The Runner with Leg Pain: What’s Wrong with My Gait?

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Disclosure

- Founder, RunSafe™, RaceSafe™
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Outline

1. Differential for Lower Extremity Running Injuries
2. Risk Factors
3. The BIG Three Gait Issues
   • Frontal plane, Valgus Collapse
   • Overstriding, Low Cadence
   • Footstrike Pros and Cons
How did I get into Running?

Boston Marathon, 1999
Running Epidemiology

- 17 studies varied from 19.4% to 79.3%

- Knee #1
- Foot and Ankle #2
Differential for Leg Pain

- Patellofemoral pain
- Medial Tibial Stress syndrome/fracture
- Tendinopathies (Achilles > Peroneal > posterior tibialis > Anterior tibialis)
- Exertional compartment syndrome
Patellofemoral Pain

- Excessive compressive forces over articulating surfaces of PFP joint

Symptoms
- Anterior knee pain
- Worse with bending (5x body wt), stairs (3x body wt)
- Crepitus under kneecap
- May sublux if loose
Too Loose?

Hyperlaxity

- Associated with subluxation of the patellae
- Medial facet more commonly affected
Too Tight?

- Lateral hyperpressure syndrome
- Tight hamstrings, ilotibial bands, high flexors and quadriceps
What about Patellar Tilt?

- No difference medial facets
- Mean $T_{1\rho}$ values of the whole patella of PF patients correlated to degree of patellar tilt ($r=0.74$)

Thullier et al, AAOS abstract, 2012

Figure 2.
Representative color contour maps of $T1\rho$ values in control (A) and PFP patients (B) show higher values in the PFP patients especially in the lateral facet. Color contour maps of $T2$ values in control (C) and PFP Patients (D) show little difference.
PFP Syndrome

- Tender over facets of patella
- Apprehension sign suggests possible instability

- X-rays may show lateral deviation or tilt
Q-angle
Arch type
Medial Tibial Stress Syndrome

- MTSS appears to be caused by alterations in tibial loading, as chronic, repetitive loads cause abnormal strain and bending of the tibia.
- Advanced imaging may show linear uptake on a bone scan or nonspecific edema of the periosteum on MRI.
How stress fractures occur?

- Failure of bone to adapt to stress
- Microinjury/microcracks in the bone

Stress Injury ↔ Stress Fracture
Bone remodeling

- Causes relative weakness
- Osteoclastic activity faster than osteoblasts
- Excess stress
When to return to sports

- N=53
- Length of recovery and MRI Grade 1-4 Pearson r= 0.627, p= 0.001)
- Grade 3 takes 12 weeks, Grade 4 takes 16 weeks
- Bone remodeling takes around 180 d

Arendt et al., AJSM 2003
Modify Risk Factors

Intrinsic Risk Factors
- Growth
- Anatomy
- Muscle/Tendon imbalance
- Illness
- Nutrition
- Conditioning
- Psychology

Extrinsic Risk Factors
- Training
- Technique
- Footwear
- Surface
What are the risk factors?

- Gait Mechanics
- Training
- Bone (Tissue) Health
- Impact

Risk Factors for PFP

- Muscle imbalances
  - Vastus medialis weakness
  - Hip abduction weakness
  - Hamstring tightness
- Cavus feet
- Foot pronation
- Increased Q angle

Risk Factors for PFP 2017

Systematic review 22 papers with risk factors identified:

- Female sex (odds ratio [OR], 2.35; CI, 1.58-3.50)
- Increased weight (standardized mean difference [SMD], 0.24; CI, 0.03-0.45)
- Higher Navicular drop (SMD, 0.44; CI, 0.21-0.67)
- Previous running injury (OR, 2.18; CI, 1.00-4.72)
- Greater hip external rotation with the hip in flexion (SMD, 0.44; CI, 0.23-0.65)
Medial Tibial Stress Syndrome

Intrinsic
- Women > Men (1.5-3.5 x higher)
- Excessive foot pronation
- Pes cavus
- Leg length discrepancies
- Higher BMI
- Decreased bone density, disordered eating
- Muscular imbalances
  - Tight triceps surae
  - Weak hip and core muscles

Extrinsic
- Increased activity, intensity, or duration
- Poor footwear
- Overtraining
- Increased mileage (>20 miles/week)

What are the risk factors?

Gait Mechanics  Training  Bone (Tissue) Health  Impact

BONE LOADING

Static Assessment vs Functional Assessment

- Need Dynamic Testing
- You need to watch people Move … and Run
Watch people Move … and Run

- Need Dynamic Testing

- Use Slow motion

- Static Assessment vs Functional Assessment

- Or Static Assessment AND Functional Assessment
#1 – Valgus Collapse
Look (Standing)

- Alignment
- Ankles together
- Ankles apart
- On toes
- Walk
- Red flag – can’t do it
- Hop test
Quick Clinical Runner’s Screen

- Alignment / Heel raise
- Hop test
- 1 legged squat (look for weak hip abductors) or Step Down
- Hip abductors and extensor strength
- VMO atrophy and activation
- Flexibility
- Ober’s, Thomas test, Popliteal angle, Ely’s test, Ankle dorsiflexion
Acute and chronic PFP Running Gait Mechanics

- Sub-groups exhibited greater knee flexion across stance and greater ankle dorsiflexion during early stance.
- The acute PFP sub-group demonstrated greater transverse plane hip motion across stance vs healthy controls.
- The chronic PFP sub-group demonstrated greater frontal plane hip motion, greater knee abduction, and reduced ankle eversion/greater ankle inversion across stance vs healthy controls.

Overstriding creates a high ankle dorsiflexion angle and less hip flexion creates, which creates a braking force and torque on the tibia.

Stress Fractures

• Stress fracture group showed greater peak hip adduction and greater peak rearfoot eversion angles vs. control group

  Milner et al, JOSPT, 2010

• Peak moments typically occurred around mid-stance, and were greater in magnitude at the distal, compared with proximal, lower leg

  Haris Phuang et al. Gait Posture. 2010
Stress Fractures

- Wider step widths were generally associated with reduced loading of the tibia and may benefit runners at risk of or experiencing stress injury at the tibia

- Tibial stresses at the distal 1/3 of the tibia differed with step width manipulation (p=0.002)

- As step width increased, compression on the surface of tibia significantly decreased

Meardon & Derrick, J Biomech, 2014
Cadence

- Suggest that runners may benefit from a stride frequency of approximately 85 strides min$^{-1}$ and by landing at the end of swing phase with a relatively vertical tibia.
  
Is it the Shoes?
Shoes or No shoes?

- Heel strike causes a force impact with a saw-toothed force profile and a high rate of loading, 400-500 bw/sec.

- Forefoot striking reduces the peak impact force.

Heel Strike Shod Runner
Forefoot Strike Minimal Shoes
Heel Striker Barefoot
Is it the Shoes?

- Dowling et al. 2016 showed very limited evidence that dynamic foot function during walking and running is a risk factor for patellofemoral pain, Achilles tendinopathy, and non-specific lower limb overuse injuries.

- NO
Tips for Treating Runners

- Think dynamic function rather than passive structure only
- Screen for muscle imbalances and flexibility issues including one leg squat adaptations
- Rehab for many running problems are similar as they often involve poor lower extremity mechanics
- Stability at the hip can affect rotational and frontal plane issues affecting the lower leg
- Gait retraining can **reduce loads** leading to injury
- Convince = Trust
Thank You