Different running techniques in shod vs. minimal footwear/barefoot runners – adaptations for prevention of injuries

Results of an exploratory study under laboratory conditions and during competition

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Background and scientific question

In the last years the number of long distance runners who wear minimal footwear or run completely barefoot increased considerably. There is an ongoing debate about the benefits and risks of running in minimal footwear/barefoot instead of running in conventional running shoes [1-4].

Methods

The objectives were to investigate the effect of different types of shoes as well as of different running techniques on acceleration of centre of gravity and to explore a potential link to injuries (subjects are described in table 1). We assessed data with a mobile accelerometry device (actibelt®; http://www.actibelt.com) during competition. 3 runners were additionally investigated during a treadmill test using a high speed camera system simultaneously coupled to a wireless stream of acceleration data. Acceleration raw data was analysed with standardized algorithm packages using R software environment.

Table 1: Participations in competitions and related injuries.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Distance</th>
<th>Participation in laboratory testing</th>
<th>Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 barefoot (male)</td>
<td>24h ultra-marathon – 129km</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>1 shod (female)</td>
<td>24h ultra-marathon – 92km</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>12 subjects shod (male/female) relay runners – 323km</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>15 subjects barefoot/minimal footwear (male/female) relay runners – 24km</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

Author (MO) minimal footwear (Vibram Five Fingers) ultra-marathon/mountain run “Karwendelmarsch” (54km, 2200m up and down) – 6:40 Yes No

Author (MO) minimal footwear (free heel running pad) ultra-marathon/mountain run “Karwendelmarsch” (54km, 2200m up and down) – 7:57 Yes No (minor – cut in sole & DOMS, spontaneous recovery in 2 weeks)

Author (MO) minimal footwear (Vibram Five Fingers) mountain run “Zugspitzlauf” (19km, 2000m up) 3:37:43 Yes No

Author (MO) normal running shoes 1 marathon – 3:31:42 Yes No (minor – low rail off)

Author (MO) normal running shoes 1 marathon – 3:34:17 Yes No

Author (MO) minimal footwear (Vibram Five Fingers) half marathon – 1:31:23 Yes No

Author (MO) minimal footwear (free heel running pad) half marathon – 1:33:19 Yes No

Figure 1: Stride lengths and frequencies of the single and relay runners as a function of speed at the 24h-ultra-marathon.

Figure 2: Example of an actibelt® signal of three forefoot-strikes (FFS) and three rearfoot-strikes (RFS). The up-down signal is marked in red.

Figure 3: Example of an injury related to barefoot running. Haemorrhagic blister of a female barefoot runner (not part of the study)

In the treadmill experiments we found smoother curves for MF/B runners particularly in the up-down acceleration (see fig. 2) and less power in the high frequencies in the Fourier spectrum similar to [1].

No severe injuries occurred during the races described (details see table 1). Another individual known by one of the authors (MD) developed severe pain in one metatarsal joint after having changed to minimal footwear running that needed surgery twice with ongoing limitations in sports participation.

Conclusions

Mobile accelerometry is a feasible technology to explore different running patterns outside of gait laboratories. We found that MF/B running was typically associated with different running patterns (higher step frequency, reduced stride length, reduced and smoother up-down peak accelerations at “belt” position) indicating a more effective use of evolutionary damping system. Well-trained barefoot runners can run long distances without injuries, but others may face the risk of severe injury. More research is needed to translate biomechanical findings from laboratory and empirically observed injury rates into individual evidence based recommendations about running style and footwear.

References