INTRODUCTION

A static contraction induces the increase of intramuscular pressure, and it causes the decrement or cessation of muscle blood flow. In addition, a static contraction induces changes in muscle architecture such as muscle fascicle length and fascicle angle. Actually, most of joint movements are achieved by multiple muscle contraction. It has not been confirmed whether the knowledge from single muscle contraction could be applicable to the multiple muscle contraction. The change of muscle blood volume has been measured using near infrared spectroscopy. The total hemoglobin and myoglobin content (cHb/Mb) reflects the muscle blood volume. When static contraction starts, muscle blood volume decreases by the elevated intramuscular pressure. Kawakami et al. (1998) reported that the muscle architecture (fascicle length and fascicle angle) is different among the synergistic muscles. Therefore, inhomogeneous changes in muscle blood volume among the synergistic muscles may occur.

The purpose of this study was to investigate the synergistic behaviour in triceps surae muscles during static plantarflexion from the view point of the relationship between muscle blood volume and muscle architecture.

METHODS

Seven healthy females were tested in the sitting position. Knee joint was extended and ankle joint angle was 0 degree. Exercise intensities were 10, 30, 50 and 70 % of maximum voluntary contraction (%MVC). After a control period, subjects exerted 30s static plantarflexion. The muscles tested in this study were medial gastrocnemius (MG), lateral gastrocnemius (LG) and soleus (SOL). Muscle blood volume change was detected as the changes in cHb/Mb using near infrared spectroscopy (NIRO-300, HAMAMTSU, JPN). The cHb/Mb maintained almost constant value during resting condition. At the onset of plantarflexion, muscle blood volume decreased quickly, and kept the bottom value in few seconds. In this study, the change of muscle blood volume during plantarflexion was defined as the early part of reduction of muscle blood volume. Fascicle length, fascicle angle and fascicle curvature (Muramatsu et al., 2002) were measured B-mode ultrasound apparatus (SSD-1000, Aloka, JPN).

RESULTS AND DISCUSSION

Blood volume decreased during static contraction in MG and SOL, and the reduction became greater with increasing of %MVC. However, in LG, blood volume did not change notably in lower level of %MVC, and blood volume tended to increase in higher level of %MVC (Figure 1). The fascicle length of all three muscles decreased during static contraction, and became shorter as the %MVC increased. The fascicle angle increased in static contraction, and became greater at higher level of %MVC. The curvature of all three muscles increased with %MVC increased. Greatest curvature was seen in SOL, and smallest one was observed in LG. The reduction of blood volume tended to increase with fascicle curvature increased in MG and SOL, not in LG. In MG and SOL, the changes of blood volume were affected by the increment of intramuscular pressure with increased of contraction level. The cause of inhomogeneity in muscle blood volume change during static contraction was discussed as follows. LG has the longest fascicle length, the smallest fascicle angle and fascicle curvature among the synergistic muscles. Then the intramuscular pressure of LG was estimated smallest among them. The present results suggest the difference of muscle architecture affects the changes in muscle blood volume.

REFERENCES


ACKNOWLEDGEMENTS

This research was partially supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for JSPS Fellows, 13-07286, 2002