COMPARISONS OF THE LOWER LIMB MECHANICS BETWEEN YOUNG AND OLDER ADULTS WHEN CROSSING OBSTACLES WITHOUT VISUAL GUIDE

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INTRODUCTION

Since tripping over obstacles during locomotion has been reported as one of the most frequent causes of falls in the elderly [1], research on the kinematics and kinetics of the lower extremities during this functional activity has received much attention [2-4]. The majority of previous studies in young adults during obstacle-crossing have been limited to presenting the kinematics of the leading swing limb and the kinetics of the trailing stance limb. It is noted that one has no visual cue when the trailing limb is crossing the obstacle, increasing the chance of tripping. Thus, a complete knowledge of the mechanics of obstacle crossing should include that of the limbs when the trailing limb is crossing, Fig. 1.

The kinematics of the crossing trailing limb has been reported for young adults [4] but the kinetics of the leading stance limb has not. Moreover, since aging may affect the performance of locomotion and obstacle negotiation, age effects on the mechanics of the leading stance limb and the trailing swing limb require detailed investigation. The purpose of the present study was thus to investigate the kinematics of the trailing swing limb and the kinetics of the leading stance limb when crossing obstacles of different heights in the healthy old people and to compare the results with those of the healthy young people.

METHODS

Fifteen young adults (age: 23±3 years, height: 176.1±6.3 cm, mass: 68±8.6 kg) and fifteen older adults (age: 72±6 years, height: 160±5.7 cm, mass: 58±10.4 kg) participated in the present study with informed consents. They all had normal corrected vision and were free of neuromusculoskeletal pathology. In a gait lab, each subject walked at self-selected pace and crossed obstacles of three different heights (10, 20 and 30% of leg length). Twenty-eight markers were used to track the motion of both limbs. Kinematic and kinetic data were measured with a 7-camera motion analysis system (Vicon512, Oxford Metrics, U.K.) and two force plates (AMTI, Advanced Mechanical Technology, U.S.A.) placed on each side of the obstacle. Height effects on temporal-distance gait parameters and joint angles of the trailing swing limbs as well as peak and crossing moments of the leading stance limbs were tested using RMANOVA for each age group (α=0.05). Independent t-test was used for between-group comparisons.

RESULTS AND DISCUSSION

The trailing clearance distances were not affected by height and age in both groups ($p>0.05$), in agreement with the literature [5-6]. Smaller leading heel-obstacle distances were found in the older group for all heights ($p<0.05$), suggesting that the older subjects may have higher risk of stumbling when the leading limb was crossing.

When the trailing toe was above the obstacle, the older group adopted bigger trailing hip flexion angles as well as bigger hip extensor, hip abductor and knee abductor crossing moments of the leading limb for all heights. Similar results were also found in the leading peak moments. Bigger joint crossing moments and more flexed positions of the stance limb may help to maintain a better stability. Bigger peak moments indicate that higher muscular demand was needed in the older group. In order to achieve the same trailing toe clearance as the young group, the older adults adopted bigger trailing hip crossing flexion angles.

The results of the study suggest that different temporal-distance, kinematic and kinetic strategies were used by the two age groups. The older group, with age-related muscle weakness, degradation of balance control and coordination, adopted a more conservative strategy possibly due to safety requirements.

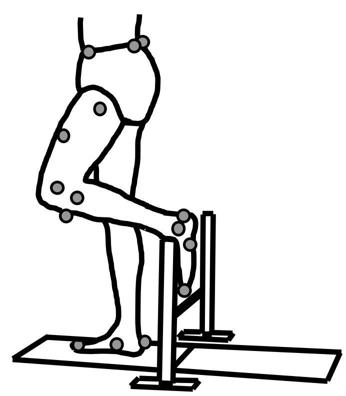

Figure 1: Schematic diagram showing a subject's trailing limb crossing a height-adjustable obstacle while the leading limb is the stance limb.

REFERENCES

1. Tinetti ME, et al. *N Engl J Med* **319**, 1701-1707, 1988.
2. Chen HS, et al. *J Gerontol* **46**, M196-M203, 1991.
3. Patla AE, Rietdyk S. *Gait Posture* **1**, 45-60, 1993.
4. Chou LS, Draganich LF. *J Biomech* **30**, 331-337, 1997.
5. McFadyen BJ, Prince F. *J Gerontol* **57A**, B166-B174, 2002.
6. Draganich LF, Kuo CE. *J Biomech* **37**, 889-896, 2004.