

HETEROGENEITY OF CHANGE IN MUSCLE CIRCULATION AMONG SYNERGISTS DURING DYNAMIC MUSCLE ACTION

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INTRODUCTION

In case of a single muscle, muscle contraction impairs blood inflow to a muscle with an increase of intramuscular pressure. Some studies have reported that muscle circulation of synergists interacted among themselves. For example, the significant decrease in muscle blood volume detected by near-infrared spectroscopy (NIRS) was found in medial gastrocnemius but not in the lateral gastrocnemius during static plantarflexion [1]. However, the result of muscle circulation in static muscle action might not be directly applicable to that in dynamic muscle action.

The purpose of present study was to clarify the heterogeneity of change in muscle circulation among synergists during dynamic muscle action. For this purpose, we investigated muscle blood volume and oxygenation in triceps surae muscle during calf-raise exercise using NIRS.

METHODS

Subjects were five healthy males. They were asked to sit quietly for more than 3 min as a control period. Then they stood up and performed 4 s calf raise consisted of 2 s heel up phase and 2 s heel down phase. They repeated the calf-raise 20 times led by an electric metronome.

Surface electromyogram (EMG) was recorded from medial and lateral gastrocnemius (MG and LG) and soleus (SOL) using bipolar electrode (SX-230, DKH, Japan).

To estimate the oxygenated hemoglobin and myoglobin (O_2Hb/Mb), deoxygenated hemoglobin and myoglobin (HHb/Mb), total hemoglobin and myoglobin (cHb/Mb) content and tissue oxygenation index (TOI) in target muscles, two channels optical probes NIRS were firmly placed on the skin surface of muscle belly (NIRO-200, Hamamatsu Photonics, Japan). Firstly, MG and LG muscles were measured at once, and MG and SOL muscles were measured using the same protocol. O_2Hb/Mb , HHb/Mb and cHb/Mb were expressed as changes from rest values, and TOI was expressed as a percentage (%).

The change of ankle joint angle was measured using an electric goniometer (SG110/A, DKH, Japan).

The data of EMG, NIRS and joint angle were stored on a personal computer by using an analog-to-digital converter (PowerLab/16sp, ADInstruments).

RESULTS AND DISCUSSION

The mean amplitude of EMG (mEMG) increased greater in MG than in LG, and mEMG of SOL showed almost constant value during exercise.

O_2Hb/Mb of all three muscles decreased during the exercise, and a marked decrease in the value of MG was observed. HHb/Mb of all three muscles decreased at the onset of exercise, then the great increase was observed in MG. The decline of TOI was greater in MG than LG. The TOI values at the last (20th) calf-raise were $29.4 \pm 3.6\%$, $47.9 \pm 3.8\%$ and $56.1 \pm 4.0\%$ for MG, LG and SOL, respectively.

Muscle blood volume of all three muscles decreased rapidly at the beginning of exercise. Then the blood volume in MG and LG increased gradually, but that in SOL continued to decrease until the end of exercise (Figure 1).

The present results suggest that muscle circulation among synergists was different from each other during dynamic exercise such as calf-raise exercise.

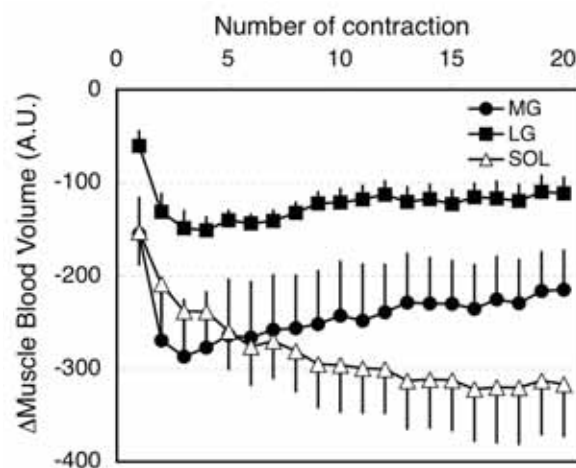


Figure 1: The changes of muscle blood volume during calf-raise exercise in MG, LG and SOL. Values are the mean \pm SE

REFERENCE

1. Muraoka and Kagaya *Proceedings of ISB XIX*, Dunedin, New Zealand, 2003.

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