AGE DIFFERENCES IN TOTAL AND REGIONAL SKELETAL MUSCLE MASS, STANDING ABILITY AND SIT-TO-STAND MOVEMENT.

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INTRODUCTION

Aging is associated with a progressive decline of muscle mass, strength, bone mineral density (BMD) and quality, i.e., a condition described as sarcopenia from aging. Also, aging affects the control mechanism of balance during quiet standing and sit-to-stand, and hence influences center of pressure (COP) of ground reaction forces. The purpose of this study is to examine control of sit-to-stand, quiet standing, skeletal muscle mass and muscular strength in elderly and young people.

METHODS

Healthy elderly (n=5, age 68.4±4.3yrs, height 162.2±5.7cm, body weight 63.2±7.4kg) and young (n=8, age 21.5±1.1yrs, height 169.1±6.4cm, body weight 60.3±6.7kg) male subjects participated in this study. They received an explanation of the experimental protocol and provided informed consent prior to testing. This study was approved by Japanese Red Cross Hokkaido College of Nursing Review Board for Health Sciences Research Involving Human Subjects. None of the subjects experienced medical, neurological or orthopedic problems on the experimental day. The subjects were measured grip strength, flexibility (sitting trunk flexion), and knee extension muscular strength (30-second chair-stand test; CS-30). The displacements of COP of ground reaction forces were recorded at a frequency of 20 Hz while the subjects were standing still on a force platform (ECG-1500A, KYOWA, Tokyo, Japan) for 30 seconds, and the total length of COP displacements (LNG) was calculated. The measurements of kinematic data during the sit-to-stand were collected by using the VICON 460 motion analysis system (Oxford's Metrics, Oxford, UK) with six cameras at 120 Hz placed on the laboratory ceiling. The motion of the subjects' sit-to-stand was recorded with this system and reflective markers. VICON Workstation software was used to calculate position of the subject's center of gravity (CG) and the relative angles between coordinate systems of each segment in the lower limb and the laboratory coordinate system. The thickness of 9 muscles was measured by B-mode ultrasonograph to estimate the total for the whole body and regional skeletal muscle mass by the method of Sanada et al. (Eur J Appl Physiol, 96: 24-31, 2006). In addition, BMD was evaluated using the osteo sono-assessment index (OSI) measured with quantitative ultrasound densitometry (AOS-100NW, Aloka, Tokyo, Japan). All values are presented as means ± SD. Statistical evaluation of the data was done by one way ANOVA. Significance level was set at the $p < 0.05$.

RESULTS AND DISCUSSION

Figure 1 shows comparison of total and regional skeletal muscle mass between elderly and young subjects. In comparison with the young subjects, the elderly subjects were significantly lower in predicted skeletal muscle mass of trunk (37%), thigh (19%), lower leg (22%) and the total for the whole body (24%). Also, young subjects were higher CS-30 (38±4 vs. 16±2 times, $p<0.001$) than elderly subjects. However, arm skeletal muscle mass and BMD were not significantly different. Figure 2 shows comparison of vertical force during sit-to-stand movement between elderly and young subjects. There was not significantly different kinematic data of sit-to-stand movement between elderly and young subjects. A significant age difference did exist for the mean anterior-posterior (A/P) length of COP displacements (31.0±6.2 vs. 41.8±5.0 mm, $p<0.01$). There was a significant negative correlation between CS-30 and A/P length of COP displacements ($r=-0.709$, $p<0.01$). These results indicated that elderly people were much more physical load than young people on sit-to-stand movement.

CONCLUSIONS

The results confirmed that muscle mass, leg strength, ability of balance control was reduced in the natural aging process. The negative correlation between CS-30 and A/P length of COP displacements indicate a conservative enlargement of the muscle mass of the supporting limb by strength training. This conservative strategy may be related to the prevention of accidental fall that causes injury and death in the elderly people.

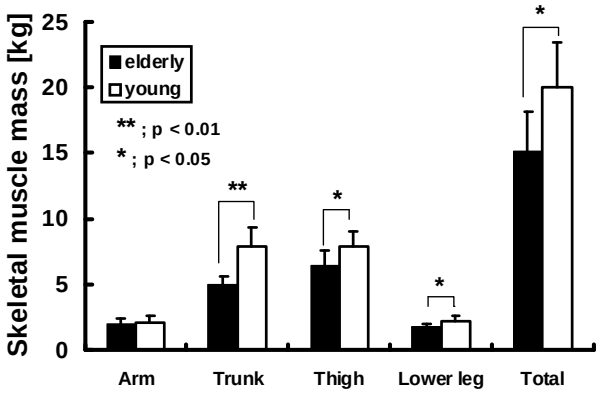

Fig. 1. Comparison of total and regional skeletal muscle mass between elderly and young subjects.

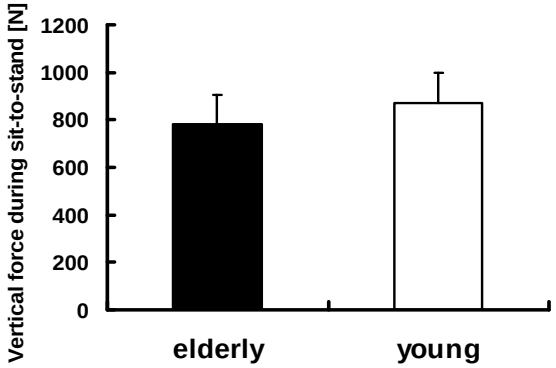

Fig. 2. Comparison of vertical force during sit-to-stand movement elderly and young subjects.