Iliotibial Band Strain and Force in Female Runners With and Without Retrospective Iliotibial Band Syndrome

Aspiring Kid, PhD
FUNCTION OF ILIOTIBIAL BAND

• Proximally: lateral hip stabilizer
  • Helps prevent hip adduction
• Distally: Slides over the lateral femoral epicondyle and attaches to proximal tibia
ILIOTIBIAL BAND SYNDROME (ITBS)

- Not really a friction syndrome
- Slight medial–lateral motion i.e. hip adduction compresses highly vascularized and innervated layer of fat between IT-band and condyle
IMPORTANT TO INVESTIGATE ITBS?

- 42% of overuse running injuries afflict the knee (Tauton et al., 2002)
- ITBS is second most common overuse injury
  - 20% knee injuries are due to ITBS
  - Female runners twice as likely to sustain injury than males
BIOMECHANICAL RISK FACTORS

• Increased hip adduction and knee internal rotation (Noehren et al., 2007; Ferber et al., 2010)

• Increased IT-band strain magnitude and increased strain rate (Hamill et al., 2008)
SPECIFIC AIMS AND HYPOTHESES

• Determine differences in IT-band: strain, strain rate, and force during the stance phase of female runners with and without a history of ITBS

• Hypotheses: IT-band: strain, strain rate, and force would be greater in female runners with a history of ITBS compared to controls
EXPERIMENTAL DESIGN

Collect Experimental Data
- Overground running data of female runners with and without retrospective ITBS

In Visual3D
- Process experimental data
- Export one motion trial for each participant to OpenSim

Scale V3D model to OpenSim gait model
- Add IT-band to gait model
- Wrap sphere at femoral epicondyle

Computations
- IT-band force length curve
- Reduce residuals to get q’s
- Compare RRA versus experimental q’s
- Run muscle analysis to get IT-band length

Future Research
- Determine how to alter gait to improve IT-band parameters
- Optimization?
EXPERIMENTAL DATA COLLECTION

- Female participants
  - ITBS: 21.0(1.9) years, 1.61(0.02) m, 59.3(4.0) kg, 23.8(9.4) mi·wk⁻¹
  - Controls: 24.0(5.2) years, 1.69(0.04) m, 56.2(2.93) kg, 23.6(10.9) mi·wk⁻¹
- Data Collection
  - Bilateral lower extremity and trunk marker data collected
  - 9 camera motion capture system sampling at frequency of 120 Hz synchronized with two force plates sampling at 1200 Hz
  - 5 overground running trials at velocity of 3.5 m·s⁻¹
MODELING IT-BAND

- Stiffness IT-band patellar band 97 N/mm (Merican et al., 2009)
- WrapSphere at height of lateral femoral epicondyle
- Natural Cubic Spline to fit points of passive F-l curve for an IT-band length of 0.525 m
  - \( <x> 0.0 \ 1.0 \ 1.0019 \ 1.0038 <x> \)
  - \( <y> 0.0 \ 0.0 \ 1.0 \ 2.0 \ <y> \)

Dimensionless model

\[
\frac{0.001}{l^l} + 1
\]

\[
l_s^l = 1
\]
DETERMINING IT-BAND FORCE

- From literature, stiffness value of 97 N/mm for IT-band patellar band (Merican et al., 2009)
- \((\text{IT-band length during stance} - \text{IT-band length in anatomical position}) \times 1000 \text{mm} = \Delta \text{IT-band length}\)
- \(\Delta \text{IT-band length mm} \times 97 \text{ N/mm} = \text{Force in IT-band}\)
IT-BAND MODEL
DETERMINE ILIOTIBIAL BAND RESTING LENGTH

Tensor Fasciae Latae Length

Muscle-Tendon Length (m)

Sagittal Plane Knee and Hip Angles
VALIDATION OF RRA KINEMATICS
VALIDATION OF RRA KINEMATICS

Experimental Kinematics vs. Kinematics Computed by RRA

Graph showing the comparison between experimental kinematics (red line) and kinematics computed by RRA (blue line). The x-axis represents time (s), ranging from 0.0 to 0.7, and the y-axis represents hip adduction angle (deg), ranging from -12.5 to 15.0.
## RESULTS

Table 1 Means(sd) of dependent variables from current investigation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>ITBS</th>
<th>Control</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strain (%) at peak knee flexion</td>
<td>2.08(4.26)</td>
<td>-0.56(1.70)</td>
<td>0.78</td>
</tr>
<tr>
<td>Strain rate (%/s)</td>
<td>43.51(10.12)</td>
<td>34.94(3.94)</td>
<td>1.00</td>
</tr>
<tr>
<td>IT-band Force</td>
<td>1087.31(2187.31)</td>
<td>-303.69(881.81)</td>
<td>0.91</td>
</tr>
<tr>
<td>Peak knee flexion (°)</td>
<td>46.83(6.09)</td>
<td>49.93(4.52)</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Table 2 Means(sd) of dependent variables from Hamill et al., 2008

<table>
<thead>
<tr>
<th>Parameters</th>
<th>ITBS</th>
<th>Control</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strain (%) at max knee flexion</td>
<td>-9.0(3.4)</td>
<td>7.3(3.4)</td>
<td>0.5</td>
</tr>
<tr>
<td>Strain rate (%/s)</td>
<td>25.1(6.3)</td>
<td>12.4(6.9)</td>
<td>1.92</td>
</tr>
</tbody>
</table>
IT-BAND STRAIN (%)
WHY DIFFERENCES IN STRAIN?
DISCUSSION

• Conclusions are consistent with previous prospective investigation (Hamill et al., 2008) and cross-sectional investigations (Miller et al., 2007)
  • However, the peak values are different
• What this study adds to the literature
  • IT-band force is greater at peak stance knee flexion angle in female runners with retrospective ITBS compared to controls
DISCUSS THE FUTURE

- Where do we go from here?
- Make sure resting length of IT-band is correct
- Running injuries are multi-factorial in nature
  - Joint kinematics and IT-band strain and force appear to be biomechanical factors involved in the development of ITBS
    - Some injured runners exhibit similar IT-band strain (%) as controls
    - Other factors still need to be considered
- From a biomechanical perspective, perhaps forward dynamics optimization approach to determine how we can alter kinematics to minimize IT-band strain rate
  - Use information to inform applied biomechanists and clinicians how to best design a gait retraining intervention
REFERENCES


