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Running-Related Injury: Integrating Video Analysis into Clinical Decision Making

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

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* 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)

Epidemiology of Running Injuries

IJSPT

ORIGINAL RESEARCH

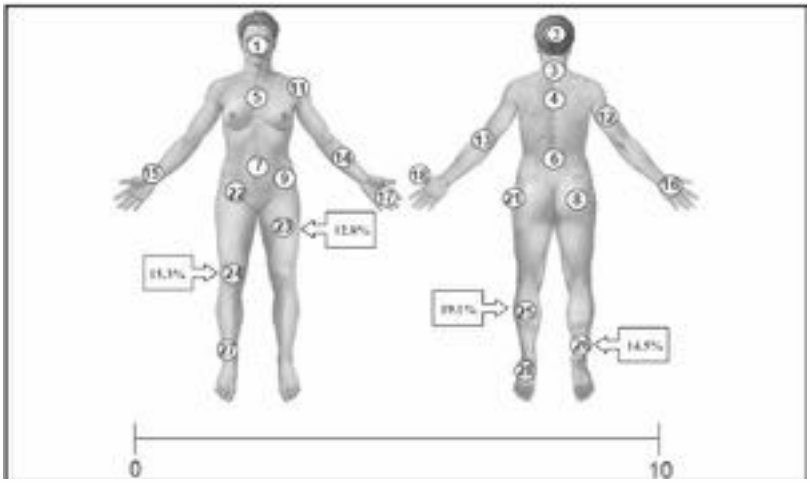
PREVALENCE OF MUSCULOSKELETAL PAIN IN MARATHON RUNNERS WHO COMPETE AT THE ELITE LEVEL

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

Objectives

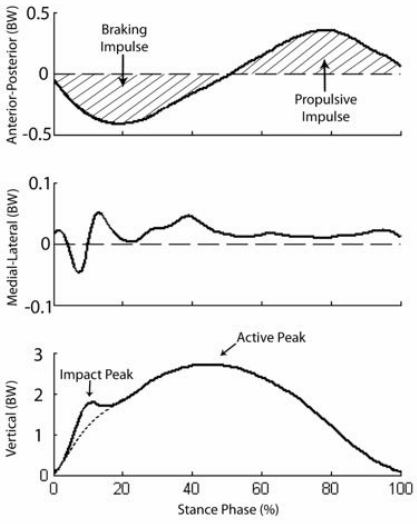
- Describe at least three key components of 2D video analysis setup in a clinical setting.
- Identify at least three factors related to running kinetics and kinematics that can be seen with a posterior and lateral view.
- List at least three ways implementation of video analysis can assist with the evaluation of runners.

Ground Reaction Forces

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

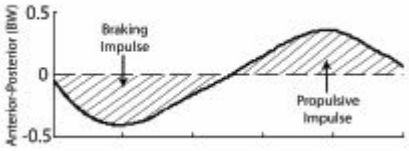
Ground Reaction Forces

- Anterior – Posterior
- Medial – Lateral
- Vertical



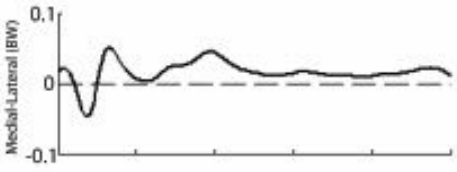
Ground Reaction Forces

- 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



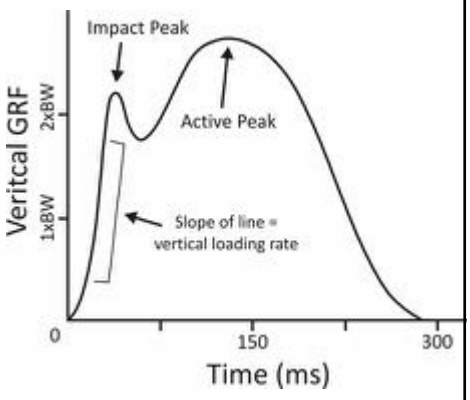
Ground Reaction Forces

- 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

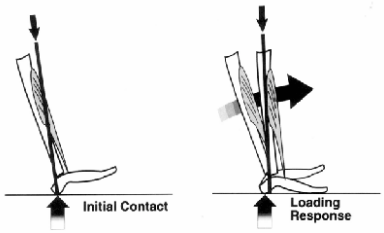


Ground Reaction Forces

- 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

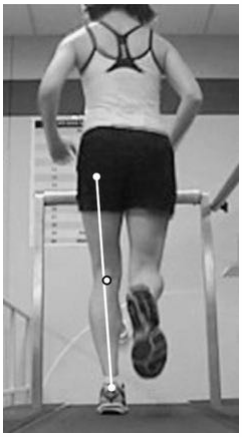
Kinetics & Kinematics

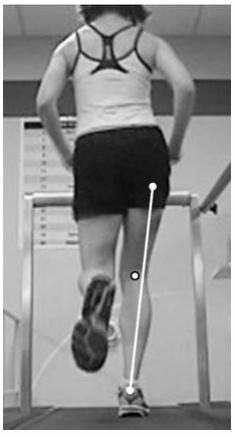
- Sagittal Plane Function
  - **Eccentric contractions**
    - Hip extensors
    - Knee extensors
    - Ankle plantar flexors
  - **Absorb mechanical energy**
  - **Hip Abductors key**
  - **Running style that ↑ GRF may ↑ demand**
    - Pelvic drop, dynamic knee valgus



Running Assessment

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



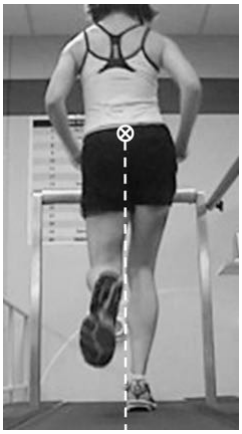


Running Assessment

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

Running Assessment

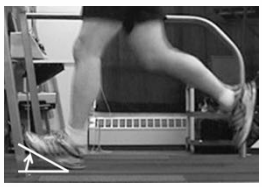
- Frontal Plane
  - **Foot Position**
    - Midline Crossover
      - ↑ lateral hip strain
    - Toe Out
      - Hip influence
        - » Capsule/Muscle/Bone
      - Knee influence
        - » Tibial torsion
        - » External malleolar torsion
      - Ankle influence
        - » Compensation for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



Running Assessment

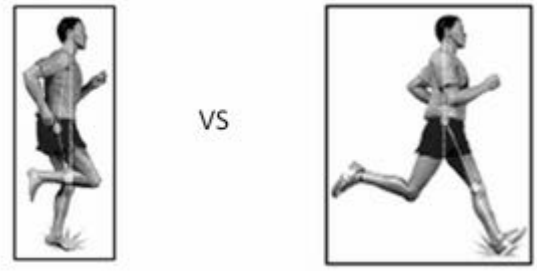
- Sagittal Plane
  - **Foot Contact Angle**
    - Plantar aspect & running surface

    - 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

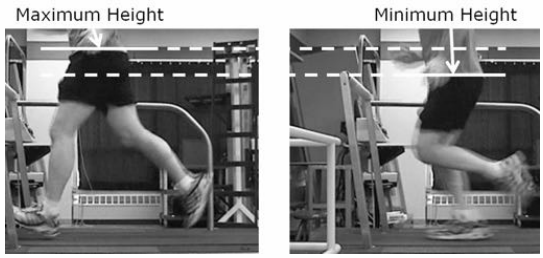


Running Assessment

- 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



Common Running Related Injuries

- Patellofemoral Pain Syndrome
- Iliotibial Band Syndrome
- Achilles Tendinopathy
- Stress Reaction / Stress Fracture
- Medial Tibial Stress Syndrome
- Plantar Fasciopathy

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

- 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

Proximal Strength

A Comparison of Hip Strength Between Sedentary Females With and Without Patellofemoral Pain Syndrome

- Magalhaes E et al. *JOSPT*, 2010

TABLE 3 HIP STRENGTH NORMALIZED TO BODY WEIGHT*

	Control (n = 50)	Unilateral PFPS (n = 21)	Bilateral PFPS (n = 29)
Abductors	14.6 ± 2.9	11.7 ± 4.2†	9.6 ± 2.8†
Adductors	15.1 ± 3.7	14.1 ± 5.7	11.4 ± 3.3†
Extensors	21.8 ± 5.6	19.1 ± 10.0†	15.8 ± 9.0†
Flexors	19.4 ± 4.3	16.3 ± 6.0†	14.9 ± 4.3†
Lateral rotators	14.5 ± 3.5	12.7 ± 4.1†	12.1 ± 3.9†
Medial rotators	14.3 ± 3.1	13.6 ± 4.4	12.7 ± 3.8†

Proximal Strength

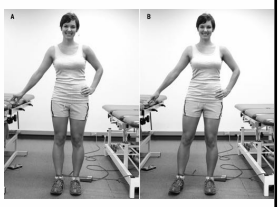
Hip Posterolateral Musculature Strengthening in Sedentary Women With Patellofemoral Pain Syndrome: A Randomized Controlled Clinical Trial With 1-Year Follow-up

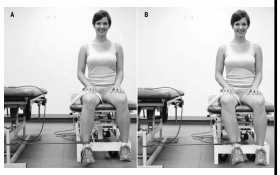
JOSPT Journal of Orthopaedic & Sports Physical Therapy

- Fukuda TY et al. *JOSPT*, 2012
  - **Added hip strengthening exercises to knee strengthening & stretching**
    - Improved function (LEFS)
    - Decreased pain

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

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

Video

Barefoot Fast Walk

Video

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 Jog

Video

Shod Run

Video

Shod Run Lateral

Video

Drop Jump

Video

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

- 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

- **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

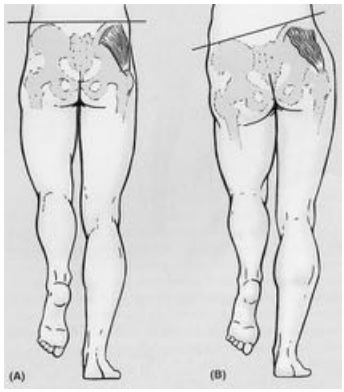
- **Ferber, R et al. *JOSPT* 2010**
  - ITBS group significantly greater hip adduction angle & knee IR angle

Iliotibial Band Syndrome

- **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

- Treatment Interventions
  - **Leetun, DT. et al. *Med Sci Sports Exer.* 2004**
    - Prospective study compared core stability measures between injured & non-injured athletes
    - Non-injured athletes were significantly stronger in hip abduction & external rotation



Patient Case
ITBS

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

Video

Barefoot Fast Walk

Video

Patient Case: ITBS

- **Key Findings**
  - **Limited ankle DF**
    - Gastroc-Soleus length & Talocrural mobility
    - Early heel rise
  - **Limited flexibility**
    - Iliopsoas: Forward trunk lean

Shod Jog

Video

Patient Case: ITBS

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

Shod Run

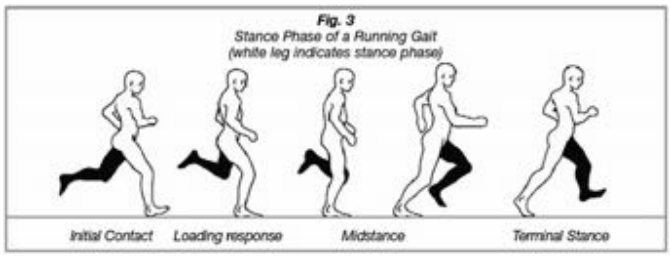
Video

Shod Run Lateral

Video

Achilles Tendinopathy

- Soleus
  - **Midstance**



- Gastrocnemius
  - **Push-Off**

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**

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

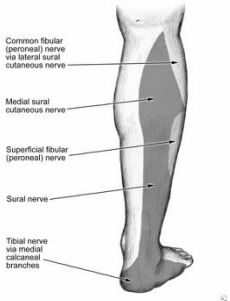
Achilles Tendinopathy

- Etiology
  - **Training errors** (Schepsis AA. et al. *AJSM* 2002)
    - ↑ intensity, change in surface or schedule and inappropriate shoewear
  - **Lower Extremity Intrinsic Factors** (Carcia CR et a. *JOSPT*. 2010)
    - Abnormal subtalar joint ROM
    - Limited ankle dorsiflexion
    - ↓ plantarflexion strength
    - Foot pronation
    - Co-Morbidities: Obesity, HTN, DM, ↑ cholesterol
  - **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° ($p = 0.04$)

Achilles Tendinopathy

- Differential Diagnosis
  - **Os Trigonum**
  - **Posterior ankle impingement**
  - **Medial tendon tendinopathy**
  - **Bursitis**
  - **Sural neuropathy**
  - **Radiculopathy**

Sports Injuries - Foot and Ankle © 2001 Primal Pictures Ltd



Achilles Tendinopathy

- Management
  - **Acute**
    - ↓ pain & effusion
    - Relative rest
      - Control load on healing tissue
    - Control dorsiflexion
      - Guided by pain
    - Possible heel lift (walking)
  - **Sub-acute**
    - Progress to full ROM
    - Initiate strengthening / remodel tissue

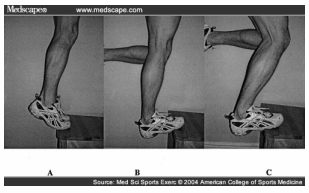
Achilles Tendinopathy

- 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%

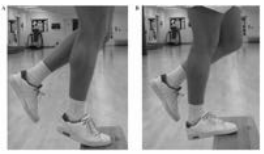


    - Shalabi A et al. *AJSM* 2004
      - 3 months of eccentric calf strengthening
      - MRI evaluation revealed:
        - » 14% decrease in tendon volume
        - » 23% decrease in intratendinous signal
      - Results correlated with improved clinical outcome

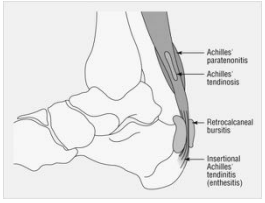
Achilles Tendinopathy

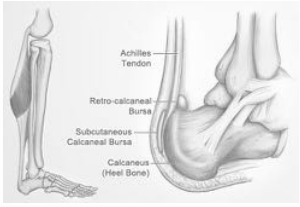
- Silbernagel KG. et al. *Am J Sports Med*. 2011
  - **34 patients with Achilles tendinopathy treated with exercise alone**
  - **5-Year follow up**
    - 80% fully recovered

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





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)

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

Achilles Tendinopathy

- Heavy 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%

Achilles Tendinopathy

- Shock-Wave Treatment
  - **Rompe JD et al. *AJSM*, 2009**
    - 68 patients with recalcitrant noninsertional Achilles tendinopathy (4 month F/U)
    - Group 1: Eccentric loading
      - VISA-A ↑: 50 to 73
      - Pain ↓: 7 to 4
      - "Completely Recovered" or "Much Improved": 56%
    - Group 2: Eccentric loading + low-energy shock-wave therapy
      - VISA-A ↑: 51 to 87
      - Pain ↓: 7 to 2
      - Completely Recovered" or "Much Improved": 82%
    - 1 year follow-up: No difference

Summary

- Tendinopathy presents many challenges to the sports medicine clinician
- Effective management requires understanding of the pathology at the tissue level
- Modification of training program is paramount in an athletic population
- Interventions should address faulty biomechanics with a bias toward eccentric strengthening

Patient Case
Achilles Tendinopathy

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

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

Video

Barefoot Fast Walk

Video

Barefoot Fast Walk-Lateral

Video

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

Video

Shod Run

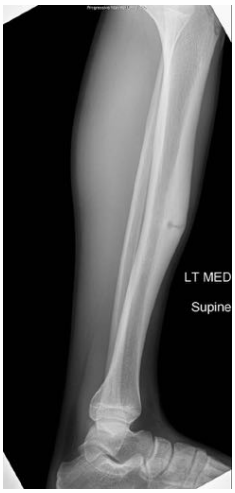
Video

Shod Run Lateral

Video

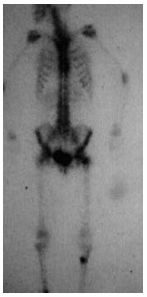
Stress Reaction / Stress Fracture

- Pathophysiology
  - **Repetitive loading alters structure**
  - **Fatigue of bone if load continues without rest**
- Etiology
  - **Training errors**
    - ↑ mileage or frequency
    - Old running shoes
  - **Biomechanical faults**
    - Lack of shock absorption in LE
      - (Milner et al. *Med Sci Sports Exerc*. 2006)
  - **Systemic conditions**
    - Osteopenia / Osteoporosis
    - Hormonal abnormalities
    - Inadequate nutrition
    - Female athlete triad
      - Low bone density
      - Disordered eating
      - Amenorrhea



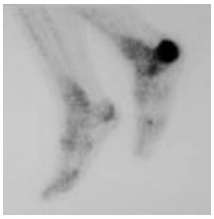
Stress Reaction / Stress Fracture

- Imaging
  - **Radiographs**
    - Early injury may not be detected
  - **CT**
    - 3D capability
  - **MRI**
    - Method of choice
  - **Bone Scan**
    - High sensitivity
    - Low specificity



Stress Reaction / Stress Fracture

- Common Sites
  - **Cortical bone most common**
    - Slower remodeling
  - **Tibia**
    - 20% - 45% of all stress fractures
      - (Brukner P. et al. *Clin J Sports Med*. 1996)
      - (Bennell KL. et al. *Am J Sports Med*. 1996)
    - Horizontal vs. Vertical tenderness
  - **Calcaneus**
    - Lateral vs. Medial
    - Posterior vs. Plantar
  - **Metatarsals**
    - 5th metatarsal = high incidence of non-union

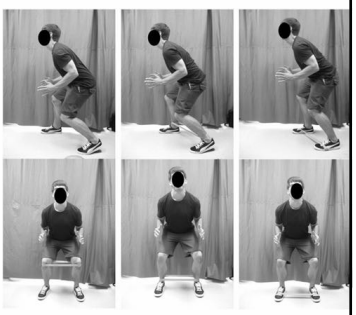


Stress Reaction / Stress Fracture

- Milner CE. et al. *JOSPT* 2010
  - **Subjects**
    - 29 females with history of tibial stress fracture
    - 29 females matched for age and weekly running distance
  - **Peak rearfoot eversion greater in tibial stress fracture group**
    - ↑ Torsional load on tibia
  - **Peak hip adduction greater in tibial stress fracture group**
  - **Runners may be utilizing frontal plane rather than sagittal plane to absorb impact forces**

Stress Reaction / Stress Fracture

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



  - **Joint mobility**
    - Subtalar
    - Talocrural
    - Knee
    - Hip

Patient Case
Stress Fracture

Case Study

- 22 yo female (Irish Step, XC, Track)
  - **10-15 hours of dance/week**
  - **XC 2 hours daily with meets on weekend**
  - **Track (4x4, 400m, 800m, 1500m)**
- Chronic history of bone stress injury
  - **R tibial stress reaction**
  - **L tibial stress fracture**
- Training for ½ Marathon & developed L calcaneal stress fracture

Barefoot Walk

Video

Barefoot Fast Walk

Video

Barefoot Fast Walk-Lateral

Video

Case Study

- Exam
  - **Gluteus medius & maximus strength**
    - B = 4-/5
  - **ROM**
    - Calcaneal eversion 0°
    - Ankle DF 2° with supinatory bias
  - **LE flexibility**
    - Limited B iliopsoas, Gastroc-Soleus
  - **Foot & Ankle joint mobility**
    - Limited talocrural joint: 2/6 posterior glide B
    - Limited subtalar joint: 1/6 lateral glide B

Shod Jog

Video

Shod Run

Video

Shod Run Lateral

Video

Shod Run Lateral-Full Body

Video

Treatment

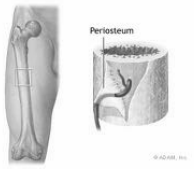
- Proximal Strength
  - **Gluteus medius**
    - Avoid TFL / Hip flexors
  - **Gluteus maximus**
    - Avoid hamstring
- Distal Mobility
  - **TC posterior glide**
  - **ST lateral glide**
- Motor Control
  - **Use new ROM**
  - **Facilitate muscle activation**
- Soft tissue
  - **Hip Flexors**
    - Impacts gluteal activation
  - **Gastroc-Soleus**
- GS stretch with supinatory bias
- Plyometric progression for accommodation of Ground Reaction Forces

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**

Medial Tibial Stress Syndrome

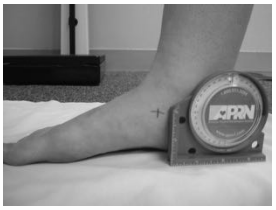
- Risk Factors (Sharma J et al. *Gait Posture*. 2011)
  - **Military recruits**
    - Most significant risk factor was "poor biomechanics" (9.2x)
      - ↑ weight bearing on medial side of foot
      - ↑ medial pressure in forefoot
      - ↑ pressure in calcaneus at heel strike
      - ↑ foot pronation

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

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 Walk

Video

Barefoot Fast Walk

Video

Barefoot Fast Walk-Lateral

Video

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 Jog

Video

Shod Run

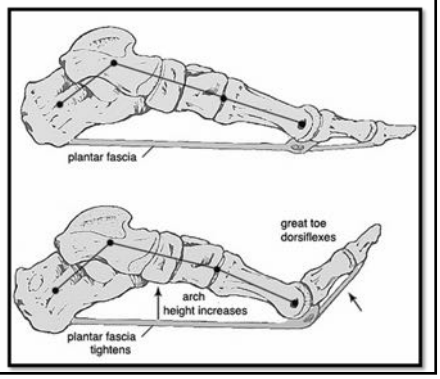
Video

Shod Run Lateral

Video

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

Plantar Fasciopathy

- **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

Podiatric Medicine and Surgery © 2001 Primal Pictures Ltd

  - (+) Windlass test & (-) Tarsal Tunnel test
  - ↑ BMI in nonathletic individuals

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

- **McPoil TG et al. *JOSPT* 2008 / Martin RL et al. *JOSPT* 2014**
  - **Modalities** (Moderate evidence)
    - Iontophoresis (dexamethasone 0.4%) or (acetic acid 5%) provides short term relief (2-4 weeks)
  - **Modalities** (Conflicting evidence)
    - May or may not use iontophoresis with dexamethasone or acetic acid to provide short-term (2-4 weeks) pain relief and improved function
  - **Stretching** (Moderate evidence)
    - Calf and/or plantar fascia provides short term relief (2-4 months)
    - No difference between dosage of 20 sec or 3 minutes
  - **Stretching** (Strong evidence)
    - Plantar-Fascia specific and gastroc-soleus stretching to provide short-term (1 week to 4 months) pain relief

Plantar Fasciopathy

- **McPoil TG et al. *JOSPT* 2008 / Martin RL et al. *JOSPT* 2014**
  - **Taping** (Weak evidence)
    - Calcaneal or low-Dye provides short term relief (7-10 days)
  - **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
  - **Orthotic Devices** (Strong evidence)
    - No difference in pain reduction or improved function between pre-fabricated or custom devices
  - **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

Plantar Fasciopathy

- **McPoil TG et al. *JOSPT* 2008 / Martin RL et al. *JOSPT* 2014**
  - **Night Splints** (Moderate evidence)
    - Patients with symptoms > 6 months most appropriate
  - **Night Splints** (Strong evidence)
    - Prescribe a 1-3 month program of night splints for individuals who consistently have pain with first step in morning
  - **Manual Therapy** (Theoretical evidence)
    - Joint mobilization & nerve gliding
  - **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"

Patient Case
Plantar Heel Pain

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

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 Walk

Video

Barefoot Fast Walk

Video

Barefoot Fast Walk

Video

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 Jog

Video

Shod Run

Video

Shod Run Lateral

Video

Summary

- Symptom-free running requires proper training with the right footwear
- Assess recent changes in training program first
- Examine potential causes for altered mechanics
- Always treat the cause and avoid chasing symptoms

THANK YOU