AGE-RELATED JOINT TORQUE ANALYSIS DURING SUPPORT PHASE OF SINGLE STEP RECOVERY

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INTRODUCTION

Unintentional falls were the leading cause of non-fatal injury in every age group except for 15 -24 year olds for the year 2002 [1]. In 1995, $64 billion dollars was spent on medical costs stemming from 14 million injurious falls [2]. Falls in the elderly can lead to many health problems including hip fractures or even death. Previous studies have shown that older adults have a reduced ability to recover from a forward fall than younger adults. The purpose of this study was to investigate age-related differences in joint torques during the support phase of recovery from a forward fall.

METHODS

Twenty healthy male subjects, 10 young (20.6 ± 1.3 years) and 10 older (74.0 ± 6.5 years) participated in the study. A forward fall was simulated by releasing subjects from a forward leaning posture. Subjects stood with each foot on a force plate with their weight evenly distributed. Once the cable was released, participants recovered by taking one step with the right leg onto an oversized forceplate. The degree of the lean was measured by the percent body weight on the cable as determined by a load cell. Initial lean was 12% body weight (BW) and increased by 4% BW after successful recoveries. The data collection ended when two unsuccessful attempts at one lean magnitude occurred. Failure to recover was defined as: 1) more than one step was taken by the right leg, 2) greater than 30% BW applied to the harness during the trial, and 3) a step of the left foot greater than 30% of body height. To prevent a fall from occurring, participants wore a full body harness.

A 2-D model of 4 rigid segments (foot, thigh, shank, head-arms-trunk) was used for torque estimation. Peak extensor torques were calculated for the support phase of balance recovery (SPBR). Body segment data was sampled at 200 Hz with an Optotrak optoelectric motion analysis system. Force plate and load cell data were sampled at 1000 Hz.

A repeated measures analysis of covariance was run on the dependent measures of peak extensor torques at the hip, knee and ankle with the independent variables being lean angle and age. Height and weight were used as the covariates. Directional hypotheses based on previous studies of observed age related differences in joint torques were used to improve statistical power [3].

RESULTS AND DISCUSSION

Young subjects were able to recover from a significantly larger lean angle than the older participants (29.9 ± 4.0° vs 20.5 ± 4.0°, $p < .001$). During the SPBR, joint torques of the hip, knee, and ankle were predominately extensor (or plantar flexor) dominant. The order for which the peak torque extensor occurred was the hip followed by the knee and finally the ankle. Peak extensor torque significantly increased with increasing lean angle at the hip, knee, and ankle. Older subjects had a significantly lower peak knee extensor torque during SPBR compared to young subjects. There was no significant age related increase in the hip extensor ($p=0.084$) or decrease ankle plantar flexor torque ($p=.909$) but a trend of larger torques in older adults was seen (fig 1).

Although the general pattern of joint torques is similar for young and older adults, the peak extensor torque values suggest a possible difference in strategy across age groups during the SPBR of single step recoveries. The extensor torques helped decelerate the body rotation about the obstacle and assisted in resisting the buckling of the stepping leg. A post-hoc power analysis was performed and showed a small increase in sample size, 5 for the hip and 6 for the ankle, would have shown significance.

CONCLUSIONS

Age related differences and trends seen in the joint torques is believed to be a combination of age related reduction in muscle strength along with neuromuscular adaptation to lessen the effects of muscle strength loss on physical performance capabilities [3].

REFERENCES

1. Center for Disease Control. WISQARS Leading Causes of Nonfatal Injury Reports. 2002.
2. Englander F, et al.. *J Forensic Sci* **41**, 733-746, 1996.
3. DeVita P, et al.. *J Appl Physiol* **88**, 1804-1811, 2000.

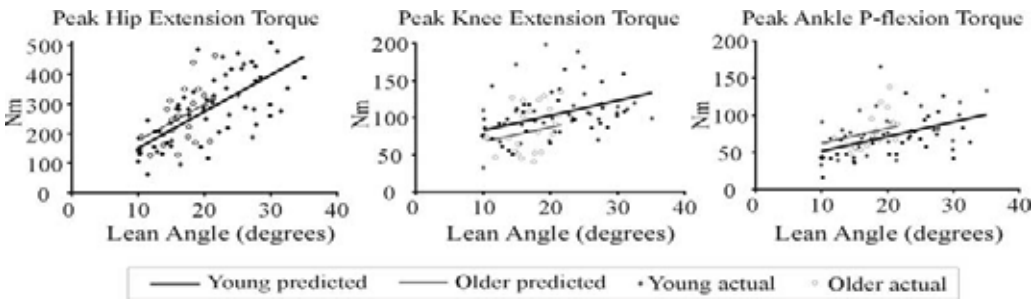

Figure 1: Peak extension and plantar flexion torques for both young (closed circle) and older adults (open circle) at all lean angles. Positive torque corresponds to extensor or plantar flexor dominance.