Locomotor muscle fatigue restricts central motor drive and exercise performance during repetitive sprints to limit the development of peripheral fatigue upon a critical threshold

Hureau T.1, Olivier N.1, Millet GY.2, Meste O.3, Blain G.1

1: UDSL2, EA 4488 (Lille, France), 2: UJM, EA 4338 (St Etienne, France), 3: CNRS-UNS, IJS (Nice, France)

Introduction

Background:
During high-intensity endurance exercise, locomotor muscle afferents feedback exerts an inhibitory influence on the determination of central motor drive to limit the peripheral fatigue development upon an individual critical threshold1,2.
Because during high-intensity endurance exercise voluntary muscle contractions are submaximal, some authors argued that performance is more dependent on cognitive/motivational factors involving self-regulation of power output rather than muscle feedback3.

Goal: We asked whether inputs from the fatiguing locomotor muscles reduce the maximal voluntary drive of central motor command, in order to tightly regulate the total degree of peripheral fatigue development during all-out sprints (i.e. when the central command is recruited at its maximal voluntary level).

Methods

Measurements:
- Normalized iEMG
- Quadriceps
  - Peripheral fatigue: potentiated twitch in response to supramaximal femoral nerve stimulation (Ototest, N)
  - Overall fatigue: maximal voluntary contraction (MVC, N)

Power output (W.kg⁻¹)

Subjects = 12 healthy men
- Age (yr) 24.7 ± 5.3
- Body mass (kg) 73.4 ± 6.8
- Body fat (%)
  - VO₂max (min⁻¹.l⁻¹) 13.5 ± 4.8
  - VO₂max (min⁻¹.l⁻¹) 54.8 ± 9.1

Control condition (performed in the fresh state)

Pre-existing level of peripheral fatigue condition

[Pre-Fatigue induced by neuromuscular electrical stimulation of the quadriceps (NMES)]

Warm-up
10 min 50 % MAP
Assessment of muscle functions
10 × 10 sec Sprints (r = 30 sec)
Assessment of muscle functions
Warm-up
10 min 50 % MAP
1 × 10 sec Sprint

Central Motor Drive

Performance

Mean power output (W/kg)

Central Motor Command

Muscles

Feedback (afferents)

Power

Goal: We asked whether inputs from the fatiguing locomotor muscles reduce the maximal voluntary drive of central motor command, in order to tightly regulate the total degree of peripheral fatigue development during all-out sprints (i.e. when the central command is recruited at its maximal voluntary level).

No significant difference was demonstrated between power output from the single sprint and the first sprint of the series of 10 sprints (S1). Potential effects of pacing strategies and/or teleoanticipation were thus limited in our study design.

Results

[Lactate]

Sprints

Pre sprint
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
R1
R2
Recovery

RPE scale

Pre fatigue
Sprints

Muscle Fatigue

Pre fatigue
Sprints

Despite significant differences in pre-existing level of fatigue, central motor drive, and exercise performance between our experimental conditions, the level of peripheral fatigue was identical at the end of the sprint trials.

Conclusion

- Central motor drive and power output are tightly regulated during repetitive all-out sprints to avoid the development of peripheral muscle fatigue upon a critical threshold.
- We thus suggest that feedback from the fatiguing locomotor muscles exert an inhibitory effect on the central motor drive and play a key role in exercise performance.

References