Effect of high- and low-intensity contraction task on fatigability and twitch properties of the triceps surae

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Summary

This study examined fatigue responses during and after sustained isometric plantar flexion at high vs. low intensities. Greater central and peripheral fatigue caused by low-intensity contractions were observed and high-intensity contractions may primarily induce central fatigue. Notable changes in neuromuscular excitability in the gastrocnemius proved muscle-specific responses. These findings suggest the distinct mechanisms of fatigue in relation to contraction intensity.

Introduction

Fatigue influences neuromuscular function and performance, resulting from central and peripheral mechanisms that differ based on the intensity and duration of muscle contractions. Low-force contractions are known to last longer, with a greater contribution of neural mechanisms than high-force tasks [1]. Other studies have found that low-force elbow flexion tasks (20% MVC; MVC: maximal voluntary contraction) induced greater central fatigue while peripheral fatigue was similar to that of high-force tasks (80% MVC) [2]. Given the different proportions of slow- and fast-twitch fibers among the triceps surae, differences in fatigability may exist depending on the contraction intensity which is muscle specific. This study aimed to examine neural and muscular fatigue mechanisms during and after sustained high- and low-intensity plantar flexion.

Methods

Eighteen healthy young males (25.2 ± 3.5 years; mean ± SD) participated. Subjects performed isometric plantar flexions in a prone position with the knee fully extended. Surface EMG was recorded from Medial Gastrocnemius (MG), Lateral Gastrocnemius (LG), Soleus (Sol), Tibialis Anterior (TA) of the dominant leg. Voluntary activation (VA%) was assessed with the interpolated twitch using supramaximal electrical stimulation to the tibial nerve. Each subject completed two randomized visits, separated by at least 48 hours, performing either a high-intensity (80% MVC) or low-intensity (20% MVC) fatiguing contraction task. The fatiguing task continued until the recorded force dropped below the target three consecutive times. The MVC, interpolated and control twitch torques, and time characteristics were measured pre-, post-fatigue and post 10 min to evaluate fatigue mechanisms.

Results and Discussion

The time to task failure was longer (p<0.05) for low-intensity contractions compared to high-intensity contractions. Larger decline (p<0.05) was found in MVC, VA%, twitch torque, and time to peak twitch (TTP) after the low-intensity contraction than high-intensity task (Fig 1). Decline in the M-wave amplitude of LG after high-intensity contraction and increase in the M-wave of MG after the low-intensity contraction were identified. Positive correlation (r>0.6, p<0.05) was found (1) between the relative decline in MVC and VA%, MVC and twitch torque after low-intensity task, respectively, (2) between the relative decline in MVC and VA% after high-intensity task, and (3) between the relative decline in time to peak twitch and twitch torque in both tasks (Fig 2).

The results indicate fatigue after sustained low-intensity contractions was characterized by both central and peripheral fatigue, while high-intensity contractions may primarily induce central fatigue. Neuromuscular excitability showed muscle-specific responses. Potential relationship between the temporal characteristics of muscle contraction and the force-generating capacity of the muscle was also observed.

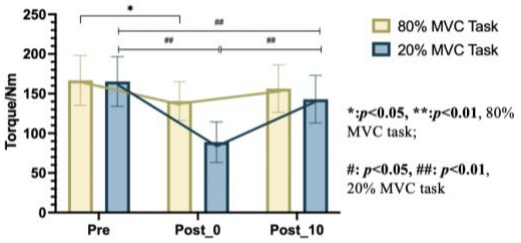

Figure 1: Changes in MVC before and after tasks

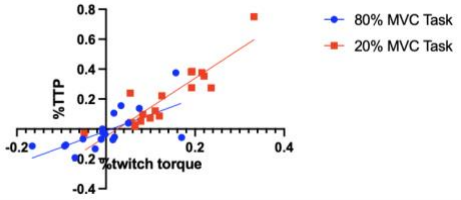

Figure 2: Correlation between %decline in time to peak twitch and %twitch torque in both tasks

Conclusions

Sustained low-intensity plantarflexion contraction induced greater central and peripheral fatigue than high-intensity task, which suggested distinct mechanisms of fatigue in relation to contraction intensity in triceps surae. Changes in neuromuscular excitability in the gastrocnemius proved muscle-specific responses.

References

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