Prevention of Running Injuries: Taking the research in to the clinic

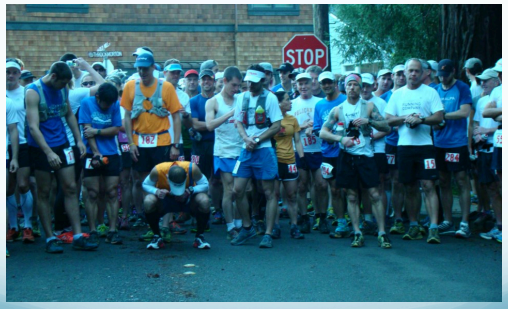
Nicole Haas, PT, DPT, OCS

Where to start?

Clinical/ static assessment + Run analysis

Gait retraining vs. Strengthening vs. Manual therapy

Prepare yourself for the runners...



Prepare yourself for the runners...

- STEP 1: Have a systematic method for evaluating your runners... don't miss the pieces of the puzzle
- STEP 2: Know the correlations between different running styles and different demands on the structures of the body
- STEP 3: Know what research is out there that correlates particular injuries with particular running patterns... and have a critical view (does one style fit all?)

Prepare yourself for the runners...

- STEP 4: Understand the importance of CHOSEN running patterns and listen to your runner's needs (listen to what they say AND listen to/ observe/ analyze what they do)
- STEP 5: Determine if the running style needs to be changed or the patient needs better tools (the hardest part?)

STEP 1: Have a systematic method for evaluating your runners... don't miss the pieces of the puzzle

Clinical assessment: What tools are needed to run?

- Good femoral/ knee control
- Strength of gluteus maximus/ medius
- Strength of ankle/ foot stabilizers
- Mobility of LE: 1st ray, talocrural joint, midtarsal joint, knee, hip, trunk...
- Trunk stability

Running analysis

- Use a systematic method

Clinical assessment

Assess the obvious links to injury (off the treadmill) – think backwards from injury and apply what research shows is connected

- Flexiblity/ mobility: trunk rotation, Ober test, Thomas test, SLR 90/90 test, TCJ mobility, 1st ray mobility, midtarsal mobility/ stability
- Strength: gluteus medius/ maximus, ankle/ foot stabilizers, SL heel raises/ lowers, abdominals
- Functional tests: FMS squat/ rotation/ rolling, Star excursion/ Y balance test, SL squat/ drop down

Clinical Screen for Runners

LoDo Physical Therapy, PLLC

CLINICAL SCREEN FOR RUNNERS

Date__________
Runner's Name____
Physical Therapist______________________________________

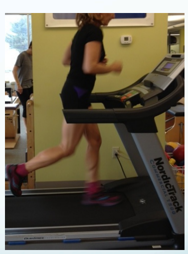
STANDING	
Static knee alignment	Neutral / Genu valgus / Genu varus
Lumbar spine AROM	__WNL __Limited: flex / ext / rot R / rot L
Single leg balance	__ Able to balance 30 seconds R / L __Unable to balance 30 sec R / L
Single leg heel raise	__Able to complete 25 reps R / L __Unable to complete 25 reps R / L
Star excursion test/ Y balance test	__WNL __ > 4 cm difference, limited R / L
Dynamic knee alignment (drop down, single leg hop/ squat)	__Good control __Valgus collapse R / L / B
SITTING	
Hip flexor strength	__WNL __Weakness noted R / L
Quadriceps strength	__WNL __Weakness noted R / L
Hamstring strength	__WNL __Weakness noted R / L
SIDELYING	
Gluteus medius strength	__WNL __Weakness noted R / L
Ober test	__WNL __Positive R / L
PRONE	
Quadriceps flexibility	__WNL __Tightness noted R / L
Gluteus maximus strength	__WNL __Weakness noted R / L
Ankle mobility	__WNL __Tightness noted R / L
1st ray mobility	__WNL __Stiffness noted R / L
SUPINE	
Hamstring flexibility: SLR 90/90 test (WNL = less than 20 degrees knee flex)	__WNL __Tightness noted R ____ / L ____
Thomas test	__WNL __Positive R ____ / L ____
Abdominal strength	__WNL __Weakness noted

Additional Notes:

Nicole Haas, PT, DPT, OCS
CSM 2013: Staying on the Right Track: Current Concepts in the Care and Prevention of Running Injuries of the Foot and Ankle

Running Analysis

- Apply the research and look for patterns that indicate issues with weakness, tightness, stability or mobility issues, etc
- Use a systematic approach… can't be emphasized enough



Running Analysis & Recommendations

RUNNING ANALYSIS SCREEN & RECOMMENDATIONS

Date__________
Runner's Name______________________________________
Physical Therapist___________________________________

POSTERIOR VIEW	OBSERVATIONS/ FINDINGS	INDICATIONS/ POTENTIAL PROBLEMS	POSSIBLE RECOMMENDATIONS
Control of foot mechanics during loading	_Good _Uncontrolled/ Accelerated	_Normal _Weakness in foot/ ankle muscles _Lack of control related to hip muscle weakness	_Ankle/ foot muscle strengthening _Hip muscle strengthening _Recommend use of non-custom orthotics _Recommend further evaluation for custom orthotics
Heel whip presence	_Absent _Medial whip _Lateral whip	_Normal _Pattern related to tautness in IT band _Pattern related to weakness in hip muscles	_Hip muscle strengthening _IT band mobilization _Correction of running form with focus on: ____________ ______________________
Femoral control/ knee mechanics	_Good _Uncontrolled _Asymmetric _Valgus collapse _Varus thrust	_Normal _Pattern correlated with weakness in hip muscles and knee pain _Pattern correlated with knee joint aggravation	_Hip muscle strengthening _Correction of running form with focus on: ____________ ______________________ _Recommend use of foot orthosis
Pelvic motion at initial contact	_PSIS drop R / L _PSIS remains level	_Normal _Pattern correlated with weakness in hip/ trunk muscles	_Hip muscle strengthening _Trunk/ core strengthening
Trunk rotation	_Symmetric _Asymmetric	_Normal _Related to limitations in trunk ROM _Related to hip/ trunk weakness	_Trunk rotation stretching _Hip muscle strengthening _Trunk/ core strengthening _Hip flexor stretching

Additional Notes:

Nicole Haas, PT, DPT, OCS
CSM 2013: Staying on the Right Track: Current Concepts in the Care and Prevention of Running Injuries of the Foot and Ankle

Running Analysis & Recommendations

LATERAL VIEW	OBSERVATIONS/ FINDINGS	INDICATIONS/ POTENTIAL PROBLEMS	POSSIBLE RECOMMENDATIONS
Running pattern/ strategy	_Rearfoot strike _Midfoot strike _Forefoot strike	_Able to perform properly _Difficulty controlling form _Correlated with specific issue: ____________	_No modifications necessary _Appropriate if overall recommendations are addressed _Specific modifications recommended____________
Ankle/ foot control during landing	_Heel striker: uncontrolled/ controlled into PF _Forefoot striker: uncontrolled/ controlled into DF	_Normal _Weakness/ tightness in anterior compartment muscles _Weakness/ tightness in posterior compartment muscles _Ankle/ foot mobility issue	_Ankle strengthening _Ankle stretching _Further evaluation of foot/ ankle joint mobility
Screen for overstride	_Present _Absent	_Normal _Pattern correlated with knee pain, stress fractures, LE injuries	_No modifications necessary _Increase cadence (# of steps per minute) by 10%
Amount of knee flexion during foot strike	_Appropriate _Decreased _Increased	_Normal _Contributing to excessive muscular use _Contributing to decreased shock absorption	_No modifications necessary _Modification of running strategy needed
Hip extension at terminal stance	_Appropriate _Decreased	_Normal _Tightness in hip flexors	_No modifications necessary _Hip flexor stretching
Pelvic tilt/ lumbar spine motion	_Appropriate _Decreased _Increased	_Normal _Tightness in hip flexors _Weakness in abdominal muscles	_Hip flexor stretch _Trunk/core strengthening
Trunk position	_Trunk lean: Forward/ Backward _ Kyphosis: Static/ Dynamic	_Normal _Tightness in hip flexors _Decreased posture awareness	_Hip flexor stretching _Focus on upright posture _Modification of running style
Vertical displacement	_Appropriate _Increased	_Normal _Pattern correlated with increased noise at impact _Pattern correlated with decreased efficiency	_"Soften" landing _Focus on forward movement vs. up and down movement

Nicole Haas, PT, DPT, OCS
CSM 2013: Staying on the Right Track: Current Concepts in the Care and Prevention of Running Injuries of the Foot and Ankle

STEP 2: Know the correlations between different running styles and different demands on the structures of the body

Rearfoot strike

- GRF is posterior to ankle resulting in PF of foot, eccentric demand on anterior tibialis, and less demand on triceps surae
- Talocrural joint mobility and dorsiflexion ROM demands
- Method for absorbing shock and unloading the foot?

STEP 2: Know the correlations between different running styles and different demands on the structures of the body

Forefoot strike

- Decreased strain on pretibial musculature
- Increased demand on eccentric recruitment of triceps surae as the heel lowers
- Decreased load on anterior knee

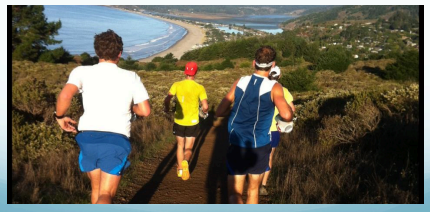
STEP 2: Know the correlations between different running styles and different demands on the structures of the body

Midfoot strike

- Load through center of foot
- Increased demand on spring in foot/ plantar fascia

STEP 3: Know what research correlates specific injuries with specific running patterns... and have a critical view. Does one style fit all?

- Forefoot strike/ barefoot/ minimalist footwear
- Video analysis and gait retraining



STEP 4: Understand the importance of CHOSEN running patterns and listen to your runner's needs (listen to what they say AND observe/ analyze what they do)

STEP 4: Questions to ask for any of the running styles/ chosen strategies...

- How is it defined? (philosophy vs. foot strike pattern)
- Why might a runner choose it?
- What is needed from a strength/ control/ flexibility/ mobility perspective to achieve it?
- What can go wrong? What should be screened to prevent injuries?
- Is there any evidence to support or refute using it?
- How do we help patients decide if the running style is appropriate for them?

STEP 5: Determine if the running style needs to be changed or the patient needs better tools

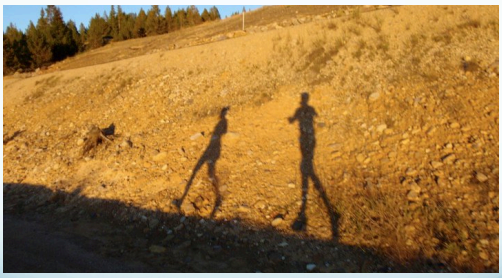
Decide what to do to the patient from the manual, strengthening, neuro re-education and gait training perspective... time to tie all the piece together

Advising the (already) injured runner…

EdURep principle for healing and prevention of further injuries and runner education can be the key

Davenport TE, Kulig K, Matharu Y, Blanco C. The EdURep model for nonsurgical management of tendinopathy. Phys Ther 2005; 85(10): 1093-1103.

Thank you!



Nicole Haas, PT, DPT, OCS
haaspt@mac.com

References

- Aredense R et al. Reduced eccentric loading of the knee with the pose running method. *Med Sci Sports Exerc*. 2004;36(2):272-277.
- Bramble D Lieberman D. Endurance running and the evolution of Homo. *Nature* 2004; 432345-352.
- Crowell H, Milner C, Hamill J, Davis I. Reducing impact loading during running with the use of real-time visual feedback. *J Orthop Sports Phys Ther*. 2010;40(4):206-213.
- Davenport TE, Kulig K, Matharu Y, Blanco C. The EdURep model for nonsurgical management of tendinopathy. Phys Ther 2005; 85(10): 1093-1103
- Dicharry J. Kinematics and kinetics of gait: From lab to clinic. Clin Sports Med 2010;29:347–364.
- Diebal A et al. Effects of forefoot running on chronic exertional compartment syndrome: A case series. Int J Sports Med 2011;6(4):312-321.

References continued

- Edwards W, Taylor D, Rudolphi T, Gillette J, Derrick T. Effects of stride length and running mileage on a probabilistic stress fracture model. *Med Sci Sports Exerc* 2009; 41(12):2177–2184.
- Ferber R, Noehren B, Hamill J, Davis I. Competitive female runners with a history of iliotibial band syndrome demonstrate atypical hip and knee kinematics. *J Orthop Sports Phys Ther.* 2010;40(2):52-58.
- Heiderscheit B, Chumanov E, Michalski M, Wille C, Ryan M. Effects of step rate manipulation on joint mechanics during running. *Med Sci Sports Exerc.* 2011;43(2):296-302.
- Lieberman D et al. Foot strike patterns and collision forces in habitually barefoot versus shod runners. *Nature* 2010; 463:531-535.
- Milner CE, Ferber R, Pollard CD, Hamill J, Davis IS. Biomechanical factors associated with tibial stress fracture in female runners. *Med Sci Sports Exerc. 2006;38:323-328.*

References continued

- Onate JA, Guskiewicz KM, Sullivan RJ. Augmented feedback reduces jump landing forces. *J Orthop Sports Phys Ther. 2001;31:511-517.*
- Pepper M, Akuthota V, McCarty EC. The pathophysiology of stress fractures. *Clin Sports Med. 2006;25:1-16.*
- Pliskey P, Rauh M Kaminski T, Underwood F. Star excursion balance test as a predictor of lower extremity injury in high school basketball players. *J Orthop Sports Phys Ther. 2006;36(12):911-919.*
- Souza R, Powers C. Differences in hip kinematics, muscle strength, and muscle activation between subjects with and without patellofemoral pain. *J Orthop Sports Phys Ther. 2009;39(1):12-19.*
- Souza RB, Powers CM. Predictors of hip internal rotation during running: An evaluation of hip strength and femoral structure in women with and without patellofemoral pain. *Am J Sports Med.* 2009;37(3):579-587.
- Wouters I et al. Effects of a movement training program on hip and knee joint frontal plane running mechanics. Int J Sports Med 2012;7(6):637-646.

LoDo Physical Therapy, PLLC

RUNNING ANALYSIS SCREEN & RECOMMENDATIONS

Date_____
Runner's Name_____
Physical Therapist_____

POSTERIOR VIEW	OBSERVATIONS/ FINDINGS	INDICATIONS/ POTENTIAL PROBLEMS	POSSIBLE RECOMMENDATIONS
Control of foot mechanics during loading	__Good __Uncontrolled/ Accelerated	__Normal __Weakness in foot/ ankle muscles __Lack of control related to hip muscle weakness	__Ankle/ foot muscle strengthening __Hip muscle strengthening __Recommend use of non-custom orthotics __Recommend further evaluation for custom orthotics
Heel whip presence	__Absent __Medial whip __Lateral whip	__Normal __Pattern related to tautness in IT band __Pattern related to weakness in hip muscles	__Hip muscle strengthening __IT band mobilization __Correction of running form with focus on: _____ _____
Femoral control/ knee mechanics	__Good __Uncontrolled __Asymmetric __Valgus collapse __Varus thrust	__Normal __Pattern correlated with weakness in hip muscles and knee pain __Pattern correlated with knee joint aggravation	__Hip muscle strengthening __Correction of running form with focus on: _____ _____ __Recommend use of foot orthosis
Pelvic motion at initial contact	__PSIS drop R / L __PSIS remains level	__Normal __Pattern correlated with weakness in hip/ trunk muscles	__Hip muscle strengthening __Trunk/ core strengthening
Trunk rotation	__Symmetric __Asymmetric	__Normal __Related to limitations in trunk ROM __Related to hip/ trunk weakness	__Trunk rotation stretching __Hip muscle strengthening __Trunk/ core strengthening __Hip flexor stretching

Additional Notes:

Nicole Haas, PT, DPT, OCS
CSM 2013: Staying on the Right Track: Current Concepts in the Care and Prevention of Running Injuries of the Foot and Ankle

LATERAL VIEW	OBSERVATIONS/ FINDINGS	INDICATIONS/ POTENTIAL PROBLEMS	POSSIBLE RECOMMENDATIONS
Running pattern/ strategy	__Rearfoot strike __Midfoot strike __Forefoot strike	__Able to perform properly __Difficulty controlling form __Correlated with specific issue: _____ _____	__No modifications necessary __Appropriate if overall recommendations are addressed __Specific modifications recommended_____ _____
Ankle/ foot control during landing	__Heel striker: uncontrolled/ controlled into PF __Forefoot striker: uncontrolled/ controlled into DF	__Normal __Weakness/ tightness in anterior compartment muscles __Weakness/ tightness in posterior compartment muscles __Ankle/ foot mobility issue	__Ankle strengthening __Ankle stretching __Further evaluation of foot/ ankle joint mobility
Screen for overstride	__Present __Absent	__Normal __Pattern correlated with knee pain, stress fractures, LE injuries	__No modifications necessary __Increase cadence (# of steps per minute) by 10%
Amount of knee flexion during foot strike	__Appropriate __Decreased __Increased	__Normal __Contributing to excessive muscular use __Contributing to decreased shock absorption	__No modifications necessary __Modification of running strategy needed
Hip extension at terminal stance	__Appropriate __Decreased	__Normal __Tightness in hip flexors	__No modifications necessary __Hip flexor stretching
Pelvic tilt/ lumbar spine motion	__Appropriate __Decreased __Increased	__Normal __Tightness in hip flexors __Weakness in abdominal muscles	__Hip flexor stretch __Trunk/core strengthening
Trunk position	__Trunk lean: Forward/ Backward __ Kyphosis: Static/ Dynamic	__Normal __Tightness in hip flexors __Decreased posture awareness	__Hip flexor stretching __Focus on upright posture __Modification of running style
Vertical displacement	__Appropriate __Increased	__Normal __Pattern correlated with increased noise at impact __Pattern correlated with decreased efficiency	__”Soften” landing __Focus on forward movement vs. up and down movement

LoDo Physical Therapy, PLLC

CLINICAL SCREEN FOR RUNNERS

Date_____
Runner's Name_____
Physical Therapist_____

STANDING	
Static knee alignment	Neutral / Genu valgus / Genu varus
Lumbar spine AROM	___WNL ___Limited: flex / ext / rot R / rot L
Single leg balance	___ Able to balance 30 seconds R / L ___Unable to balance 30 sec R / L
Single leg heel raise	___Able to complete 25 reps R / L ___Unable to complete 25 reps R / L
Star excursion test/ Y balance test	___WNL ___ > 4 cm difference, limited R / L
Dynamic knee alignment (drop down, single leg hop/ squat)	___Good control ___Valgus collapse R / L / B
SITTING	
Hip flexor strength	___WNL ___Weakness noted R / L
Quadriceps strength	___WNL ___Weakness noted R / L
Hamstring strength	___WNL ___Weakness noted R / L
SIDELYING	
Gluteus medius strength	___WNL ___Weakness noted R / L
Ober test	___WNL ___Positive R / L
PRONE	
Quadriceps flexibility	___WNL ___Tightness noted R / L
Gluteus maximus strength	___WNL ___Weakness noted R / L
Ankle mobility	___WNL ___Tightness noted R / L
1st ray mobility	___WNL ___Stiffness noted R / L
SUPINE	
Hamstring flexibility: SLR 90/90 test (WNL = less than 20 degrees knee flex)	___WNL ___Tightness noted R _____ / L _____
Thomas test	___WNL ___Positive R _____ / L _____
Abdominal strength	___WNL ___Weakness noted

Additional Notes:

Nicole Haas, PT, DPT, OCS
CSM 2013: Staying on the Right Track: Current Concepts in the Care and Prevention of Running Injuries of the Foot and Ankle

Assessment and Alteration of Running Technique Using Clinical Video Analysis

Bryan Heiderscheit, PT, PhD
Associate Professor
Department of Orthopedics & Rehabilitation
Department of Biomedical Engineering
Director, UW Runners' Clinic
Director, Sports Performance Research, UW Athletics
Co-director, UW Neuromuscular Biomechanics Lab

Case History

- 44 y/o female
- Left shin and knee pain for past 8 wks
- Unknown cause but felt it to be related to uneven terrain on recent trail run
- Unremarked medical history
- Running goal: marathon in 4 wks

Physical Exam

- Normal strength
  - Isometric MMT
  - Single-leg squat
- Mild-moderate drop of medial longitudinal arches in WB
- Normal ankle DF in WB
- Normal flexibility
- No tenderness to palpation

Video Analysis

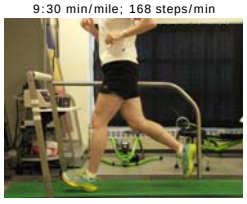
9:30 min/mile; 168 steps/min

- heel strike pattern with knees near extension
- foot well ahead of COM at contact
- Vertical displacement of COM

Intervention

- Intervention
  - Increased step rate to 174 steps/min (5%)
  - Shift point of contact off heels toward midfoot
  - Gradually integrate over next 4 wks

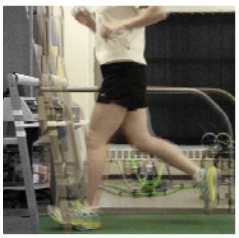
9:30 min/mile; 168 steps/min

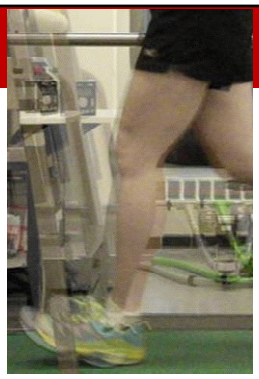


9:30 min/mile; 174 steps/min

Outcome

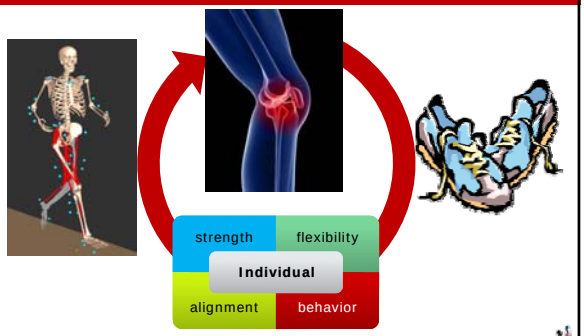
pre





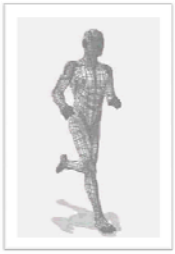
- Outcome
  - Immediately resolved pressure/pain during visit
  - Returned to normal mileage; completed marathon without issue

Running Injury Management

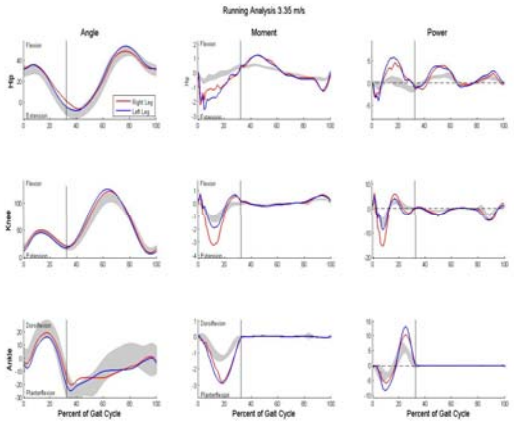


Overview

- Clinically feasible approach to video analysis of running gait
- Retraining of running gait



Motion Analysis Labs



Clinical Feasibility

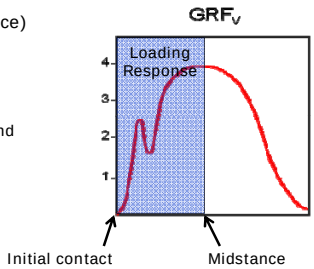
- Qualitative video analysis is likely the most common approach to assessing running mechanics

Where to Start?

- Focus on loading response (initial contact to mid-stance)
  - characterize body control during energy absorption

Critieria

- Provide insights into forces and joint loading
- Minimize potential for error



Key Parameters

Frontal

- Midstance
  - Joint center alignment
  - Lateral pelvic tilt
  - Foot-COM placement
  - Knee separation
  - Rearfoot/shoe alignment

Sagittal

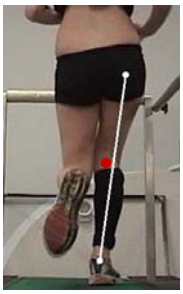
- Initial Contact
  - Foot-ground angle
  - Heel-COM distance
  - Knee flexion angle
- Midstance
  - Max knee flexion angle
- COM vertical displacement

Joint Center Alignment at Midstance

- Connect a line between the estimated hip and ankle joint centers
- Evaluate the location of the knee joint center with respect to this line
- Prefer knee joint center to fall on the line

Joint Center Alignment at Midstance

Medial deviation



Lateral deviation

Willy et al. (2012) Med Sci Sports Exerc

Lateral Pelvic Tilt at Midstance

- Defined relative to the horizontal
- Gender differences in this measure is expected with women typically displaying 3-5° more than men

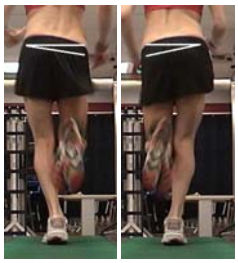
Chumanov et al. (2008) Clin Biomech
Noehren et al. (2012) Med Sci Sports Exerc

Lateral Pelvic Tilt at Midstance

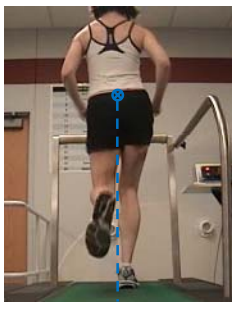
normal

excessive

excessive



Foot-COM Placement at Midstance



- Location of the foot with respect to the whole body's line of gravity (LOG)
- As running speed increases, this distance decreases

9:30 min/mile

Knee Separation at Midstance

typical

narrow with stance leg deviation

narrow with swing leg deviation

WISCONSIN

UW Neuromuscular Biomechanics Lab

Redundancy between Measures

Lateral knee alignment

Increased knee separation

Narrow foot placement

WISCONSIN

UW Neuromuscular Biomechanics Lab

Foot Inclination Angle at Contact

Heiderscheit et al. (2011) Med Sci Sports Exerc

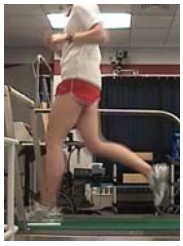
WISCONSIN

UW Neuromuscular Biomechanics Lab

Foot Inclination Angle at Contact

rearfoot

midfoot

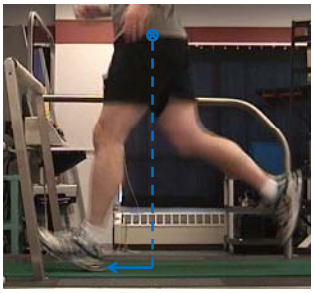


forefoot

WISCONSIN

UW Neuromuscular Biomechanics Lab

Horizontal Distance from Heel to COM at Contact



- The horizontal distance of the foot with respect to the whole body's LOG is directly associated with the braking impulse

Heiderscheit et al. (2011) Med Sci Sports Exerc

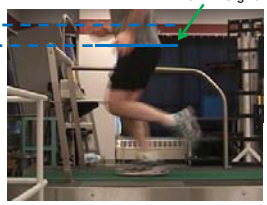
WISCONSIN

UW Neuromuscular Biomechanics Lab

COM Vertical Displacement

Maximum Height

Minimum Height



- 6-8 cm appears to be target displacement for recreational runners
- may see some novice runners having 12+ cm

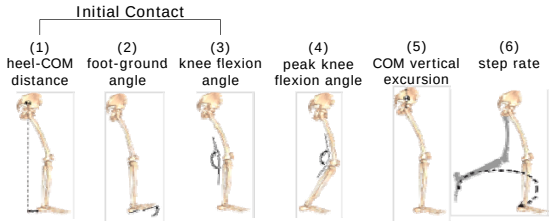
Heiderscheit et al. (2011) Med Sci Sports Exerc

WISCONSIN

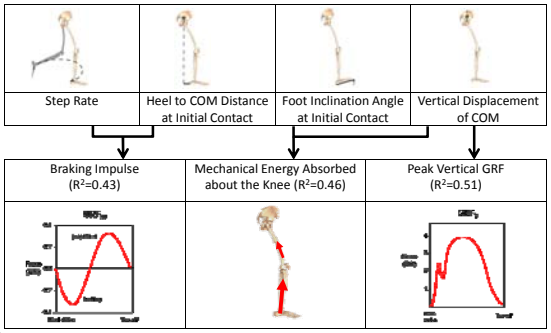
UW Neuromuscular Biomechanics Lab

Kinematic Predictors of Loading

- Can discrete kinematic parameters predict running kinetics?



Kinematic Predictors of Kinetics



Wille et al. (2011). J Orthop Sports Phys Ther

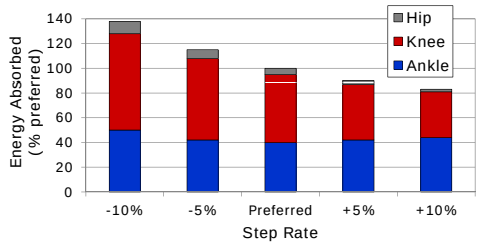
Goal of Retraining

- reduce the mechanical demands of the task
  - modify running form to reduce external forces the body encounters
- potential strategies:
  - focused instruction
    - foot-strike
    - hip adduction
    - whole-body form (Pose)
  - global approach
    - peak tibial acceleration
    - step rate

Heiderscheit (2011) J Orthop Sports Phys Ther

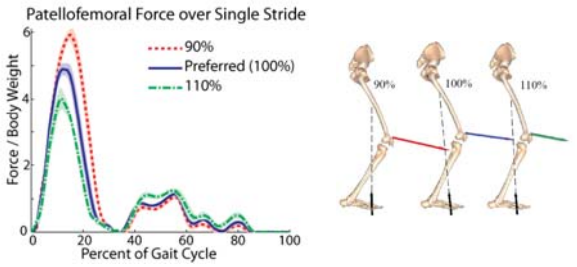
Negative Work Performed at each Joint

- Energy absorption
  - substantial reduction at knee and hip



Heiderscheit et al. (2011) *Med Sci Sports Exerc*

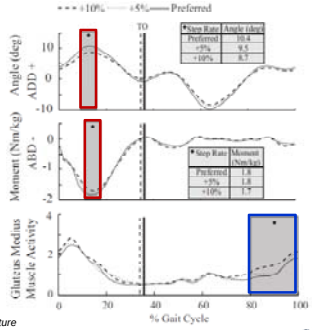
Reduced PF Forces with Increased Step Rate



Lenhart et al. (2012) proc, Am Soc Biomech

Increased Pre-activation

- Gluteus medius pre-activation in swing may facilitate reduction of hip adduction angle and abduction moment in stance



Chumanov et al. (2012) *Gait Posture*

Training Protocol

- Goal is to alter the landing mechanics and running form, not to achieve a constant step rate
- Single session on treadmill
  - 5-10% increase in step rate
  - May require verbal cueing to refine
- At 1 month F/U, able to reproduce without cueing within 2% of prescribed
  - normal daily variation is 3%

PSF (144) with knee pain

158 without knee pain

UW Neuromuscular Biomechanics Lab

Which Strategy is Best?

- Biomechanical effects are likely overlapping
  - Forefoot training induces a shorter stride length and higher step rate
  - Decreased tibial accelerations (run softly) is likely achieved by decreased stride length and avoidance of heel-strike
- Best strategy is the one that:
  - reduces current symptoms without producing new symptoms
  - the specific patient can learn most easily and quickly
  - does not compromise performance
  - likely to promote long-term compliance

UW Neuromuscular Biomechanics Lab

Case History

- 37 y/o male
- Bilateral Achilles pain intermittent for past 2 yrs
  - Current episode onset 4 wks prior, R >L
- Previously treated with heavy load eccentrics and responded well
- D/C exercises and increased running mileage/training; symptoms returned after 4 month period

UW Neuromuscular Biomechanics Lab

Physical Examination

- Midportion tendon pain with palpation (5cm from insertion)
  - No nodules or significant swelling
- Normal strength
- Well maintained medial arch in WB and NWB
- Substantial tightness felt in lateral calf and thigh with hip flex/add and ankle DF, both right and left sides
- Tightness in left rectus femoris

UW Neuromuscular Biomechanics Lab

Video Analysis

9:30 min/mile; 150 steps/min

- slight medial displacement of knees (R >L)
- fairly narrow step width
- COM vertical displacement ~11-12 cm
- asymmetrical landing pattern; L, rearfoot; R, midfoot
- foot well ahead of COM at contact

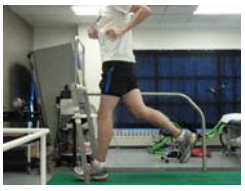
UW Neuromuscular Biomechanics Lab

Intervention

- Intervention
  - Increased step rate to 160 steps/min (~8%)
  - Reduce COM vertical displacement
  - Promote symmetric midfoot landing pattern
  - Return to heavy load eccentric program with RF stretch

9:30 min/mile; 150 steps/min

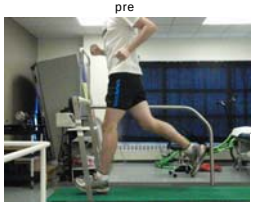
9:30 min/mile; 160 steps/min



UW Neuromuscular Biomechanics Lab

Outcome

pre



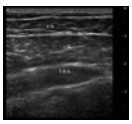
4wks post

- 4 wk follow-up
  - No pain or symptoms
  - 80% back to pre-injury level; remaining limitation is reduced mileage

Post-pregnancy Status

- Common running mechanics observed among women post-pregnancy
  - Increased anterior pelvic tilt
    - reduced hip extension
    - increased lumbar extension
  - Increased lateral pelvic tilt

- Reduced neuromuscular control of lumbopelvic region
  - Reduced recruitment of transversus abdominus
  - Internal oblique dominant
  - Isometric weakness of gluteus medius



Chumanov et al. (2013) CSM, San Diego

Case History

- 34 y/o female
- Right foot pain for past 2 months with no known cause
  - working Dx: stress reaction of 4th metatarsal
- Prior care:
  - NWB for 3 wks
- Running 2-3 miles/d for past week with pain 3/10
- Regular runner for past year only
- Mother of 3 with youngest 3 y/o
- Running goal: ½ marathon in 8 wks

Physical Exam

- Mild tenderness to palpation over mid-distal shaft of right metatarsals 3 and 4
- Normal foot mobility and alignment in NWB and WB
- Poor abdominal drawing-in maneuver (ADIM)
- 10° limited hip internal rotation bilateral
- Figure 4 position ~50% limited on left with elevated knee
- Medial knee collapse during single-leg squat, bilaterally
  - worse when performed at a faster velocity

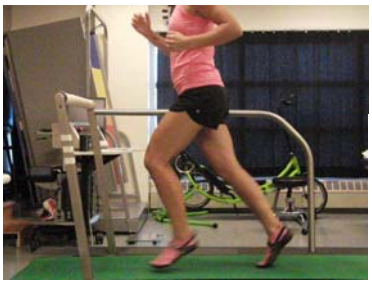
Running Mechanics

8:30 min/mile; 176 steps/min

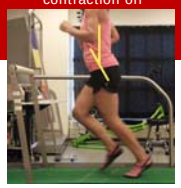
- increased lateral pelvic motion during mid stance, bilaterally
- medial knee collapse evident, bilaterally
- Increased anterior pelvic tilt and excursion
- Forefoot strike pattern

Pelvic Floor Contraction

contraction off/on/off/on



contraction off



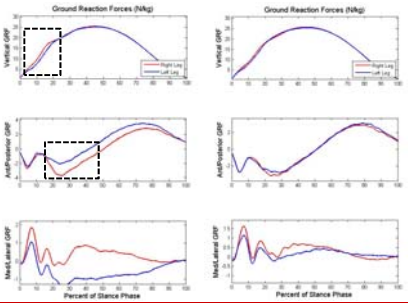
contraction on

GRFs


Without contraction | With contraction

Increased loading rate

Increased braking impulse



UW Neuromuscular Biomechanics Lab

Intervention and Follow-up

- Initial visit
  - Gait retraining to control pelvis with intermittent pelvic floor contraction
  - Supine ADIM
- 4wk F/U
  - No pain over past 2 wks
  - Feels "remarkably better"
  - Maintained running form modifications
  - Fair ADIM
- USI exam
  - showed over-contraction of internal and external obliques
  - reduced recruitment of right TrA
  - unable to maintain TrA contraction with a leg lift but able to hold TrA with a hooklying marching movement

UW Neuromuscular Biomechanics Lab

Outcome

- Finished the ½ marathon without pain
  - Ran 12K trail race week prior
  - Ran 16K trail race week after

UW Neuromuscular Biomechanics Lab

Summary

- Video examination provides useful insights
  - experience with running mechanics
  - know the limitations of the analysis
- Treatment strategy should be based on physical examination and video findings
- Altering running form can facilitate changes to joint/tissue loading

UW Neuromuscular Biomechanics Lab

Acknowledgements

- **Graduate Students / Fellows / Residents**

  Current
  - Liz Chumanov, PhD, DPT
  - Christa Wille, BS
  - Amanda Gallow, DPT
  - Evan Nelson, DPT

  Alumni
  - Max Michalski, MD, MS
  - Michael Ryan, PhD
  - Kristin Ebert, MD
  - Erin AuferHeide, MD
  - Katie Steingraber, DPT

- **Collaborators**
  - Amy Schubert, DPT
  - Jen Kempf, MPT

- **Support**
  - NIH
  - UW Sports Medicine Classic

UW Neuromuscular Biomechanics Lab

Thank You

UW Neuromuscular Biomechanics Lab