EFFECT OF 20 DAYS OF BED REST ON PASSIVE MECHANICAL PROPERTIES OF HUMAN GASTROCNEMIUS MUSCLE BELLY

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INTRODUCTION

Immobilisation affects mechanical properties of muscle [1, 2]. Animal experiments showed that passive mechanical properties of muscle belly, which play an important role in movement, changed with immobilisation [1]. However, these results might not be directly applicable to humans in vivo because of the differences in species. Moreover, the influence of immobilisation differs muscle to muscle [2]. Recently, the passive mechanical properties of the human gastrocnemius (GAS) muscle belly in vivo can be measured using ultrasonography [3].

The aim of this study was to investigate the effect of 20 days bed rest (BR) on passive mechanical properties of the human GAS muscle belly in vivo.

METHODS

Subjects were four healthy males (20 ± 0 yr). Each subject provided written informed consent. Subjects remained at a continuous 6˚ head-down tilt throughout a 20-days BR period. Five days before the start of the BR period and a day after the end of the BR period, passive mechanical properties and muscle thickness of the GAS muscle belly were measured. This study was approved by the ethical review board of NASDA and the Faculty of Medicine, the University of Tokyo.

Each subject lay on his right side with the right hip joint flexed and held constant within the range of 30˚ to 50˚. Transverse ultrasound images of the medial head of the GAS were taken during passive slow knee extension from 65˚ to 5˚ with a constant ankle joint angle of 10˚ dorsiflexion. The change in passive ankle joint moment (Mp), which is produced only by the GAS length change, was also measured.

Baseline of the Mp was defined as the plantarflexion moment in the knee joint angle range of 55˚ to 60˚, in which the moment was almost constant for all subjects. The first point to rise above the 99 % confidence interval of the baseline of the plantarflexion moment for 5˚ while extending the knee joint was set as the onset of the Mp produced by the GAS, and the knee joint angle at this onset was defined as the slack knee joint angle for the GAS (θs). The slack length of the GAS muscle fascicles (Lfs) was defined as the length of the GAS muscle fascicles (Lf) at θs. The relationship between Lf and Mp in the knee joint angle range from 5˚ to θs˚ was fitted with a linear regression equation using a least squares method.

Muscle thickness of the GAS (Tm) was measured from left leg at 70% of the lower leg length proximal to the lateral malleoluls using a B-mode ultrasonography.

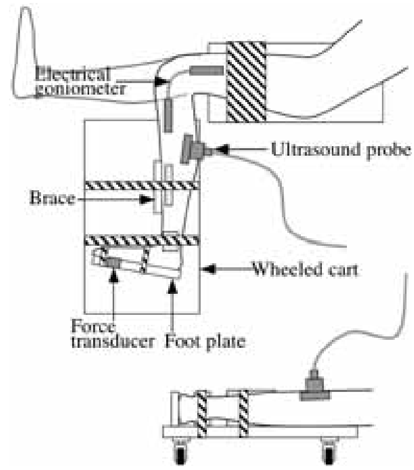

Figure 1: Top and side view of the experimental setup used for the measurement of the passive ankle joint moment during passive slow knee extension.

RESULTS AND DISCUSSION

Tm slightly decreased from 60 ± 2 mm to 59 ± 2 mm with BR. θs decreased from 42˚ ± 6˚ to 28˚ ± 12˚, but Lfs was almost constant (the pre-BR Lfs was 42 ± 4 mm and the post-BR Lfs was 44 ± 5 mm). Thus, BR had little effect on Lfs, which was in agreement with the previous result [1]. The slack length of the human GAS tendinous tissues in vivo might be lengthened with BR, although the tendinous tissues of rabbit soleus muscle in vitro were shortened with immobilisation [1]. The slope of the relationship between Lf and Mp in the knee joint angle range from 5˚ to θo˚ decreased from 0.085 ± 0.027 Nm/mm to 0.071 ± 0.042 Nm/mm with BR. Thus, BR decreased the passive stiffness of the human GAS muscle belly in vivo, although the stiffness of rabbit soleus muscle fascicles in vitro was unchanged with immobilisation [1].

CONCLUSIONS

Twenty days of bed rest had little effect on the slack length of gastrocnemius muscle belly, but decreased its passive stiffness.

REFERENCES

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