PASSIVE TENSION-LENGTH RELATIONS OF HUMAN TRICEPS SURAE MUSCLES AFTER REPEATED ECCENTRIC-CONCENTRIC EXERCISE

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INTRODUCTION

It is well known in animal and human studies that eccentric contractions increase the passive tension of muscle [1,2,3,4]. In the previous studies of human skeletal muscles, however, the passive tension-length curve has been investigated by torque-angle relationship [2], or model based calculations [3,4]. The lack of direct observation of length in vivo human skeletal muscles makes it insubstantial. The purpose of this study was to examine the passive tension-length relations for human triceps surae muscles after repeated eccentric-concentric exercises.

METHODS

Eight healthy male subjects (age 22.4±1.5 years, height 173±10cm, and mass 69±9kg) were instructed to execute one-legged calf raise exercise (eccentric and concentric plantar flexions) with a designated tempo (0.5Hz for one cycle). The ankle angle range of motion of each repetition was set from dorsiflexion at 15deg (-15º) to plantar flexion at 20deg (+20º). The exercise consisted of a series of 10 sets of 20 repetitions. Measurements were performed before (PRE), immediately after (POST, within 1 hours), and subsequent days after exercise. Passive torque of the right ankle and fascicle length for medial gastrocnemius (MG) and soleus (SOL) were measured at fixed 6 different ankle angles (-20º,-10º, 0º, +10º, +20º, +30º) with his knee joint fully extended. For three subjects, however, soreness after exercise limited passive dorsiflextion at -20º in a several experimental times.

Intensity of muscle soreness was assessed with a visual analog scale (VAS) anchored at 0 (no soreness) and 10 (maximal soreness), when palpating over the muscles and passively dorsiflexing the ankle joints by an examiner.

RESULTS AND DISCUSSION

The passive tension-length curves of human triceps surae muscles at PRE, POST, and following a few days after exercise were shown in Figure 1. Following the exercise, the curves of the tension-length of MG shifted upward and remained subsequent days. Alternatively, that of SOL also shifted upward immediately after the exercise and gradually recovered to the initial level. Increased passive tension immediately after the exercise and the remnant increment of passive tension after subsequent days were consistent with the previous studies [1,4]. However, the different alterations of tension-length relationship for MG and SOL have been yet mentioned.

All subjects reported the muscle soreness on subsequent days, which peaked around 3days after the exercise (VAS 5.8±2.6 and 6.2±2.3 for palpation and flexion respectively) and had disappeared at 7days. The time course of muscle soreness did not coincide with that of increment of passive tension or the changes in passive tension-length curve.

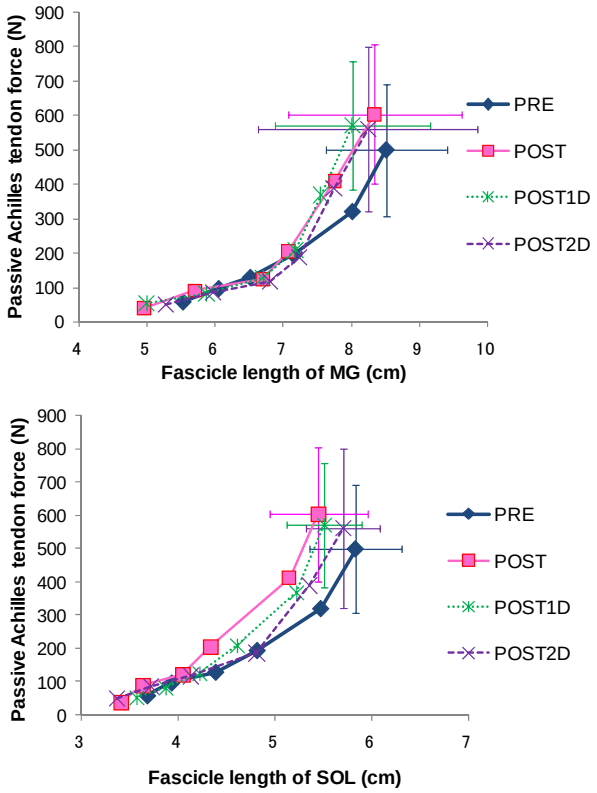

Figure 1: Passive tension-length curves of medial gastrocnemius and soleus muscle measured before (PRE), immediately after (POST) and following a few days after exercise.

CONCLUSIONS

After repeated eccentric-concentric exercises, passive tension increased, and the curves of the passive tension-length relations for both MG and SOL shifted upward immediatily after the exercise. There was no apparent correlation between increased passive tension against muscle soreness.

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