AGE-RELATED SARCOPENIA: AN ELECTROMYOGRAPHIC AND MECHANOMYOGRAPHYIC STUDY

Yong Wei, Yu Liu, Peijie Chen-Qianhua Peng*

Faculty of Sport Science, Shanghai University of Sport, Shanghai, China
***Institute of Sport Coaching Science, Chinese Culture University, Taipei, Taiwan, China**

The purpose of this study was to investigate the effects of age-related sarcopenia on muscle mass, relative muscle strength/power performance in the lower limbs, and the responses of electromyography (EMG) and mechanomyography (MMG) on the activation patterns of motor units under leg extension muscle power performance in the elderly. Subjects were healthy old (n=10, 64.5 ± 4.5 yrs) and young (n=10, 22.6 ± 2.8yrs) people. All subjects performed quadriceps maximal voluntary contraction (MVC) and fastest speed leg extension with different levels (75%, 60%, 45% 1RM), and 45% fatigue test to all-outThe results indicate the declines of muscle mass, neuromuscular performance and changes of MU activation patterns may result from age-related sarcopenia, and the age affects muscle power more than muscle strength.

KEY WORDS: sarcopenia, aging, electromyography, mechanomyography.

INTRODUCTION:

The term sarcopenia, originally coined by Rosenberg (Rosenberg , 1997) and recently reviewed by the National Institutes of Aging (Holloszy , 1995), refers to the involuntary loss of skeletal muscle mass and strength. This is in contrast to wasting, the involuntary loss of weight driven largely by inadequate nutrition, and cachexia, the involuntary loss of fat-free mass (FFM), especially body cell mass, generally resulting from a state of hypermetabolism and hypercatabolism (Roubenof , 1999).
Aging is associated with the decreasing of the strength performance of maximal voluntary contraction（Vandervoort & McComas, 1986; Narici, Bordini, & Cerretelli, 1991）.Loss of muscle mass results in diminished strength and power-generating capacity (Hakkinen K & Hakkinen A, 1995). There is a significant correlation between strength and leg power and maximal walking speed and stair-climbing height ((Hakkinen K & Hakkinen A, 1995).
In sport science research area, surface electromyography (sEMG) and mechanomyography (MMG) have been widely used to obtain biological information of muscle activities（Tarata, 2003）.Therefore the purpose of this study was to investigate the effects of age-related sarcopenia on muscle mass, relative muscle strength/power peroformance in the lower limbs, and the responses of electromyography (EMG) and mechanomyography (MMG) on the activation patterns of motor units under leg extension muscle power performance in the elderly.

METHOD:

Data Collection: Subjects were healthy old (n=10, 64.5 ± 4.5 yrs) and young (n=10, 22.6 ± 2.8yrs) groups (table 1). Subjects' lean thigh volumes (LTV) were measured before task. All subjects performed quadriceps maximal voluntary contraction (MVC) and fastest speed leg extension with different levels (75%, 60%, 45% 1RM), and 45% fatigue test to all-out. Primary information of EMG, MMG, rate of joint motion (ROM) , acceleration and force were recorded at the same time, and were disposed with transducer (NI DaqCard, 6024E, National Instruments Corporation, Germany). LTV, Absolute/relative maximal MVC (MVCmax), maximal power of 75%1RM (Pmax), different level EMG/MMG amplitudes (root mean square, rmsEMG/rmsMMG) and frequencies (mean power frequency, mpfEMG/mpfMMG) responses of vastus lateralis concentric contraction, and median frequency (mdfEMG/mdfMMG) response to fatigue were compared between groups.

Data Analysis: Data were analyzed with SAS version 8.0 statistical package (SAS Institute Inc., Cary NC, 1999–2000). Independent samples t-test was used and significance was defined as p＜0.05.

Table 1 Demographic Data in the Two Groups

Group	Age（years）(Mean± SD)	Height (cm) (Mean±SD)	Weight (kg) (Mean±SD)	Fat（%）(Mean±SD)
Old（n=10）	64.5 ± 4.5	163.3 ± 5.6	66 ± 8.7	24.1 ± 3.7
Young（n=10）	22.6 ± 2.8	172 ± 5.9	66.6 ± 10.1	16.4 ± 5.1

RESULTS:

Comparing to the young, the elderly had significantly less LTV, absolute/relative MVCmax and Pmax (p<.05), whereas relative Pmax (-72%) decreased more than MVCmax (-26.3) with 46.2%, the elderly also had lower rmsEMG for 75% and mpfEMG/rmsMMG/mpfMMG for all levels (p<.05); the decreased 75% rmsEMG and rmsMMG were observed among the elderly due to failure recruitement of fast-twitch; the lower post-fatigue mdfEMG demonstrated the elderly fatigued more than the young (p<.05), but no age difference in post-fatigue mdfMMG(Figure 1-3).

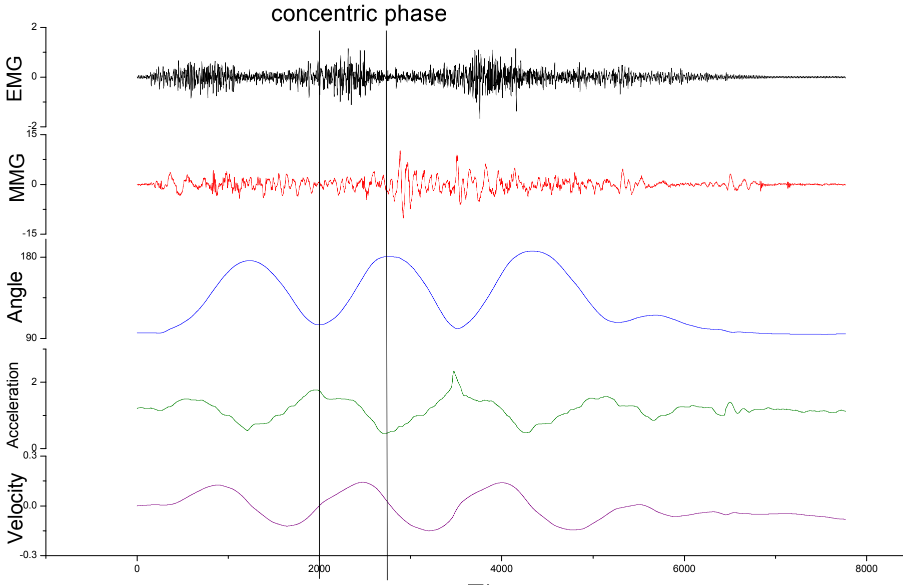

Figure 1　Primary information of concentric phase

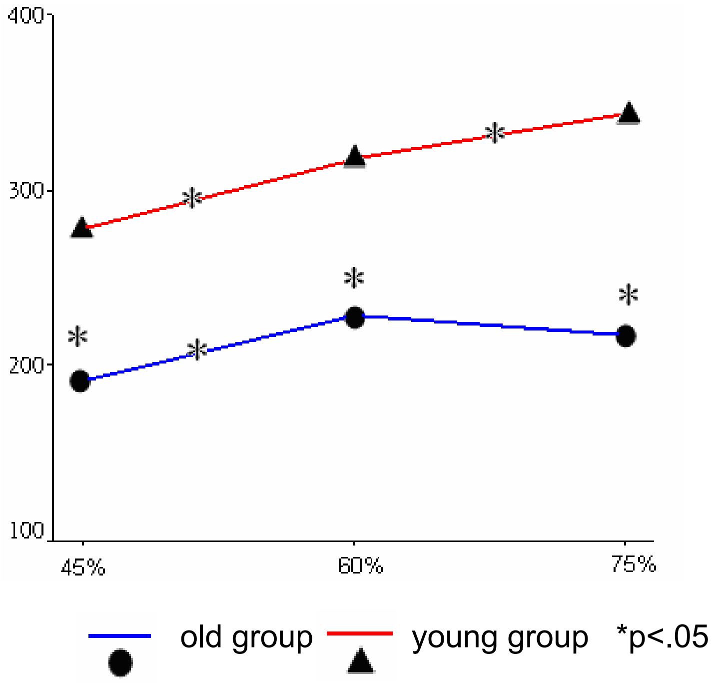

Figure 2 The compare of concentric phase standard MMG amplitude（%MVC）between young and old group

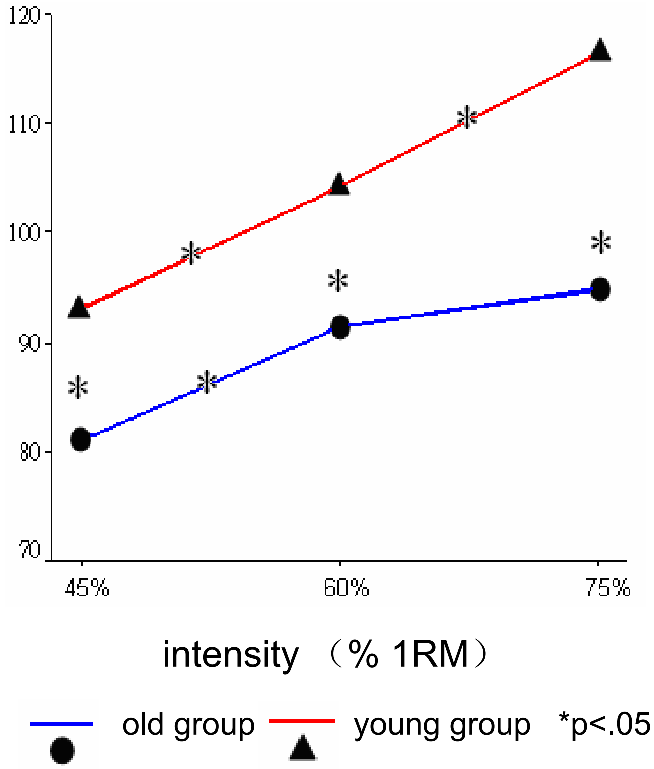

Figure 3 The compare of concentric phase standard MMG Frequency（%MVC）between young and old group

DISCUSSION:

Comparing to the young, the elderly had significantly less LTV, absolute/relative MVCmax and Pmax, indicated that there is the involuntary loss of skeletal muscle mass and strength in the aged.Relative Pmax of the elderly decreased more than MVCmax, indicated that the influence of aging on Pmax is much more than on MVCmax.The elderly also had lower rmsEMG and mpf EMG/rmsMMG/mpfMMG for all levels than those of the young, indicated that the decreased rmsEMG and rmsMMG were observed among the elderly due to failure recruitement of fast-twitch.Because of the changes of aging on neuromuscular performance, the activation strategy of the elderly's motion unit is not the same as that of the young's.The lower post-fatigue mdfEMG demonstrated the elderly fatigued more than the young, but no age difference in post-fatigue mdfMMG. As the muscles contract, the activation patterns of the motion unit are observed by means of MMG when dynamic maximal concentric contraction produces muscle power. There are similar patterns to those of EMG both in time domain and frequency domain. However the reaction of MMG is more significant than that of EMG as far as time domain is concerned. It is maybe because the relationship between MMG and muscle power is closer than the relationship between EMG and muscle power.Using MMG as one way to research muscle functions can effectively observe the mechanical activities when the neuro muscles contract.

CONCLUSION:

The results indicate the declines of muscle mass, neuromuscular performance and changes of MU activation patterns may result from age-related sarcopenia, and the age affects muscle power more than muscle strength.

REFERENCES:

Hakkinen K. & Hakkinen A.(1995).Neuromuscular adaptations during intensive strength training in middle-aged and elderly males and females. *Electromyogr Clin Neurophysiol.* 35:137–147.
Holloszy JO. (1995). Workshop on sarcopenia: muscle atrophy in old age. *J Gerontol.* 50A:1–161.
Narici, M.V., Bordini,M., & Cerretelli, P. (1991). Effect of aging on human adductor pollicis muscle function. *Journal of Applied Physiology,* 71(4), 1277-1281.
Rosenberg IH. (1997). Sarcopenia: origins and clinical relevance. *J Nutr.* 127:990S–991S.
Roubenof R. (1999). The pathophysiology of wasting in the elderly. *J Nutr.* 129:256S–259S.
Tarata, M.T. (2003). Mechanomyography versus Electromyography in monitoring the muscular fatigue. *BioMedical Engineering OnLine,* 2(1), 3
Vandervoort, A. A. & McComas, A. J. (1986). Contractile changes in opposing muscles of the human ankle joint with aging. *Journal of Applied Physiology,* 61(1), 361-367,

Acknowledgement

This study was supported by *Shanghai Key Subject Construction* (T0901). The authors also gratefully acknowledge the subjects who participated in this study and the laboratory assistants in Sport Biomechanics Laboratory at the Chinese Culture University, Taipei, Taiwan.