

Neuromuscular adaptation in human calf after disuse evaluated by muscle fMRI and EMG

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INTRODUCTION

The triceps surae (TS) muscle group plays a key role during postural control and physical activities in humans. It is well known that disuse (e.g. spaceflight and bed rest) induces deconditioning of the TS muscle group. We demonstrated that the neuromuscular adaptation took place in the TS muscle group during fatigable exercise after 20-d bed rest [1]. However, it is not well known whether this adaptation may occur during moderate fatigable exercise in this muscle group. The purpose of this study, therefore, is to elucidate change of function in the TS muscle group during both moderate fatigable and fatigable exercises after disuse using muscle functional magnetic resonance imaging (mfMRI) and surface electromyography (EMG) techniques.

METHODS

Five subjects participated in this study. The subjects were remained a 6 degree head-down tilted bed during 20 days, they were not permitted to be in any weight-bearing posture and all physical activities were kept to a minimum during this period. mfMRI (spin echo, TR 1500 ms, TE 25/70 ms) of the medial and lateral gastrocnemius (MG and LG, respectively), soleus (Sol) muscles was measured at rest and immediately after 25 repetitions (moderate fatigable, 25-rep Ex) and 50 repetitions (fatigable, 50-rep Ex) of unilateral calf-raising exercises [1]. Transverse relaxation time (T₂) of the TS muscle group was measured as an index of neuromuscular properties. EMG activity (sampling rate: 1 kHz, band-pass filter: 20 to 450 Hz) was recorded from the MG, LG, Sol, and tibialis anterior (TA) muscles during 25-rep Ex and 50-rep Ex. Raw EMG signals was rectified and root mean squares was calculated. EMG activity was presented as the ratio of the last three repetitions to the first three repetitions. All data are presented as means and standard deviation. A one-way ANOVA and the Newman-Keuls was used for comparison.

RESULTS AND DISCUSSION

There was no significant change in resting T₂ due to 20-d bed rest (Fig. 1). Overall, the T₂ of the TS muscle group significantly increased with increase of the number of repetitions (Fig. 1). In the MG, Sol muscles, and TS muscle group, the T₂ change was significantly higher after bed rest than before bed rest at 25-rep Ex and 50-rep Ex (both P < 0.05), suggesting a greater number of muscle fibers were involved in performing during 25-rep Ex and 50-rep Ex under the same absolute load [1, 2].

EMG activity of the Sol muscle and TS muscle group during 50-rep Ex was significantly higher after bed rest than that of before (Fig. 2, P < 0.05). No any significant changes of EMG activity were found in the MG, LG, and TA muscles.

We conclude that a short period of disuse affects on muscle function during moderate fatigable exercise as well as

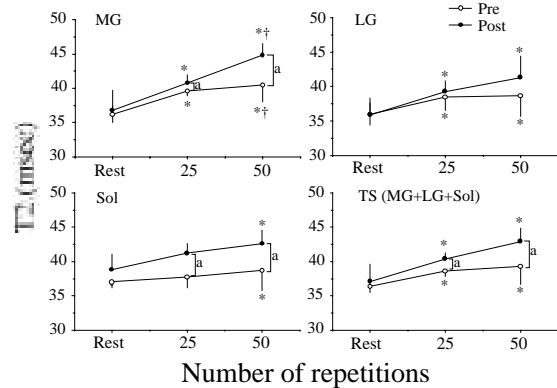


Figure 1: T₂ changes of the TS muscle group during unilateral calf-raising exercises before and after 20-d bed rest. *: P < 0.05 vs rest, †: P < 0.05 vs 25-rep Ex, a: P < 0.05 pre vs post.

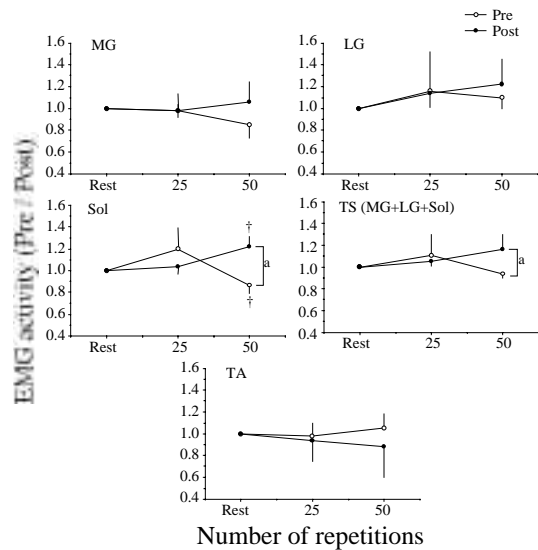


Figure 2: EMG activity of the TS muscle group during unilateral calf-raising exercises before and after 20-d bed rest. †: P < 0.05 vs 25-rep Ex, a: P < 0.05 pre vs post.

fatigable exercise, and that the functional adaptation is muscle-specific in human calf.

REFERENCES

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ACKNOWLEDGEMENTS

This study is funded by a part of "Ground Research for Space Utilization" promoted by Japan Space Forum.