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

Results of an exploratory study under laboratory conditions and during competition

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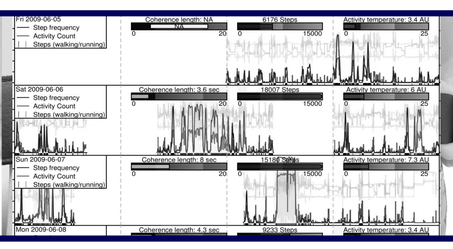

Background and scientific question

In the last years the number of long distance runners who wear minimal footwear or run completely barefoot increased considerably. There is an on-going 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.

Subject	Distance	Participation in laboratory testing	Injury
1 barefoot (male)	24h ultra-marathon – 128km	No	No
1 shod (female)	24h ultra-marathon – 92km	No	No
12 subjects shod (male/female)	relay runners – 323km	No	No
15 subjects barefoot/minimal footwear (male/female)	relay runners – 243km	No	No (1 injury not related to race: One barefoot runner was hospitalized and underwent surgery (implant) some weeks after the 24h race. In a follow-up phone call after 6 months the runner reported full recovery and that the event was not related to participation in the race.)
Author (MD) minimal footwear (Vibram Five Fingers)	ultra-marathon/mountain run “Karwendelmarsch” (54km, 2200m up and down) – 6:40	Yes	No
Author (MD) 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 (MD) minimal footwear (Vibram Five Fingers)	mountain run “Zugspitzlauf” (19km, 2000m up) 3:37:43	Yes	No
Author (MD) minimal footwear (Vibram Five Fingers)	mountain run “Zugspitzlauf” (19km, 2000m up) 3:32:03	Yes	No
Author (MD) normal running shoes	1 marathon – 3:31:42	Yes	No (minor – toe nail off)
Author (MD) minimal footwear (Vibram five fingers)	1 marathon – 3:24:17	Yes	No
Author (MD) minimal footwear (free heel running pad)	1 marathon – 3:22:51	Yes	No (minor – blister)
Author (MD) minimal footwear (Vibram Five Fingers)	half marathon – 1:31:23	Yes	No
Author (MD) minimal footwear (free heel running pad)	half marathon – 1:33:19	Yes	No

Table 1: Participations in competitions and related injuries.

Results

Analysable actibelt® data could be recorded during the “self-tests” and the 24 h ultramarathon by two single-runners and the barefoot relay team. Only a few recordings could be done in shod running team (compliance problems during night). No complaints were reported about actibelt® wearing comfort.

By analysing data from actibelt®, we could confirm a general tendency for increased step frequency and reduced step length in minimal footwear/barefoot (MF/B) vs. shod runners. In the 24 h ultramarathon both shod and MF/B runner controlled gait speed via step frequency, correlation to step length was less obvious (details see fig. 1).

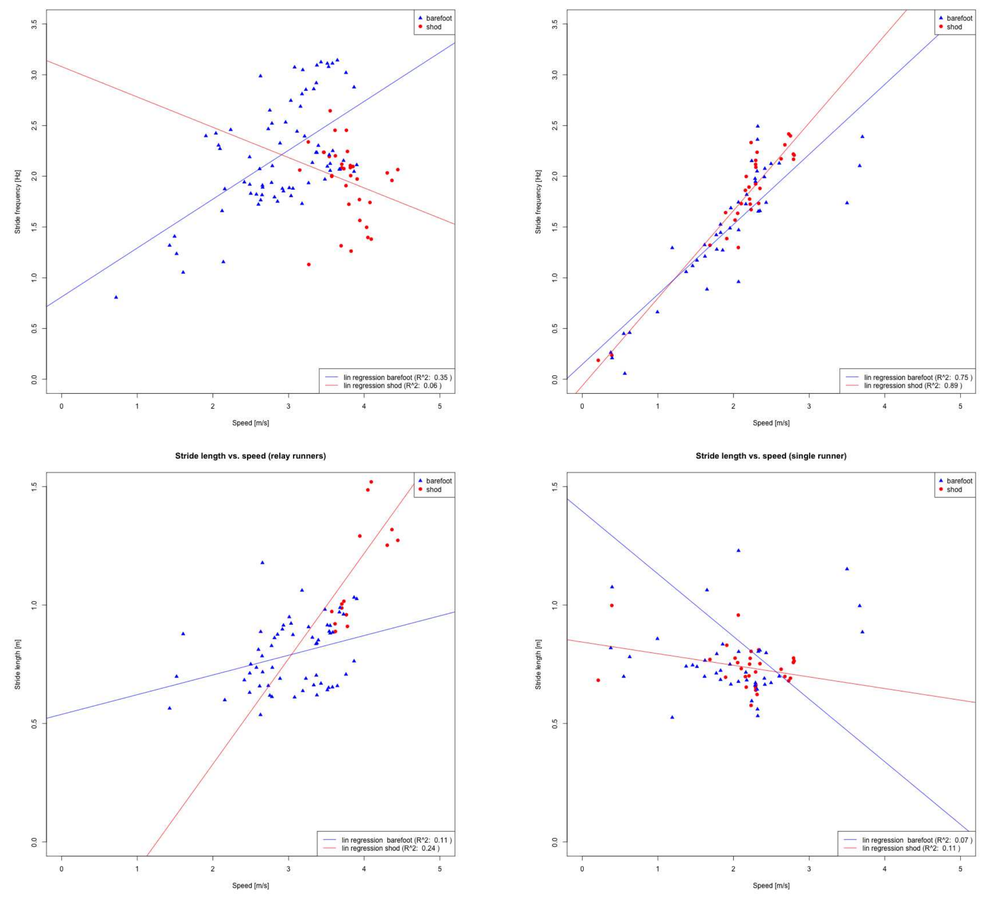

Figure 1: Stride lengths and frequencies of the single and relay runners as a function of speed at the 24h ultra-marathon.

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].

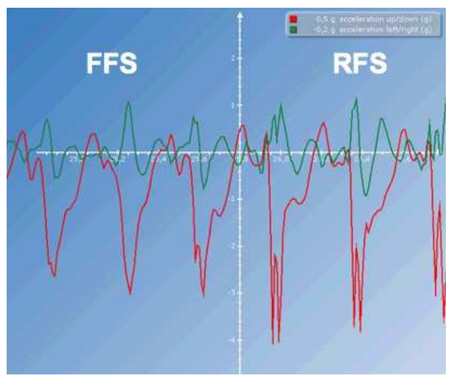

Figure 2: Example of an actibelt® signal of three forefoot-strikes (FFS) and three rearfoot-strikes (RFS). The up-down signal is marked in red.

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

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

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