P619

Structure of locomotion and neuromuscular activity of lower extremity muscles during non-fatigued and fatigued running

K. Hottenrott, O. Hoos, H.-M. Sommer, Philipps-University of Marburg (Marburg, D)

Introduction

Neuromuscular and metabolic fatigue are important factors to assure adaptations in a training process. On the other hand, fatiguing exercises increase the load on the musculo-skeletal system and thus bear the risk of overload (3). The aim of the study was to assess the effects of fatigue on the structure of locomotion and neuromuscular activity in running.

Methods

24 well-trained endurance athletes performed two standardized running-tests of graded speed levels on a treadmill, before (pre: 3,3 m/s to 5,5 m/s) and after (post: 3,3 m/s to 4,4 m/s) a fatiguing bicycle exercise. Muscle activity of 6 primarily propulsive lower limb muscles (TA, GA, BF, VM, VL, RF) were recorded at each level in running. Simultaneously, kinematics (goniometry, inertia switch) of the lower limb were obtained.

Results

A comparing of the third speed level of pre- and post-test ($v = 4,4$ m/s) yielded the following significant results :

Structure of locomotion

- decrease of stride frequency, increase of stride length and stance time ($p < 0,01$)
- increased knee flexion during initial ground contact, decreased knee extension during toe off ($p < 0,05$)
- higher knee extension velocities in the eccentric phase and lower knee extension velocities during early swing ($p < 0,05$).

Neuromuscular activity

- increase in muscle activation time (> 30% of Peak EMG-value) of M. tibialis anterior (TA) and M. biceps femoris (BF) ($p < 0,05$)
- earlier EMG onset of BF and TA (left-shift), later EMG onset of M. rectus femoris (RF) (right-shift) ($p < 0,05$)
- increase in AEMG values of leg extensors (VM, VL, RF, GA) during preactivation and eccentric phase ($p< 0,01$) and unchanged AEMG values of leg flexors (TA, BF)
- decrease in AEMG values of leg extensors (VM, VL, RF) in concentric phase ($p<0,01$).

Discussion

Our results support the thesis that changes in foot contact timing are typical consequences of increasing fatigue in running (1,2). Stability of initial ground contact is altered by a much higher incline in EMG-activity (AEMG) for the leg extensors in preactivation and eccentric phase in comparison to the antagonistic flexor muscles. This dysbalance disturbs an optimal tension ratio between flexor and extensor muscles in order to stabilize the joints during initial ground contact. The non-optimal tension ratio is supported by the fact of increasing knee extension velocities, stance times and decreased EMG-activity of leg extensors during the concentric phase.

In conclusion, neuromuscular fatigue alters motor control, leads to unfavorable lower limb kinematics, supports the development of muscular dysbalance and therefore increases the risk of musculo-skeletal overload.

References

1. DUTTO, D. & SMITH, G. (1999). 23rd Congress Am. Soc. Biomech. University of Pittsburg, October, 21-23.
2. GOLLHOFER, A. et al.. (1989). Dt. Z. Sportmed., 40 (11), 348-354
3. HOTTENROTT, K. et al. (1998). XVIth Internat. Symp. Biomechanics in Sports (Proceedings), 192-195