

MOTOR OUTPUT VARIABILITY DURING ISOMETRIC, CONCENTRIC, AND ECCENTRIC CONTRACTIONS IN YOUNG AND OLD ADULTS

Evangelos A. Christou

Department of Kinesiology and Applied Physiology, University of Colorado, Boulder
Email: echristo@colorado.edu Web: www.Colorado.EDU/kines/Lab/NCM.html

INTRODUCTION

Rapid eccentric contractions of the quadriceps have been shown to produce a more variable motor outcome than isometric and concentric contractions (Christou & Carlton, 1999, 2000). These findings provide additional support to the hypothesis that the central nervous system may control gradation of muscle force differently for eccentric contractions (Enoka, 1996). Several studies suggest that when old adults perform isometric or slow anisometric contractions they produce more variable movements compared with young adults (Laidlaw et al., 2000). These differences between young and old adults as a function of contraction type, however, have not been examined during rapid tasks. The aim of this study was to compare the ability of young and old adults to control motor output during rapid isometric, concentric and eccentric contractions of the knee extensor muscle group.

PROCEDURES

Twenty-four young (25.3 ± 2.8 years) and 24 old (73.3 ± 5.5 years) healthy and active individuals with no history of previous knee pathology were recruited for this study. A KIN-COM 500H isokinetic dynamometer was used to provide a constant velocity of $25^\circ/\text{s}$ throughout the range of motion (ROM) and assess force production and motor output variability during a knee extension task. Each participant attended three testing sessions and performed knee extensions through a 10° ROM (90° - 100° of knee flexion, isometric at 90°). Six different parabolas were displayed on the monitor of the dynamometer based on maximum voluntary contraction (MVC) (20, 35, 50, 65, 80 and 90% MVC) and with a time to peak force of 200ms. Each participant was instructed to match the parabola by

controlling the knee extension force. To familiarize the participants with the targeted parabolas, thirty practice trials were given for each target prior to the data collection. In addition to verbal feedback, the first half of the practice trials received visual feedback. The remainder of the practice trials and the test trials were given visual feedback only after the trial was completed. All target parabolas were randomly assigned for each subject and were counterbalanced in order across subjects. A rest period of 120 seconds was given between data collection trials. Means, standard deviations (SD) and coefficient of variations (CV) for variability in peak force (PF), impulse (IMP), time to peak force (TPF) and impulse duration (ID) were computed (Figure 1) from forty trials per contraction at each %MVC.

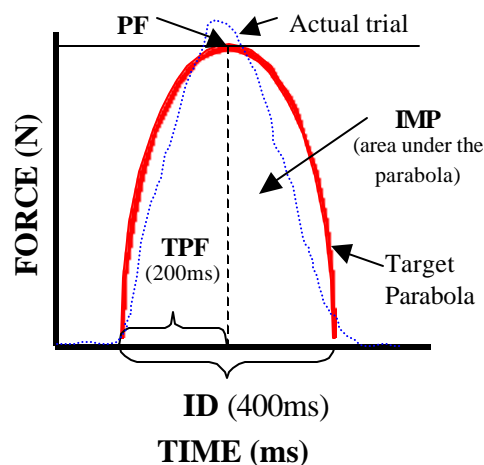


Figure 1. Illustration of the task and parameters computed for analysis.

RESULTS AND DISCUSSION

Subjects produced similar MVC forces for the three contractions ($p > 0.05$), and young subjects produced greater MVC forces than old subjects ($p < 0.05$). The SD of PF and IMP was greater for young than old subjects because of the higher absolute forces

produced by young subjects. Results in this abstract are presented as the CV, a measure of variability that normalizes SD to the amount of force or time produced.

The CV for PF and IMP revealed significant differences between the three contractions and two age groups ($p < 0.01$). Eccentric contractions had a more variable outcome compared with isometric and concentric contractions and old adults were more variable than young adults. For both PF and IMP the interactions for age x %MVC (Figure 1 for PF) and contraction x %MVC (Figure 2 for IMP) were significant ($p < 0.01$). Old adults were more variable than young adults particularly at the low forces; whereas the motor output was more variable during low and high levels of force for eccentric contractions. The age x contraction and the three-way interaction were not significant ($p > 0.05$).

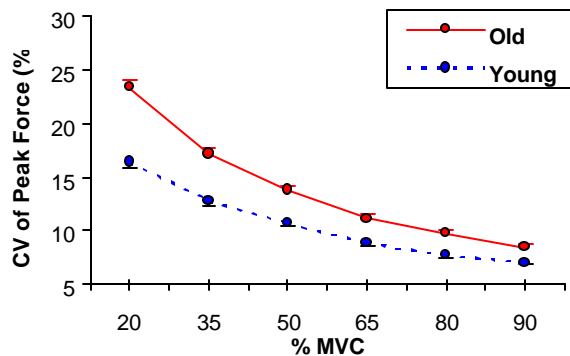


Figure 1. Old adults exhibit greater CV for PF than young adults, particularly at low forces.

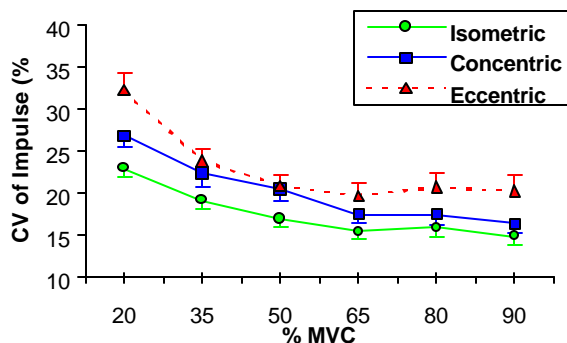


Figure 2. The CV for Impulse was greater during low and high %MVC for eccentric than concentric and isometric contractions.

The CV for TPF and ID revealed significant differences between the three contractions, however, only TPF revealed differences between the two age groups ($p < 0.01$). In general, eccentric contractions were more variable compared with isometric and concentric contractions, and old adults were more variable than young adults. For both TPF and ID, the interaction for age x %MVC was significant ($p < 0.01$). Old adults were more variable than young adults, particularly at the low forces. For TPF, furthermore, the contraction x %MVC, age x contraction, and the three-way interaction among age, contraction and % MVC were significant ($p < 0.05$). Old adults were more variable than young adults during low forces; however, these differences were greater during eccentric contractions. For ID the contraction x %MVC, age x contraction, and the three-way interaction were not significant ($p > 0.05$).

The results of this study provide further evidence that control of the motor output is different for eccentric compared with concentric and isometric contractions. In addition, these results support and extend previous research (Laidlaw et al., 2000) indicating that old adults are less consistent than young adults, particularly during eccentric contractions.

SUMMARY

The CV of the motor output was found to be greater for eccentric than concentric and isometric contractions, and old adults were more variable than young adults.

REFERENCES

- Christou, E.A., & Carlton, L.G. (1999). *ASB Proceedings*, 122-123.
- Christou, E.A., & Carlton, L.G. (2000). *ASB Proceedings*, 137-138.
- Enoka, R.M. (1996). *Journal of Applied Physiology*, **81**, 6, 2339-2346.
- Laidlaw, D.H., Bilodeau, M., Enoka, R.M. (2000). *Muscle and Nerve* **23**, 600-612.