Orthopedic Concerns in Runners

Jennifer Volberding PhD, LAT, ATC
Associate Professor
Athletic Training Program Director
Oklahoma State University Center for Health Sciences
Disclosure

I have no relevant financial relationships or affiliations with commercial interests to disclose.
Learning Objectives

- Discuss differences in walking and running gait
- Identify the most common injuries in runners
- Discuss rehabilitation recommendations for these injuries
- Identify training recommendations for runners
- Discuss barefoot running
Gait Review

The Gait Cycle

Stance Phase - 60%

Swing Phase - 40%

Heel Strike  Foot Flat  Mid-stance  Push-off  Acceleration  Mid-Swing  Deceleration
Gait Terminology

- Cadence — number of steps taken per unit time (i.e., steps per minute)
- Adults average = 107 +/- 2.7 steps per minute
- Velocity — distance covered per unit time (i.e., m/sec)
- Gait velocity — meters per second
- Gait cadence — steps per minute
Gait Terminology

- Stride time — time required to complete a single stride
- Stride length — linear distance covered in one stride
Gait Terminology

Ground reaction force (GRF)
Contact of the foot with the ground creates force yielding vertical, anteroposterior (A/P), and mediolateral (M/L) components

Center of pressure (CoP)
Shows the path of the pressure point under the foot during gait
Walking Gait Phases

- Efficient gait
- Minimal side-to-side motion
- Maximal forward motion
- Body rises and falls approx. 5 cm
- Center of gravity
- Path is a sinusoidal curve
8 Phases of Gait

- Weight Acceptance
  - Initial Contact
  - Loading Response
- Single Limb Support
  - Mid Stance
  - Terminal Stance
- Limb Advancement
  - Pre-Swing
  - Initial Swing
  - Mid Swing
  - Terminal Swing
Running Gait Cycle

Differences from walking gait

- Flight phase — neither foot is in contact with a supportive surface
- No period of double limb support
- Vertical GRF
  - $2.0 - 6.0 \times$ the body weight
- Stance phase time

As speed increases there are changes in
- Arm swing
- Stride length
- Cadence
- Knee flexion ROM
- Muscular force
- Speed of contraction
- Less up and down motion
What Leads to Running Injuries?
Injury Rates

- 27-70% of recreation and competitive distances runners experience at least 1 injury per calendar year\(^1,4,6,7\)
  - Knee most common 42%
    - Patellofemoral
  - Foot, ankle, low leg 40%
Predictors

- Previous history$^{4,9,10,15,17}$
- Lack of experience$^{4,18}$
  - Too much too soon$^{1}$
- Distance$^{1,4,9,10,15,17}$
  - More than 40 miles per week$^{10}$
- Intensity$^{1,4}$
- Frequency$^{17}$
- Shoes/speed/surface$^{8,10}$
- Gender
  - Men: BMI$^{4}$
  - Women: Hip IROT, Navicular Drop, Q angle$^{4,5,17}$
Anatomical and Biomechanical Causes

- Foot Posture\textsuperscript{6,10}
- Hip Strength\textsuperscript{6,8,9}
- Q Angle\textsuperscript{5,6,9}
- Hip IROT\textsuperscript{5,6,9}
- Genu Valgum\textsuperscript{5,6,9}
- Leg Length\textsuperscript{8,10}
- Kinematics\textsuperscript{8}
Influence of Foot Structure on Pathology

- Pes planus
  - “Flat feet”
  - Talus tilts medially
  - Navicular displaces inferiorly
Influence of Foot structure on pathology

- Pes cavus
  - High medial longitudinal arch
  - Decreased ground contact area
  - Calluses formation over the PIP joints
  - Soft orthotics
Common Training Errors

- 60% of injuries due to training errors\textsuperscript{1,10}
- 60% related to distance and intensity\textsuperscript{2,15}
  - More than 2 long runs per week\textsuperscript{9}
- Surface\textsuperscript{2}
Common Injuries and Rehabilitation Interventions
Most Common Injuries\textsuperscript{1,5,6,7,8,10}

- Patellofemoral Pain Syndrome
- Stress Fractures
- Medial Tibial Stress Syndrome
- Patella Tendonitis
- Plantar Fasciitis
- Achilles Tendonitis
- IT Band Syndrome
Plantar Fasciitis

- Inflammatory or degenerative
  - Fasciosis: the noninflammatory degeneration of fascia
  - Many causes
  - Signs and symptoms
    - Pain on medial calcaneal tubercle
    - Pain when stepping out of bed in the morning
    - Pain in heel after activity

- Plantar fascia rupture
  - MOI: forced ankle DF and toe extension
  - Signs and symptoms
    - Difficulty WB
    - “Tearing” sensation
    - Swelling around medial calcaneal tubercle
    - Acute hammer toe
Plantar Fasciitis Rehabilitation Suggestions

- Evaluate shoes
- Consider orthotics
- Roll on ball or frozen water ball
- Calf stretching (knee straight and flexed)
- Toes crunches
Stress Fracture

Evaluation
- Accumulation of microtraumatic forces
- Pain increases with activity and decreases with rest
- Pain at night
- Can occur at the tibia, fibula and talus
- Special Tests:
  - Bone scan

Rehabilitation
- REST
- Cross Train
- Consider underlying physiological factors
  - Menstrual status
  - Dietary status
Achilles Tendon Strain or Rupture

- MOI
  - DF and eccentric contraction
  - PF and concentric contraction

- Signs and Symptoms
  - Dependent upon severity
  - 3rd degree loud pop and deformity

- Special Tests
  - Thompson test
  - Inability to perform calf raise
Rehabilitation of Achilles Pathologies

- STRETCHING!!!
- Look at the heel counter of shoe for rubbing
- Cross friction massage
- Strengthen calf
Compartment Syndrome

**Evaluation**
- Acute or chronic
  - Chronic call occur in all 4 compartments
  - Anterior and lateral typically occur together
- MOI:
  - Excessive exercise performed
  - Signs and Symptoms
  - Extreme pain
  - Muscle is hard like bone
  - Pain and pressure felt during exercise
  - Glossy skin
- Special Test
  - Pressure gauge

**Intervention**
- Surgical fasciotomy
- Orthotics
Medial Tibial Stress Syndrome

Evaluation
- Periostitis at the posterior border of the tibia
- Caused by:
  - Repetitive use
  - Training errors
    - Increasing load too quickly
    - Muscle fatigue
  - Incorrect shoes
  - Biomechanical abnormalities

Intervention
- Shoes/orthotics
- Soft tissue along medial tibial border and posterior tibialis origin
- Strengthening
Contributors to Patellofemoral pain

- Contralateral hip drop
- IROT of femur
- Valgus knee
- IROT of tibia
- Foot pronation
<table>
<thead>
<tr>
<th>Alignment</th>
<th>Resulting Forces and Biomechanical Changes</th>
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</thead>
<tbody>
<tr>
<td>Genu varum</td>
<td>Increased compressive forces on the medial tibiofemoral articulating surfaces</td>
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<tr>
<td></td>
<td>Tensile forces on the lateral tibiofemoral soft tissue structures and LCL</td>
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<tr>
<td></td>
<td>Quadriceps exerting medially directed forces on the patella</td>
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<td></td>
<td>Compressive forces on the lateral facet</td>
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<td>Stretching of the medial patellar restraints</td>
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<td>Increased Q angle</td>
<td>Lateral tracking of the patella</td>
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<td>or lax medial</td>
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<tr>
<td>Decreased Q angle</td>
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<td>restraints</td>
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</tr>
<tr>
<td>Genu recurvatum</td>
<td>Decreased compressive forces in terminal knee extension</td>
</tr>
</tbody>
</table>
Patellofemoral Pain Syndrome

- MOI
  - Gradual onset due to change in surface, activity level, or intensity.
  - Change in footwear
- Signs and Symptoms
  - Increased Q angle, patella alta, baja
  - Think hip and foot predispositions
  - Pain at medial knee and facets
- Special Tests:
  - Ober’s
  - Navicular drop
Interventions for PFPS

- Strengthen VMO
- Eccentric training
- Stretching
- Bolstered knee brace
- Shoes/orthotics
Patellar Tendinopathies

- **MOI**
  - Repeated knee extension
  - Increase in activity
  - Jumping

- **Signs and Symptoms**
  - Crepitus
  - Inflammation on either end of patella tendon
  - Swelling
  - Thickening of the tendon

- **Rehabilitation**
  - Cho Pat/Patella Tendon Strap
  - Eccentric strengthening
IT Band Friction Syndrome

- Friction between the IT band and lateral femoral epicondyle
- Repeated knee flexion sports
- Management
  - Correct biomechanical issues
  - Decrease inflammation
  - Proprioceptive exercises
  - Strengthening exercises

- MOI:
  - Repeated knee flexion and extension

- Signs and Symptoms:
  - Pain over lateral femoral condyle
  - Pain increased with running downhill
  - Genu varum
  - Excessive pronation
  - Leg-length discrepancy

- Special Tests:
  - Ober’s
  - Noble’s
Rehabilitation of IT Band Syndrome

- Stretching
- Foam Roller
- ID biomechanical issues
- Cross training
Training Recommendations
Shoes

- Critical to reduce injuries\textsuperscript{1,10}
- Replace every 300-430 miles\textsuperscript{2}
- Neutral to stability for hyper pronators\textsuperscript{11}
Orthotics

- 70% of patients respond positively to orthotics\(^2\)
- Prevent stress fractures\(^{10}\)
- Breaking in process is ESSENTIAL
Distance/Intensity

- Less than 40 miles per week\textsuperscript{10,12}
- Novice should run no more than 45 minutes per outing\textsuperscript{12}
- 8 week training protocol has been demonstrated to be most effective\textsuperscript{12}
Frequency

- 2-5 runs per week\textsuperscript{12}
- 24-48 hours of rest between runs\textsuperscript{2}
- Increasing step rate can decrease patellofemoral forces by 14\%\textsuperscript{14}
Surface

- Key is cross training between surfaces
- Running Routine
- Those with PFPS and MTSS should avoid hard surfaces
- Those with PFPS and ITBS should avoid hills
Cross Training

- Strengthening$^{2,10}$
  - Eccentric quadriceps
  - Hip abduction (gluteus medius)
- Plyometrics increase performance$^{16}$
How Does a Novice Runner Begin??

- Use the 10% Rule\textsuperscript{3,12}
  - Initial goal should be run 30 minutes
  - Then to run 2 miles non-stop regardless of time
  - Most novice running programs run 5-8 weeks
    - No noted differences between 8 and 13 week programs\textsuperscript{12}
- Start no more than 3 times per week running/walking
- Stretch afterwards
- Cross Train
- REST!
Novice Walk-Run Program

Table 1. Sample walk-run program: The walk-run program is started after a patient has demonstrated the ability to walk 30 minutes consecutively without injury 3 times weekly on alternate days. The goal is to run pain-free for 30 minutes 3 times weekly. It involves a total activity period of 30 minutes structured into six sets of 5 minutes on alternate days. In each set, there is a combination of running and walking where the run component is increased after each session by 30 seconds.

<table>
<thead>
<tr>
<th>WEEK</th>
<th>MONDAY</th>
<th>WEDNESDAY</th>
<th>FRIDAY</th>
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<tbody>
<tr>
<td>1</td>
<td>10-min walk</td>
<td>20-min walk</td>
<td>30-min walk</td>
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<tr>
<td>2</td>
<td>6x (4.5-min walk + 0.5-min run)</td>
<td>6x (4-min walk + 1-min run)</td>
<td>6x (3.5-min walk + 1.5-min run)</td>
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<tr>
<td>3</td>
<td>6x (3-min walk + 2-min run)</td>
<td>6x (2.5-min walk + 2.5-min run)</td>
<td>6x (2-min walk + 3-min run)</td>
</tr>
<tr>
<td>4</td>
<td>6x (1.5-min walk + 3.5-min run)</td>
<td>6x (1-min walk + 4-min run)</td>
<td>6x (0.5-min walk + 4.5-min run)</td>
</tr>
<tr>
<td>5</td>
<td>30-min run</td>
<td>30-min run</td>
<td>30-min run</td>
</tr>
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What about Barefoot Running???
Barefoot Running

- High tech running shoes didn’t appear until 1970
- Shod = heavy heel strike
- Barefoot = midfoot or forefoot strike
Barefoot Running

- Shorten Stride$^{10}$
  - Decreases risk of stress fractures
- Increase step count
  - 600 strikes/KM$^{13}$

*Figure showing proper barefoot running form.*
References

References