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Running Injury Mechanics

1. Patellofemoral Pain Syndrome

Incidence
Most common injury in runners  
2X more common in females  
25% of all knee related issues  
Suggested it may be on a continuum of PFJ OA

Presentation
Retro and peripatellar pain associated with knee flexion on a loaded knee  
Squatting  
Running  
Stairs

Excessive Pronation

Effect of Pronation on the PFJ: A Theoretical Model

Apparent Paradox
↑Eversion = ↑Tibial IR  
↓Q Angle

Doesn’t explain association of pronation and PFJ Pain

……but if:

Prolonged EV → Prolonged TIR

As the Knee extends, it needs TER

Potential Solution

Femur IR → ↑TFJ ER → ↑Q Angle

Timing Issue?
Gender Differences in Movement

<table>
<thead>
<tr>
<th>Single Leg Squat</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>![Male Bar Chart]</td>
<td>![Female Bar Chart]</td>
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Hewett, 2002

Gender Differences - Running

<table>
<thead>
<tr>
<th>Movement</th>
<th>Control</th>
<th>PFPS</th>
</tr>
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<tbody>
<tr>
<td>Hip ADD</td>
<td>![Hip ADD Bar Chart]</td>
<td>![Hip ADD Bar Chart]</td>
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<tr>
<td>Hip IR</td>
<td>![Hip IR Bar Chart]</td>
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<tr>
<td>Knee ADD (val)</td>
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<tr>
<td>Knee ER</td>
<td>![Knee ER Bar Chart]</td>
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<tr>
<td>Foot EV</td>
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<tr>
<td>Foot INV</td>
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Mechanics of PFPS (females)

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Wilson et al, 2008

Mechanics of PFPS (females)

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<tr>
<td>Knee IR angle (deg)</td>
<td>![Knee IR Angle Chart]</td>
<td>![Knee IR Angle Chart]</td>
</tr>
<tr>
<td>Pelvic drop angle (deg)</td>
<td>![Pelvic Drop Angle Chart]</td>
<td>![Pelvic Drop Angle Chart]</td>
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</tbody>
</table>

Willy et al, 2012

Prior studies have been cross-sectional or retrospective

A word about males (who also get PFP)

![Male Comparison Chart]

Healthy male | Male with PFPS Inc. CPD, KADD | Female with PFPS Inc. CPD, HADD

Willy et al, 2012
But not purely a sex difference

HADD
KADD

3/18 M-PFP similar to F-PFP
4/18 F-PFP similar to M-PFP

Willy et al, 2012

15-20% demonstrate the opposite sex mechanics

Effect of Tibiofemoral Angle on PFJ

Huberti and Hayes, 1984, Lee et al., 2003,
Besier et al., 2008

PFPS = Associated with High Impacts!

Bowser and Davis, 2010

2. Iliotibial Band Syndrome

Incidence
2nd Most common injury in runners
Most common injury of the lateral knee
2X more common in females

Presentation
Pain at distal lateral knee
Often comes on with downhill running

Iliotibial Band Syndrome

ITB moves posteriorly
Creates friction
No diff in Knee Flex (Orchard 1996)

Iliotibial Band Syndrome

Running downhill
Iliotibial Band Syndrome

Retrospective

Prospective

Knee IR

3. Hamstring Strain

Definition
Strain of the Hamstring Muscle
Mid-substance
Insertional

Incidence
8-25% in general sporting population

3.1 Hamstring Strain

Overstriding

Pelvic Instability

4. Stress Fractures

Definition
A crack in the bone from repeated mechanical stress
Bone resorption > Bone deposition

Incidence
5-30% of athletes and military recruits
Females more likely
Tibia most common site
Stress Fractures

Clinical Presentation
Focal Pain with loading

Differential DX
Stress Fracture
Fracture
Nerve Entrapment
Tumor

Tibial
Structural
Low area moments of inertia
Long thin bones: lower resistance to bending

Stress Fractures

Tibial
Biomechanical
Increased Hip ADD
RF EV
Free Moment

Stress Fractures

Femoral
Biomechanical
Excessive stride length

Stress Fractures

Metatarsal
Biomechanical

Stress Fractures

Structural
High Arch
Low Arch
High Arch/Inversion
Forefoot Strike

High Arch/Eversion
Low Arch
Long thin bones
Weak feet
5. Compartment Syndrome

**Definition**
Elevated pressures in one of the lower leg compartments due to increased blood flow and/or hypertrophy

- Anterior
- Lateral
- Superficial Posterior
- Deep Posterior

**Incidence**
14% of those with unknown lower leg pain

Quarfordt et al. 1983

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**Clinical Presentation**
- Aching, cramping, burning
- Tightness – rock hard
- Numbness
- Foot drop

**Differential DX**
- Stress Fracture
- Nerve Entrapment
- Tumor

**Structural Causes**
- Tight fascia
- Muscle Hypertrophy

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**Compartment Syndrome**

**Overtraining**

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**Forefoot Running Improves Pain and Disability Associated With Chronic Exertional Compartment Syndrome**

- Methods: A randomized controlled trial in 21 patients with chronic exertional compartment syndrome
- Results: Significant improvements in pain and disability
- Conclusion: Forefoot running is an effective intervention for chronic exertional compartment syndrome
7. Posterior Tibialis Tendinitis

**Definition**
Inflammation of the Posterior Tibialis tendon
Stage 1 PTTD?

**Incidence**
More common in Females
More common in flat feet

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**Posterior Tibialis Tendinitis**

**Clinical Presentation**
Pain behind medial malleolus
Pain in medial arch
Worsens with activity

**Differential DX**
Flex Dig Longus
Flex Hall Longus
Spring lig sprain

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**Posterior Tibialis Tendinitis**

**Structural**

**Pes planus**
(limited DF)

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**Posterior Tibialis Tendinitis**

**Excessive EV (RF or MF)**
Cross-over Gait
Toe-out

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8. Achilles Tendinitis

**Definition**
Inflammation of the Achilles tendon
Midsubstance
Insertional
Presents as a pain and stiffness in tendon

**Incidence**
24% Lifetime incidence
40-50% Lifetime incidence in runners

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**Achilles Tendinitis**

**Forefoot Striker**
High Arch
Low Arch
Excessive Eversion
9. Plantar Fasciitis

**Definition**
Inflammation of the plantar fascia – a ligament on the plantar surface of the foot

**Incidence**
10% of population will experience
Most common cause of heel pain
Females 2X more likely

**Clinical Presentation**
Heel pain on first morning step
Can extend the length of the PF
Loosens up when you run
Then begins to get sore at end of run or after

**Differential DX**
Fat Pad Atrophy
Tarsal Tunnel Syndrome
Calcaneal Stress Frx
Flex Dig Brev tendinitis

**Repetitive Traction Injury**

**Structure**
Limited DF
Weak Calf
High Arch
Low Arch

**Mechanics**
Excessive Rearfoot Pronation
Excessive Midfoot Pronation

Other factors: Age, BMI, Activity level
**Plantar Fasciitis**

Plantar Fasciitis group had greater vertical ground reaction force load rates than age and mileage matched controls.  

*Pohl et al. 2009*

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**10. FAI/Labral Tear**

- Females = Pincer  
- Males = Cam  

*HADD and HIR*

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**Low Back Pain**

- Prenation  
- Supination  
- Cross-over  
- Anything that causes gait asymmetry  
- High impact loading