INCREASES IN KINETIC DEMANDS OF THE SUPPORTING LIMB DURING OBSTACLE CROSSING

Shing-Jye Chen and Li-Shan Chou

Department of Exercise and Movement Science, University of Oregon, Eugene, Oregon, USA
E-Mail: chou@oregon.uotegon.edu

INTRODUCTION

Skeletal muscle strength involved in postural control and locomotion declines with age and disease. The knee extensor and the ankle plantar flexor strength of nursing home fallers were only 37 and 10%, respectively, of those of elderly community dwellers (Whipple et al., 1987). As the available strength reduced, a greater challenge will be imposed on a muscle group when performing activities of daily living. Understanding the change in joint kinetics in reaction to different perturbations during walking may provide us information to better reveal mechanisms underlying increased incidence of falling in the frail elderly. Previous studies demonstrated that significantly greater external knee flexion, hip adduction, and ankle dorsiflexion moments were generated in the trailing limb when supporting the leading limb to step over a higher obstacle (Chou and Draganich, 1997). However, limited information is available to document how the obstacle height affects the joint kinetics when the leading limb is supporting immediately after crossing the obstacle (Chou et al., 2000). Therefore, the purpose of the study was to identify any increases in joint kinetics during both supporting periods when stepping over an obstacle in healthy young adults.

METHODS

Fourteen young healthy subjects, including ten male (mean age, 25.1 years) and four female adults (mean age, 24.6 years) were recruited for this study. Subjects were instructed to walk along an 8m walkway at a comfortable self-selected speed while barefoot. Whole body kinematic data were collected from each subject using a six-camera HiRes™ system (Motion Analysis Corp., Santa Rosa, California) during unobstructed level walking and when stepping over an obstacle of height corresponding to 2.5%, 5%, 10%, or 15% of the subject’s height.  The order of obstacle height was randomly selected. Joint kinetics was computed using the OrthTrack™ software. Effects of the obstacle height on joint moments of both limbs were tested with one-way ANOVA with repeated measures at $\alpha = 0.05$ level of significance.

RESULTS AND DISCUSSION

During the support of the trailing limb, the peak external hip and knee flexion moments in the early stance and the peak external ankle dorsiflexion moment in the late stance were found to increase significantly as the obstacle height increased ($p<0.013$; Table 1). During the support of the leading limb, the peak external hip flexion moment in the early stance and ankle dorsiflexion moment in the late stance were found to increase significantly as the obstacle height increased ($p=0.004$ and $p<0.001$, respectively).

Effects of the obstacle height on joint moments of the trailing limb identified in this study were in agreement with those reported previously (Chou and Draganich, 1997). Greater muscular demands on extensors of the hip, knee and ankle joints of the trailing limb are required to support and elevate the whole body over the obstacle. Similarly, the hip extensor of leading limb is then challenged to accommodate a greater and faster downward movement of the whole body after crossing the obstacle during early stance. Furthermore, a greater effort from the ankle plantar flexor of leading limb is needed at the end support to regain the normal walking speed.

SUMMARY

Results of this study indicated that greater external flexion moment are generated at the hip and ankle joints of the leading limb when stepping over a higher obstacle. Greater muscular demands on the hip extensor and ankle plantar flexor during early and late stance, respectively, are required to maintain a smooth motion of the whole center of mass and to resume a normal walking speed after successfully crossing the obstacle.

REFERENCES


ACKNOWLEDGEMENTS

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<td>Late stance</td>
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↑ level of significance, $p<0.05$; ↑: Joint moment increased with the obstacle height.