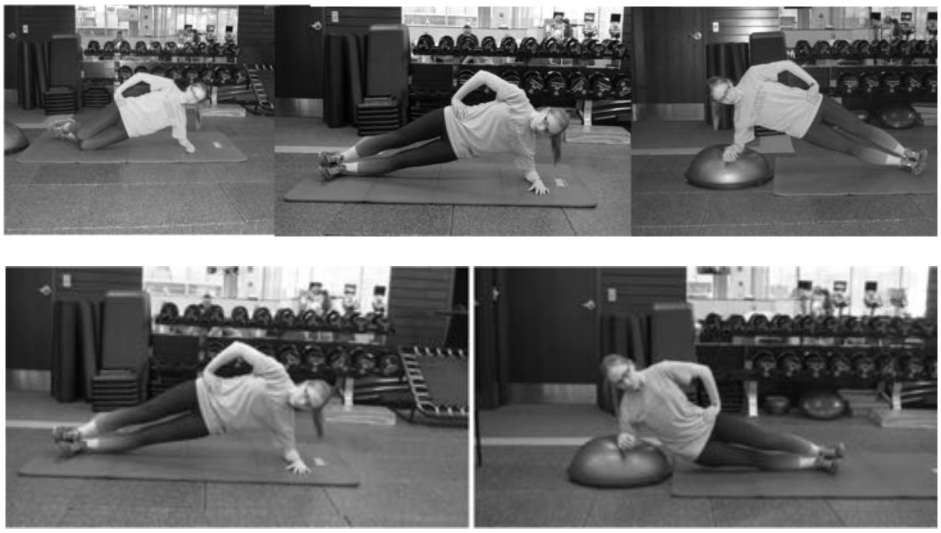



Success with a weak core?

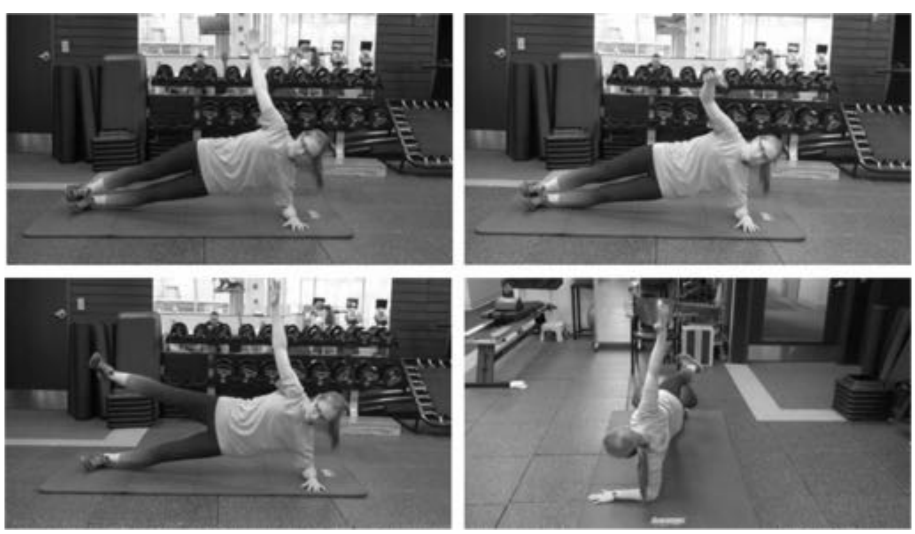
Progress Off The Table



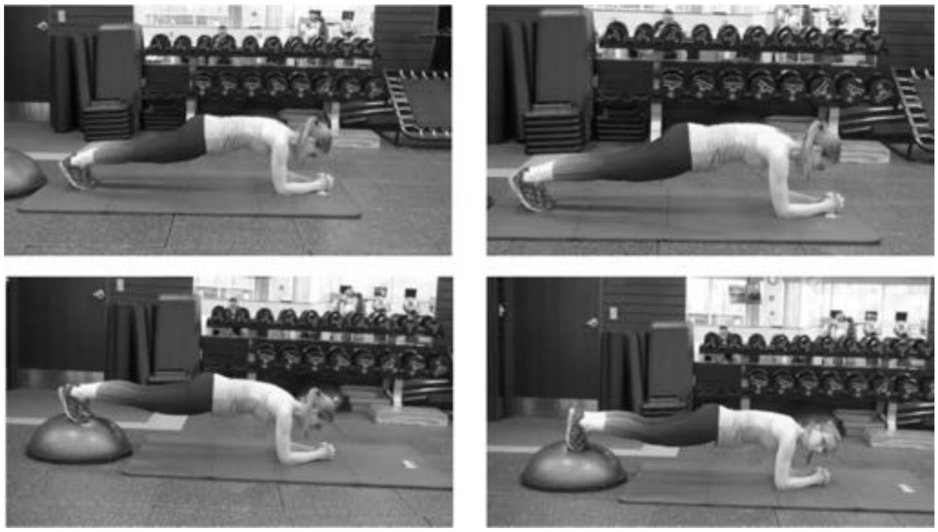
Plank Progressions



Plank Progressions



Plank Progressions



Plank Progressions

[RESEARCH REPORT]

ATSUSHI IMAI, MS[1] • KOJI KANEOKA, MD, PhD[2] • YU OKUBO, PT, MS[3] • ITSUO SHIINA, MD[1]
MASAKI TATSUMURA, MD[1] • SHIGEKI IZUMI, PhD[3] • HITOSHI SHIRAKI[4]

Trunk Muscle Activity During Lumbar Stabilization Exercises on Both a Stable and Unstable Surface

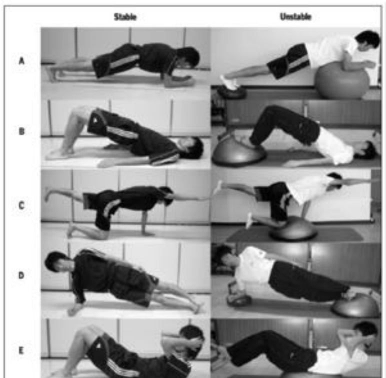


FIGURE 1. Exercises performed for this experiment: (A) elbow-toe, (B) back bridge, (C) hand-knee, (D) side bridge, and (E) curl-up.

- Imai A et al. *JOSPT* 2010
  - ↑ **EMG activity when performed on unstable surfaces**

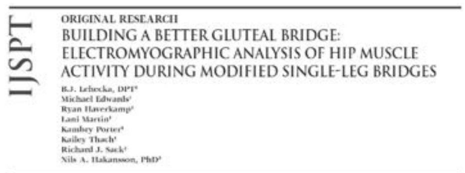
Dynamic Progressions

Dynamic Progressions

Bridge Progression

Bridge Progression

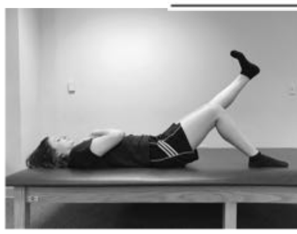
Bridge Progression

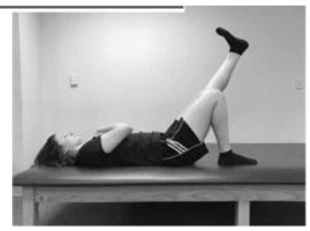

IJSPT

ORIGINAL RESEARCH

BUILDING A BETTER GLUTEAL BRIDGE: ELECTROMYOGRAPHIC ANALYSIS OF HIP MUSCLE ACTIVITY DURING MODIFIED SINGLE-LEG BRIDGES

B.J. Lehecka, DPT[1]
Michael Edwards[1]
Ryan Haverkamp[1]
Lani Martin[1]
Kambry Porter[1]
Kailey Thach[1]
Richard J. Sack[1]
Nils A. Hakansson, PhD[2]





- 90° Knee Flexion
  - **HS = 75.34% MVIC**
  - **GMax = 51.01% MVIC**
  - **GMed = 57.81% MVIC**
- 135° Knee Flexion
  - **HS = 23.49% MVIC**
  - **GMax = 47.35% MVIC**
  - **GMed = 57.23% MVIC**

Plyometric Progression

- **Double leg PBW**
- **Double leg FBW**
  - **In place → Forward / Backward → Side to Side**
- **Single leg PBW**
- **Single leg FBW**
  - **In place → Forward / Backward → Side to Side**
  - **Resistance → Multi-planar**

Plyometric Progression

Strengthening

- DiStefano LJ. et al. *JOSPT*. 2009
  - **21 Healthy subjects (22 yo ± 3)**
    - 9 males & 12 females
    - Physical activity 60 minutes 3x/week
  - **Surface EMG of dominant limb**
    - Gluteus Medius & Gluteus Maximus
  - **Performed 8 reps of 12 exercises**
    - Randomized order

Strengthening

- DiStefano LJ. et al. *JOSPT*. 2009

Strengthening

- DiStefano LJ. et al. *JOSPT*. 2009

TABLE 2 NORMALIZED GLUTEUS MEDIUS MEAN SIGNAL AMPLITUDE (% MVIC)

Exercise	Mean ± SD (95% CI)
Side-lying hip abduction	81 ± 42 (62, 101)
Single-limb squat	64 ± 24 (53, 75)
Lateral band walk	61 ± 34 (46, 76)
Single-limb deadlift	58 ± 25 (47, 70)
Sideways hop	57 ± 35 (41, 73)
Transverse hop*	48 ± 25 (37, 59)
Transverse lunge*	48 ± 21 (38, 57)
Forward hop*	45 ± 21 (38, 57)
Forward lunge*†	42 ± 21 (33, 52)
Clam with 30° hip flexion*	40 ± 38 (23, 57)
Sideways lunge*†	39 ± 19 (30, 47)
Clam with 60° hip flexion*†	38 ± 29 (25, 51)

Strengthening

- DiStefano LJ. et al. *JOSPT*. 2009

TABLE 3 Normalized Gluteus Maximus Mean Signal Amplitude (% MVIC)

Exercise	Mean ± SD (95% CI)
Single-limb squat	59 ± 27 (47, 72)
Single-limb deadlift	59 ± 28 (46, 71)
Transverse lunge	49 ± 20 (39, 58)
Forward lunge	44 ± 23 (33, 54)
Sideways lunge	41 ± 20 (32, 50)
Side-lying hip abduction	39 ± 18 (31, 47)
Sideways hop	30 ± 19 (31, 48)
Clam with 60° hip flexion	39 ± 34 (24, 54)
Transverse hop*†	35 ± 16 (28, 43)
Forward hop*†	35 ± 22 (25, 45)
Clam with 30° hip flexion*†	34 ± 27 (21, 46)
Lateral band walk*†‡	27 ± 16 (20, 35)

Strengthening

- Boren K. et al. *IJSPT*. 2011
  - **26 healthy subjects**
  - **Surface EMG of dominant leg**
    - Gluteus Maximus & Gluteus Medius
  - **Performed 18 exercises**
    - Randomized order

IJSPT

ORIGINAL RESEARCH

ELECTROMYOGRAPHIC ANALYSIS OF GLUTEUS MEDIUS AND GLUTEUS MAXIMUS DURING REHABILITATION EXERCISES

Kristen Boren, DPT[1]
Cara Conrey, DPT[1]
Jennifer Le Coguic, DPT[1]
Lindsey Paprocki, DPT[1]
Michael Voight, PT, DHSc, SCS, OCS, ATC, CSCS[1]
T. Kevin Robinson, PT, DSc, OCS[1]

Strengthening

- Boren K. et al. *IJSPT*. 2011
  - **Gluteus Medius**

Table 4. *Results for Gluteus Medius recruitment, %MVIC and rank for all exercises.*

Exercise condition	# Subjects Included for analysis	%MVIC Gluteus Medius	Rank Gluteus Medius
Side plank abd, DL down	21	103.11	1
Side plank abd, DL up	22	88.82	2
Single limb squat	22	82.26	3
Clamshell (Hip Clam) 4	23	76.88	4
Front plank with Hip Ext	23	75.13	5
Clamshell (Hip Clam) 3	22	67.63	6
Side-lying abd	23	62.91	7
Clamshell (Hip Clam) 2	22	62.45	8
Lateral step-up	21	59.87	9
Skater squat	22	59.84	10
Pelvic Drop	23	58.43	11
Hip circumduction, stable	23	57.39	12
Dynamic Leg Swing	22	57.30	13
Single limb deadlift	22	56.08	14
Single limb bridge, stable	22	54.99	15
Forward step-up	22	54.62	16
Single limb bridge, unstable	20	47.29	17
Clamshell (Hip Clam) 1	22	47.23	18
Quadruped hip ext, DOM	23	46.67	19
Gluteal squeeze	23	43.72	20
Hip circumduction, unstable	23	37.88	21
Quadruped hip ext, non-DOM	23	22.03	22

Strengthening

- Boren K. et al. *IJSPT*. 2011
  - **Gluteus Medius**
    - Hip Extension

Table 4. *Results for Gluteus Medius recruitment, %MVIC and rank for all exercises.*

Exercise condition	# Subjects Included for analysis	%MVIC Gluteus Medius	Rank Gluteus Medius
Side plank abd, DL down	21	103.11	1
Side plank abd, DL up	22	88.82	2
Single limb squat	22	82.26	3
Clamshell (Hip Clam) 4	23	76.88	4
Front plank with Hip Ext	23	75.13	5
Clamshell (Hip Clam) 3	22	67.63	6
Side-lying abd	23	62.91	7
Clamshell (Hip Clam) 2	22	62.45	8
Lateral step-up	21	59.87	9
Skater squat	22	59.84	10
Pelvic Drop	23	58.43	11
Hip circumduction, stable	23	57.39	12
Dynamic Leg Swing	22	57.30	13
Single limb deadlift	22	56.08	14
Single limb bridge, stable	22	54.99	15
Forward step-up	22	54.62	16
Single limb bridge, unstable	20	47.29	17
Clamshell (Hip Clam) 1	22	47.23	18
Quadruped hip ext, DOM	23	46.67	19
Gluteal squeeze	23	43.72	20
Hip circumduction, unstable	23	37.88	21
Quadruped hip ext, non-DOM	23	22.03	22

Strengthening

- Boren K. et al. *IJSPT*. 2011
  - **Gluteus Maximus**

Table 5. *Results for Gluteus Maximus recruitment, %MVIC and rank for all exercises.*

Exercise condition	# Subjects Included for analysis	%MVIC Gluteus Maximus	Rank Gluteus Maximus
Front plank with Hip Ext	22	106.22	1
Gluteal squeeze	22	80.72	2
Side plank abd, DL up	22	72.87	3
Side plank abd, DL down	21	70.96	4
Single limb squat	22	70.74	5
Skater squat	21	66.18	6
Lateral step-up	20	63.83	7
Quadruped hip ext, DOM	22	59.70	8
Single limb deadlift	21	58.84	9
Forward step-up	22	54.67	10
Single limb bridge, stable	21	54.24	11
Clamshell (Hip Clam) 1	22	53.10	12
Side-lying abd	22	51.13	13
Single limb bridge, unstable	18	49.35	14
Hip circumduction, stable	22	37.85	15
Dynamic leg swing	22	33.65	16
Hip circumduction, unstable	22	28.87	17
Clamshell (Hip Clam) 3	22	26.63	18
Clamshell (Hip Clam) 4	22	26.22	19
Pelvic Drop	22	25.10	20
Quadruped hip ext, non-DOM	22	21.04	21
Clamshell (Hip Clam) 2	22	12.36	22

Strengthening

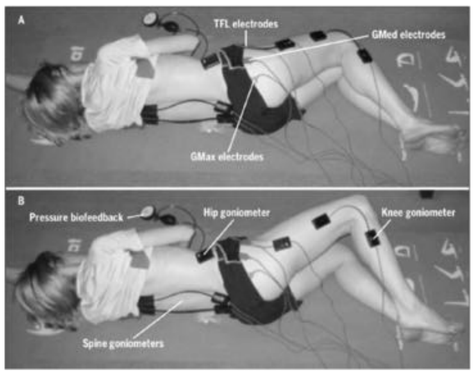
- Boren K. et al. *IJSPT*. 2011

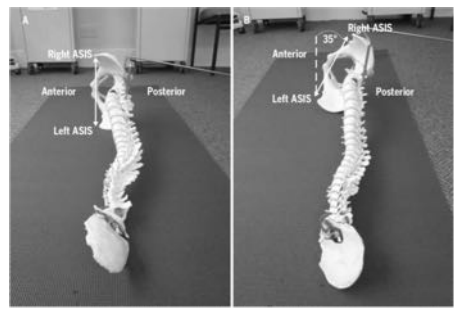
Table 6. *Top exercises for muscle activation of both gluteus medius and gluteus maximus (> 70% MVIC).*

Exercise condition	%MVIC Gluteus Medius	%MVIC Gluteus Maximus
Front plank with Hip Ext	75.13	106.22
Side plank abd, DL up	88.82	72.87
Side plank abd, DL down	103.11	70.96
Single limb squat	82.26	70.74

Clamshell Exercise

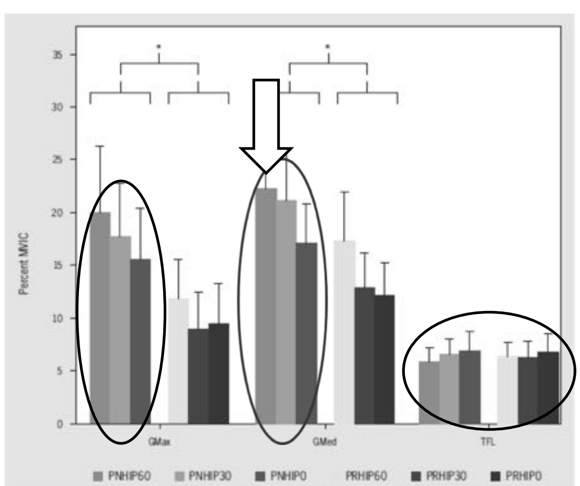
- Willcox EL & Burden AM. *JOSPT* 2013
  - **17 healthy subjects**
  - **Surface EMG**





Clamshell Exercise

- Willcox EL & Burden AM. *JOSPT* 2013



- ↑ Glut in PNeutral
- ↑ Gmed in 60° flex
- TFL activation low

continued

Gluteus Medius / TFL

- Selkowitz DM et al. *JOSPT* 2013
  - **Activate gluteus medius and superior gluteus maximus while minimizing TFL**
  - **Fine-wire EMG; 11 exercises**
  - **20 healthy subjects**
  - **Calculated Gluteal to TFL Index for each exercise**
    - Not simply looking at EMG values

Gluteus Medius / TFL

- Selkowitz DM et al. *JOSPT* 2013

TABLE 2 GLUTEAL-TO-TFL INDEX FOR EACH EXERCISE

Exercise	Gluteal-to-TFL Activation Index
Clam*	115
Sidestep*	64
Unilateral bridge*	59
Quadruped hip extension, knee extending*	50
Quadruped hip extension, knee flexed*	50
Sidelying hip abduction	38
Step-up	32
Bilateral bridge*	32
Squat*	28
Hip hike	28
Lunge	18

Abbreviation: TFL, tensor fascia lata.
**Exercises in which both gluteal muscles demonstrated significantly higher normalized electromyographic signal amplitude than the TFL.*

Gluteus Medius / TFL

- Selkowitz DM. et al. *JOSPT* 2013



Gluteus Medius / TFL

- Selkowitz DM et al. *JOSPT* 2013







Gluteus Medius / TFL

- Selkowitz DM et al. *JOSPT* 2013

TABLE 1 NORMALIZED ELECTROMYOGRAPHIC AMPLITUDE OF EACH MUSCLE FOR EACH EXERCISE*

Exercise	Tensor Fascia Lata	Gluteus Medius	Superior Gluteus Maximus
Sidelying hip abduction	32.3 ± 13.1	43.5 ± 14.7 (P = .012)[†]	23.7 ± 15.3 (P = .033)[‡]
Bilateral bridge	8.2 ± 7.4	15.0 ± 10.5 (P = .011)[†]	17.4 ± 11.9 (P = .008)[†]
Clam	11.4 ± 11.4	26.7 ± 18.0 (P = .006)[†]	43.6 ± 26.1 (P<.001)[†]
Hip hike	31.4 ± 14.4	37.7 ± 15.1 (P = .196)	17.7 ± 15.2 (P = .001)[‡]
Lunge	21.6 ± 14.5	19.3 ± 12.9 (P = .623)	20.1 ± 11.1 (P = .728)
Quadruped hip extension, knee extending	15.6 ± 9.3	27.3 ± 14.9 (P<.002)[†]	28.5 ± 16.6 (P<.007)[†]
Quadruped hip extension, knee flexed	18.7 ± 10.6	30.9 ± 15.2 (P = .001)[†]	30.1 ± 12.5 (P = .012)[†]
Sidestep	13.1 ± 7.1	30.2 ± 15.7 (P = .002)[†]	27.4 ± 16.7 (P = .002)[†]
Squat	4.6 ± 3.8	9.7 ± 7.3 (P = .017)[†]	12.9 ± 7.9 (P<.001)[†]
Step-up	21.4 ± 11.4	29.5 ± 14.9 (P = .065)	22.8 ± 15.6 (P = .754)
Unilateral bridge	18.1 ± 12.9	30.9 ± 20.7 (P = .007)[†]	34.6 ± 16.8 (P = .001)[†]

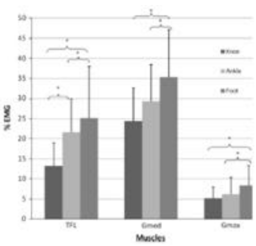
**Values are mean ± SD percent maximum voluntary isometric contraction.*
[†]Significantly greater than tensor fascia lata (P<.05).
[‡]Significantly less than tensor fascia lata (P<.05).

Gluteus Maximus

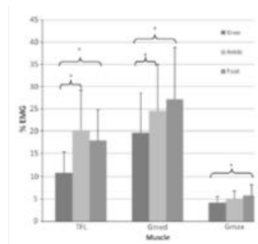
- Selkowitz DM et al. *J Orthop Sports Phys Ther.*2016
  - **Superior Gmax**
    - Clam (43.6 26.1)
    - Unilateral Bridge (34.6 16.8)
    - Qped Hip Ext Knee Flex (30.1 12.5)
  - **Inferior Gmax**
    - Unilateral Bridge (36.67 10.0)
    - Qped Hip Ext Knee Flex (34.3 16.3)
    - Qped Hip Ext Knee Ext (31.2 16.5)

Strengthening

- Proximal strength
  - Cambridge ED et al *Clin Biomech* 2012
    - – Forefoot resistance:↑ gluteals vs. TFL
    - – Likely due to ER of hips



Sumo Walk



Monster Walk

Posture Matters

- Berry JW et al. *JOSPT*. 2015
  - – **Resisted side stepping upright & squat positions**
  - – **EMG of Gmed, Gmax & TFL**
  - – **EMG > in stance limb (p≤.001)**
  - – **Glut activity > TFL activity in squat position (p≤.001)**

FIGURE. Participant side stepping to the right in the upright standing posture and the squat posture.

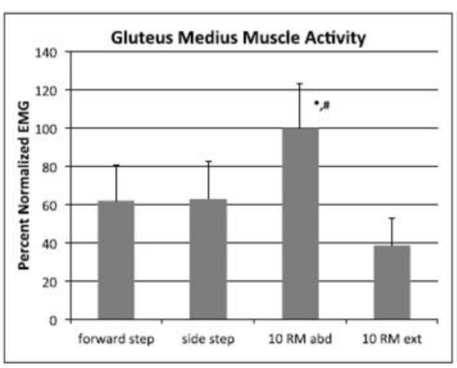
Strengthening

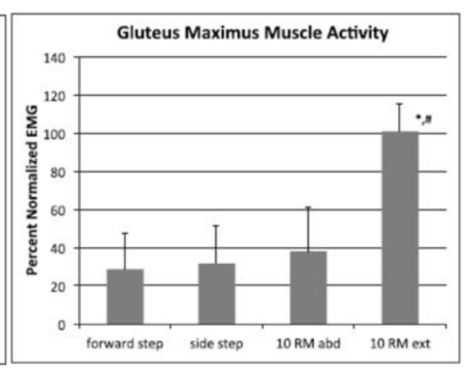
- **MacAskill MJ et al *IJSPT* 2014**
  - **Surface EMG (Gmax & Gmed)**
  - **Weightbearing**
    - **Forward Step-Up**
    - **Lateral Step-Up**


  - **Non-Weightbearing**
    - **10RM**
    - **Prone Hip Extension**
    - **Sidelying Hip Abduction**


Strengthening

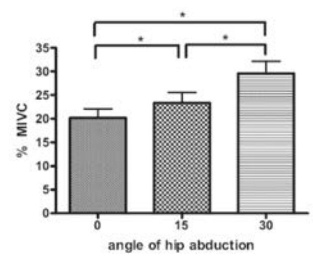
- **MacAskill MJ et al *IJSPT* 2014**



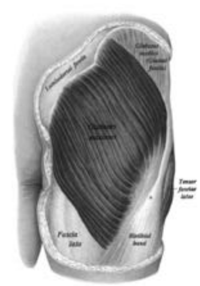


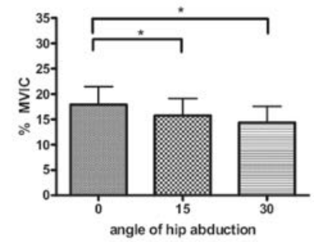
Clinical Pearls

- Do the ***Correct*** exercises the ***Correct*** way
  - **Kang SY et al. *Manual Ther* 2013**



Gluteus Maximus Activation





Hamstring Activation

Summary

- Gluteal strengthening shown to be critical in lower extremity function
- Consider the quality of tissue, phase of healing and baseline strength
- What muscle should be activated and what muscle activation should be minimized

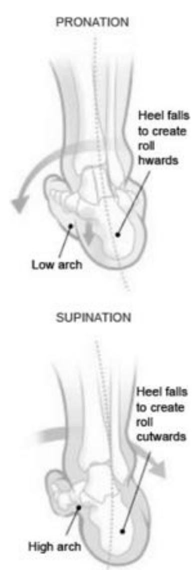
Therapeutic Exercise: Distal Considerations

David Nolan, PT, DPT, MS, OCS, SCS, CSCS

163

Tri-Plane Motion

- Pronation
  - **Dorsiflexion**
    - Sagittal
  - **Abduction**
    - Transverse
  - **Eversion**
    - Frontal



- Supination
  - **Plantarflexion**
    - Sagittal
  - **Adduction**
    - Transverse
  - **Inversion**
    - Frontal

Guiding Principles

- Require certain amounts of ROM and strength for gait: exercise is designed with that in mind
- Balance between mobility and stability
- Challenges include variable speed, terrain, shoewear etc.
- The fate of the foot/ankle region is often determined by the hip/knee

Gastrocnemius / Soleus

- Gait function
  - **Gastrocnemius**
    - Decelerate/control forward progression of tibia on talus
  - **Soleus**
    - Active around the time of heel strike

- Rehab focus
  - **Flexibility**
    - Prevent compensatory pronation at midfoot
  - **Strength**
    - Eccentric contraction key
    - Respect stage of healing / reactivity of tissue

Gastrocnemius / Soleus

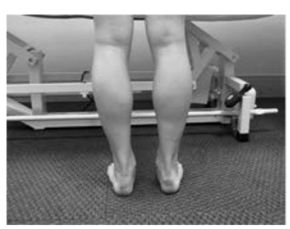
- Flexibility
  - **Maintain supinatory bias**
    - Inverted calcaneus
  - **Prevent oblique midtarsal compensation**



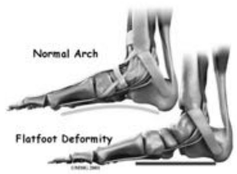

Gastrocnemius / Soleus

- Strength
  - **Eccentric is key**
    - Manual resistance
    - Resisted band
    - Weight bearing






Tibialis Posterior



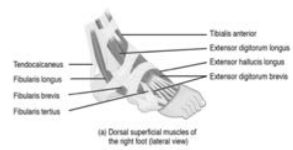
- Anatomical Function
  - **Inverter, adductor, plantar flexor of foot**
- Gait function
  - **Decelerate/control GRF moving foot into eversion & abduction**
  - **Greater activation in low arch foot types**
- Rehab focus
  - **Strength**
    - Eccentric contraction key
    - Works in concert with peroneus longus

Tibialis Posterior

- Strength
  - **TB resistance**
  - **Manual resistance**
  - **CKC progression**

Peroneals

- Anatomical Function
  - **Abduct & evert the foot in OKC**
- Gait function
  - **Brevis**
    - Stabilizes calcaneocuboid joint
  - **Longus**
    - Stabilize first ray as weight transfers from lateral to medial
- Rehab focus
  - **Strength focus is OKC & CKC**



Download for free at https://openstax.org/details/books/anatomy-and-physiology

Peroneals

- Strength
  - **OKC:**
    - TB Resistance
    - Manual Resistance
  - **CKC:**
    - Weight shift control
    - 1st ray vs ground

Return to Running Considerations

David Nolan, PT, DPT, MS, OCS, SCS, CSCS

Risk Factors

- Prior activity level / mileage
  - Tenforde AS et al. *PMR*. 2011.
  - Messier SP et al. *Med Sci Sports Exerc*. 2008
  - Ryan M et al. *Int Sportsmed* J. 2006
- Injury history
  - Buist I et al. *Am J Sports Med*. 2010
  - Van Gent RN et al. *Br J Sports Med*. 2007
- >15-20 hours of activity each week

Risk Factors

- Intrinsic
  - Psychological variables
    - Runners want to run

Psychological Factors

Development and Preliminary Validation of the Injury-Psychological Readiness to Return to Sport (I-PRRS) Scale

Douglas D. Glazer, DPE, ATC

- ***J Athl Train* 2009**

- **Injury-Psychological Readiness to Return to Sport Scale (I-PRRS)**
  - Questionnaire
  - 0 (no confidence) to 100 (complete confidence)

- **Injury-Psychological Readiness to Return to Sport Scale (I-PRRS)**
  - My overall confidence to play is___
  - My confidence to play without pain is___
  - My confidence to give 100% is___
  - My confidence to not concentrate on the injury is___
  - My confidence in the injured body part to handle demands of the situation is___
  - My confidence in my skill level/ability is___

  - Score <50: Athlete may not be psychologically ready

Risk Factors

- Intrinsic
  - Hip Adduction
  - Genu valgus
- Extrinsic
  - Training errors
    - Excessive volume
    - Progressing distance/pace too quickly
  - Running surface
    - GRF
  - Running form
    - Cadence

Milestone Criteria

- Full ROM
- Minimal pain / swelling
- >90% strength compared to uninjured
  - Variable in literature (70%)

Not Just Strengthening

[RESEARCH REPORT]

RICHARD W. WILLY, PT, PhD, OCS[1] • IRENE S. DAVIS, PT, PhD, FAPTA[2]

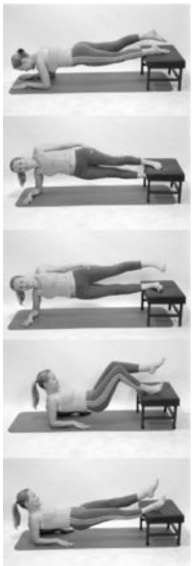
The Effect of a Hip-Strengthening Program on Mechanics During Running and During a Single-Leg Squat

- Willy RW & Davis IS. *JOSPT.* 2011
  - Strengthening alone did not improve running mechanics
  - ***Must integrate running specific interventions***

Functional Tests

- Small Knee Bend (SKB) / Single-Leg Squat (SLS)
  - Whatman C. et al. *Phys Ther Sport*. 2011
    - Standing upright squat to max DF without heel rise
    - Similar hip & knee ROM seen with running
    - Trunk / Pelvis
    - Hip
    - Knee
    - Foot

Functional Tests



- Bunkie Test
  - deWitt B & Venter R. *J Bodyw Mov Ther*. 2009
    - Assess function of core musculature
    - Maintain test position for 40 sec
      - Anterior power line
      - Medial power line
      - Lateral power line
      - Posterior stabilizing line
      - Posterior power line

Video Analysis

- 2-D is a reliable option

IJSPT

ORIGINAL RESEARCH

CONCURRENT VALIDITY AND RELIABILITY OF 2D KINEMATIC ANALYSIS OF FRONTAL PLANE MOTION DURING RUNNING

Jennifer N. Maykut, PT, DPT, CSCS[1]
Jeffery A. Taylor-Haas, PT, DPT, OCS, CSCS[2]
Mark V. Paterno, PT, PhD, MBA, SCS, ATC[2]
Christopher A. DiCesare, MS[3]
Kevin R. Ford, PhD, FACSM[4]

[BRIEF REPORT]

ANDREW PIPKIN, DPT[1] • KRISTY KOTECKI, DPT[2]
SCOTT HETZEL, MS[3] • BRYAN HEIDERSCHEIT, PT, PhD[1,4]

Reliability of a Qualitative Video Analysis for Running

IJSPT

ORIGINAL RESEARCH

RELIABILITY OF VIDEO-BASED QUANTIFICATION OF THE KNEE- AND HIP ANGLE AT FOOT STRIKE DURING RUNNING

Camma Damsted[1]
Rasmus Oestergaard Nielsen[2]
Lars Henrik Larsen[3]

Outcome Measures

- Lower Extremity Functional Scale (LEFS)
  - Generic LE function
  - ? Ceiling effect
  - 20 questions; max score of 80

- University of Wisconsin Running Injury and Recovery Index (UWRI)
  - Limited data right now
  - 9 questions; max score of 36
  - Specific to running

UW Neuromuscular Biomechanics Lab

Milestone Criteria

- Fast-paced walk for 60 minutes
  - No pain/swelling during or after

- Plyometric progression
  - Double leg PBW
  - Double leg FBW
    - In place → Forward / Backward → Side to Side
  - Single leg PBW
  - Single leg FBW
    - In place → Forward / Backward → Side to Side
    - Resistance → Multi-planar

Milestone Criteria

- No symptoms & proper form
  - Triple flexion / extension
    - Hip flexion, Knee flexion, ankle DF
    - Hip Extension, Knee extension, Ankle PF
  - "Soft landing"
- 750 foot contacts per mile (each leg)

Walk – Jog Progression

- Each bout begins with 15' warm up and 10' cool down

Day	1	2	3	4	5	6	7
Week 1	W5/J1 x5		W5/J1 x5		W4/J2 x5		W4/J2 x5
Week 2		W3/J3 x5		W3/J3 x5		W2/J4 x5	
Week 3	W2/J4 x5		W1/J5 x5		W1/J5 x5		**Return to Run**

- Progress only if no pain/swelling during/after

Return to Run

- No running back to back days
  - Non-impact cross training
- One day off each week (complete rest)
- Progress only if no pain/swelling during/after
- Begin on treadmill if possible
  - Maintain flat terrain
  - Maintain selected pace
- Focus on increasing distance / time before pace
- Pitfall: Modifying multiple parameters simultaneously

Return to Run Progression

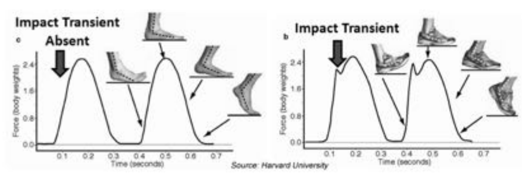
- Each bout begins with 15' warm up and 10' cool down

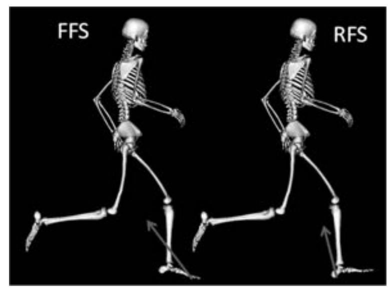
Week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	20 min		20 min		20 min		25 min
2		25 min		25 min		30 min	
3	30 min		30 min		35 min		35 min
4		35 min		40 min		40 min	
5	40 min		45 min		45 min		45 min
6		50 min		50 min		50 min	
7	55 min		55 min		55 min		60 min
8		60 min		60 min			

- Initiate running on consecutive days
- Integrate modifications to pace

General Recommendations

- No more than 10% increase in weekly mileage
  - Hrejac A. *Phys Med Rehabil Clin N Am*. 2005
- Avoid running downhill initially: ↑ impact force
  - Gottschall J & Kram R *J Biomech*. 2005
- Consider strike pattern





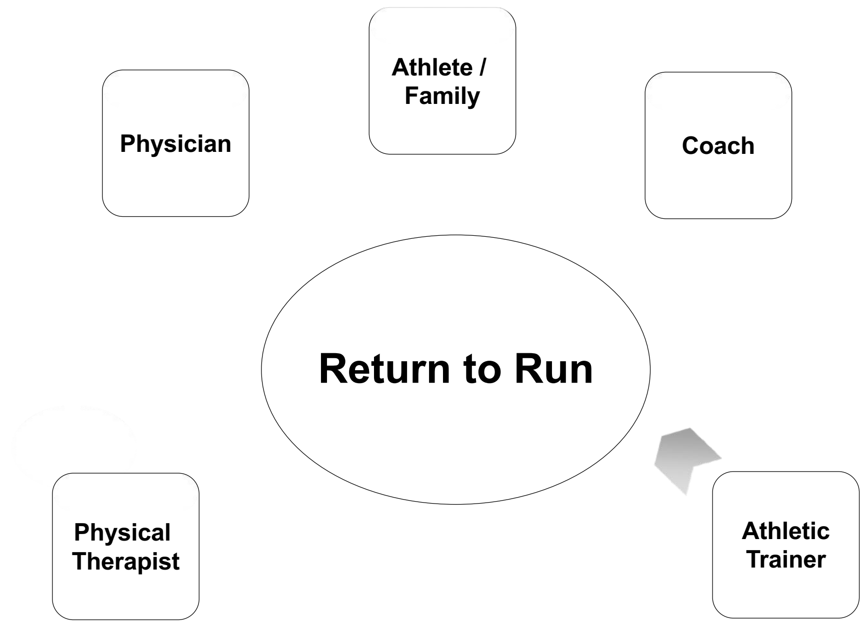
General Recommendations


[RESEARCH REPORT]

RASMUS ØSTERGAARD NIELSEN, PT, MHSc • ERIK THORLUND PARNER, PhD • ELLEN AAGAARD NOHR, PhD • HENRIK SØRENSEN, PhD • MARTIN LIND, PhD • STEN RASMUSSEN, MD

Excessive Progression in Weekly Running Distance and Risk of Running-Related Injuries: An Association Which Varies According to Type of Injury

- Nielsen RO et al. *JOSPT*. 2014
  - 3 progression groups: <10%, 10-30%, >30%
  - No statistically significant differences in RRI rates
  - ↑ rate of "distance-related injuries" in >30% group



THANK YOU

Northeastern University
Bouvé College of Health Sciences

MASSACHUSETTS GENERAL HOSPITAL
SPORTS MEDICINE