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Repeated bout effect: Neuromuscular and cardiorespiratory responses during downhill walking in relation to muscle function loss

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Introduction

It has been well established that performing a bout of unaccustomed, predominantly eccentric exercise may result in a long-lasting muscle function deficit (> 24 h) and in a set of symptoms (e.g., muscle soreness, increased levels of circulating proteins). It is also well established that repeating the same bout within few weeks results in reduced loss of muscle function and symptoms of muscle damage compared to the initial bout. It has been suggested that neural, mechanical and cellular adaptations may explain the protection conferred by a single bout of eccentric exercise, called the "repeated bout effect" (RBE).

Currently, there is no consensus about how the adaptations involved in the RBE could affect neural (muscle activation) and mechanical (muscle/tendon elongation) behavior during a second bout of eccentric-biased exercise. Moreover, while it is well known that neural/mechanical behavior could affect running/walking economy, no study investigated cardiorespiratory changes for a given running/walking speed in a RBE context. The aim of the present study was to: 1) quantify any mechanical, neural or cardiorespiratory changes that occur between two identical eccentric biased exercises separated by two weeks; 2) explore whether these parameters were associated with muscle function loss or any muscle damage markers.

Methods

12 participants performed two sessions of 45-min downhill walking (DW) separated by 2 weeks. DW was performed on a treadmill with a load 30% of the body mass, at a 25%-gradient and a velocity of 4.5 km.h⁻¹. Oxygen consumption (VO₂), heart rate (HR), rating of perceived exertion (RPE), fascicle elongation/pennation angle of the vastus lateralis (VL) and EMG activity of the VL, rectus femoris (RF), biceps femoris (BF), gastrocnemius medialis (GM), soleus (SOL) and tibialis anterior (TA) muscles were assessed during the downhill walking. Maximal voluntary contraction (MVC) torque, delayed-onset muscle damage (DOMS), knee range of motion (ROM), creatine kinase (CK), myoglobin (Mb), matrix metalloproteinase 9 (MMP-9) and shear modulus assessed by shear wave elastography were assessed before (PRE), within 1h (POST) and 4h after the exercises (POST), and the days after the two sessions (24h, 48h, 72h and 168h).

*Speaker

Results

MVC torque measured 24h after the DW was reduced by 22.8 ± 11.7 % and 7.4 ± 8.2 % for the first (DW1) and the second (DW2) DW. Relative DOMS, ROM and shear modulus values were also significantly reduced after DW2 compared to DW1 ($p < 0.01$). Biochemical analyses are in progress. Muscle activation (RF and SOL EMG activity), cardiorespiratory (HR and VO₂) and subjective (RPE) responses were significantly decreased during DW2 compared to DW1 ($p < 0.05$). Fascicle elongation and pennation angle analyses are in progress.

Conclusion

As expected, we found a reduced loss of muscle function and symptoms of muscle damage after the second bout compared to the initial bout of downhill walking. Protective adaptations conferred by the first bout induce a lower perceived exertion and cardiorespiratory responses when the same exercise is repeated within few weeks. Neural and mechanical adaptations could partly explain the lower perceptual and physiological responses during a second bout of eccentric biased exercise.

Keywords: eccentric exercise, exercise, induced muscle damage, muscle function, shear, wave elastography, load carriage, muscle architecture.