AN KNEE JOINT KINETICS IN RUNNERS WITH AND WITHOUT LOWER EXTREMITY OVERUSE INJURIES

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INTRODUCTION

Running injuries occur at an alarming rate. According to epidemiological studies (e.g. Macera et al., 1989), anywhere from 27% to 70% of distance runners are injured during any one year period. The most common site of overuse running injuries is the knee (Taunton et al., 2002). Although the exact causes of overuse running injuries have yet to be determined, it could be stated with certainty that the etiology of these injuries is multifactorial and diverse (Rolf, 1995; van Mechelen, 1995). Some researchers (e.g. James, 1998) have concluded that there are no specific risk factors that correlate with specific types of injury in a reliable fashion. There are, however, several risk factors which may be associated with a variety of running injuries. These factors could be placed into three general categories: training, anatomical, and biomechanical factors. Biomechanical variables include impact forces, impact loading rates, and peak tibial acceleration (Ferber et al., 2002; Hreljac et al., 2000). Joint kinetics may be more indicative of stress levels to injured structures. One study (Stefanyshyn et al., 1999) found that increased knee joint forces and moments are a factor in developing patellofemoral pain syndrome in runners. The purpose of this investigation was to evaluate the lower extremity overuse injury potential of runners by identifying joint kinetic variables which may predispose a runner to overuse injuries.

METHODS

A group of five injury free (IF) runners, who had never sustained an overuse running injury (> 3 years experience) were matched in training and anatomical variables with a group of five injured (I) runners who had suffered at least one overuse running injury of the knee. All runners were heel strikers and were pain free at the time of the study. Subjects performed three successful trials of running down a 20 meter runway, and over a floor mounted force platform at a speed of 3.5 m·s⁻¹ while being filmed by a single digital video camera (240 Hz) in the sagittal plane. The 2D kinematic data of five reflective markers (right greater trochanter, knee joint center, lateral malleolus, calcaneus, and head of the fifth metatarsal) were synchronized with ground reaction force data (960 Hz). A trial was successful if the speed was within ± 3% of 3.5 m·s⁻¹, the landing foot completely contacted the force platform, and if the stride length did not visibly change. After smoothing, ankle and knee joint reaction forces and moments were determined using a standard inverse dynamics approach. All variables were normalized by dividing by body mass. Dependent variables (DVs) analyzed included maximum knee extensor moment, maximum ankle plantar flexor moment, and maximum knee and ankle power absorption and generation. All DVs were compared between groups using a MANOVA (α = 0.05).
RESULTS AND DISCUSSION

The I group had significantly greater maximum knee extensor moments and knee power absorption than the IF group, while the IF group had significantly greater maximum ankle plantar flexor moments and ankle power absorption than the I group (Table 1). In addition, there was a trend toward greater knee power generation by the I group. Differences between groups occurred most notably during the first half of stance, when the lower extremity joints are acting as shock absorbers. The ratio of knee/ankle joint energy absorption was approximately 3.5 for the I runners, and about 1.3 for the IF runners. More compliant joints have been found to be superior at absorbing energy (Hamill et al., 2000), suggesting that the IF runners had a more compliant ankle joints than the I runners. Since the ankle is more compliant when pronating, it is likely that runners who pronate to a greater extent, provided that it is within physiological limitations, may be at a reduced risk of injury, as suggested in a previous study (Hreljac et al., 2000).

Table 1: Value of all DVs (mean ± 1 SD) for injured (I) and injury free (IF) groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>I Group</th>
<th>IF Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee-ExM (N·m·kg⁻¹)</td>
<td>3.18 ± 0.49*</td>
<td>2.23 ± 0.60</td>
</tr>
<tr>
<td>Ankle-PFM (N·m·kg⁻¹)</td>
<td>2.11 ± 0.76</td>
<td>3.10 ± 0.54*</td>
</tr>
<tr>
<td>P-Abs-Knee (W·kg⁻¹)</td>
<td>16.73 ± 3.08*</td>
<td>11.82 ± 3.53</td>
</tr>
<tr>
<td>P-Abs-Ankle (W·kg⁻¹)</td>
<td>4.84 ± 2.45</td>
<td>9.03 ± 2.24*</td>
</tr>
<tr>
<td>P-Gen-Knee (W·kg⁻¹)</td>
<td>9.63 ± 2.56</td>
<td>6.41 ± 2.46</td>
</tr>
<tr>
<td>P-Gen-Ankle (W·kg⁻¹)</td>
<td>12.52 ± 3.78</td>
<td>15.96 ± 2.86</td>
</tr>
</tbody>
</table>

*Value of variable is significantly greater for this group.

SUMMARY

The results of this study demonstrate that runners who had previously sustained overuse injuries rely more heavily on muscles of the knee than of the ankle for energy absorption, while runners who had never sustained an overuse injury utilize the plantar flexors and other muscles of the ankle to a greater extent for energy absorption. This suggests that an excessive reliance upon the knee joint musculature to absorb the energy from impact is a risk factor for overuse running injuries of the knee. More specifically, a high knee/ankle joint ratio of power absorption during running may be indicative of a runner with an increased risk of sustaining an overuse injury of the knee.

REFERENCES