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Consolidation of the atypical rearfoot strike pattern in distance runners and linkage to tibial shocks

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Keywords: running; foot strike pattern; Athletic footwear; external load; tibial shock

Introduction

Shod rearfoot striking can be subdivided into typical and atypical using plantar pressures (Breine, Malcolm, Frederick, & De Clercq, 2014). The atypical pattern makes an initial rearfoot contact, followed by a fast center of pressure displacement along the lateral shoe margin, and was present in 24% of runners wearing customized shoes at 3.2 m/s (Breine et al., 2014). To exclude a potential shoe-induced effect, the runners should be evaluated in their own footwear.

Atypical rearfoot strikers experienced a greater instantaneous loading rate of the vertical ground reaction force than typical rearfoot strikers (Breine et al., 2014). This loading measure has been associated with severe running-related injuries such as a tibial stress fracture (van der Worp, Vrielink, & Bredeweg, 2016). Since loading rate correlates to tibial shocks (Van den Berghe, Six, Gerlo, Leman, & De Clercq, 2019), atypical rearfoot strikers may also experience greater tibial shocks.

Purpose of the study

This study examined up to what extent the atypical rearfoot strike pattern occurs when running over-ground in own athletic footwear and if atypical rearfoot strikers experience greater impact-like loading.

Methods

One hundred and four distance runners (1.73 ± 0.08 m, 68.8 ± 11.7 kg, 36.5 ± 9.5 years) were bilaterally instrumented with lightweight accelerometers strapped to pre-stretched skin on the lower leg and connected to a backpack system (Van den Berghe et al., 2019). Subjects ran at ~3.2 m/s across a 30 m runway with a 2 m sensitive pressure plate (Footscan, RSscan International; 500 Hz) mounted on a force platform (2.1×0.5 m, AMTI; 1000 Hz) to collect dynamically calibrated plantar pressures.

We retained five footfalls fully contacting the force platform. Tibial accelerations and forces were processed as in Van den Berghe et al. (2019). The strike pattern of a right and a left footfall was identified using Breine et al.’s (2014) refined strike index method. 78% of the runners were bilateral rearfoot, 5% bilateral non-rearfoot, and 17% asymmetrical strikers. Atypical rearfoot strikers had at least one atypical rearfoot contact (strike index ≤0.333, initial metatarsal contact ≤8% of contact time). In case of bilaterally similar rearfoot strikes, the side with the greatest resultant tibial shock was chosen for comparison. In subjects with only one (a)typical rearfoot strike, the corresponding values were used.

Between-group differences in demographics, impact, and spatio-temporal characteristics were evaluated by independent \(t\)-tests in SPSS v25 (\(\alpha = 0.05\)).

Results

Atypical rearfoot strikes were prevalent in 26% of the runners and had greater axial (\(\Delta \ddot{X} = 1 \text{ g}\)) and resultant (\(\Delta \ddot{X} = 5.6 \text{ g}\)) tibial shocks, and loading rate (\(\Delta \ddot{X} = 14.3 \text{ BW/s}\)) (Table 1).

Discussion and conclusion

The atypical rearfoot strike is a distinct strike pattern that frequently occurs in distance runners wearing habitual athletic footwear, confirming the findings of Breine et al. (2014). Given the substantial differences in impact...
Foot strike angle calculation during running based on in-shoe pressure measurements

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Keywords: modeling; forefoot strike; heel strike; mid-foot strike; running

Introduction

The foot strike angle (FSA) is a common biomechanical parameter in the analysis of human running. It can be used for shoe recommendation purposes by classifying runners into foot strike patterns (Zrenner et al., 2018) or for fatigue detection during running (Strohrmann, Harms, Tröster, Hensler, & Müller, 2011). The FSA can accurately be determined in a laboratory setting using motion capture systems. However, those systems do not allow for continuous FSA measurement during natural running.

Table 1. Demographics, impact, and spatio-temporal characteristics for the groups of rearfoot strikers.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Typical rearfoot (n = 72)</th>
<th>Atypical rearfoot (n = 27)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>35.4 ± 10.3</td>
<td>36.7 ± 7.7</td>
<td>0.537</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.72 ± 0.09</td>
<td>1.75 ± 0.07</td>
<td>0.252</td>
</tr>
<tr>
<td>Mass (kg)</td>
<td>68.2 ± 12.6</td>
<td>70.7 ± 9.2</td>
<td>0.357</td>
</tr>
<tr>
<td>Resultant tibial shock (g)</td>
<td>11.7 ± 3.39</td>
<td>17.3 ± 4.6</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Axial tibial shock (g)</td>
<td>8.1 ± 2.5</td>
<td>9.1 ± 3.1</td>
<td>0.040*</td>
</tr>
<tr>
<td>Vertical loading rate (BW/s)</td>
<td>95.9 ± 22.2</td>
<td>110.2 ± 29.2</td>
<td>0.027*</td>
</tr>
<tr>
<td>Speed (m/s)</td>
<td>3.21 ± 0.07</td>
<td>3.22 ± 0.06</td>
<td>0.785</td>
</tr>
<tr>
<td>Contact time (ms)</td>
<td>270.4 ± 20.5</td>
<td>254.1 ± 18.6</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Step frequency (Hz)</td>
<td>2.80 ± 0.14</td>
<td>2.78 ± 0.15</td>
<td>0.517</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SD.

*One-tailed test.

References

