THE EFFECTS OF AGE AND STEP LENGTH ON JOINT KINEMATICS AND KINETICS DURING THE MAXIMUM STEP LENGTH TEST

Brian Schulz [1], Neil Alexander [2], and James Ashton-Miller [2]

[1] Patient Safety Center, James A. Haley VA Hospital, Tampa, FL, USA
[2] University of Michigan, Ann Arbor, MI, USA
E-mail: Brian.Schulz@va.gov Web: www.patientsafetycenter.com

INTRODUCTION

The Maximum Step Length (MSL) test is a clinical measure of the maximal distance that can be reached using a single 'out-and-back' step with the arms folded across the chest. The MSL test can be used to determine whether the elderly are at an increased risk for falls (Medell and Alexander 2000; Cho et al. 2004), but little is known about the kinematic and kinetic determinants of the known age-related decrease in MSL performance.

METHODS

Eleven unimpaired young (mean age=24 years) and 10 older (mean age=73 years) women performed the MSL test. Body segment motions were recorded during the MSL at 100 Hz using an Optotrak 3020 system and ground reaction forces were recorded at 1000 Hz using four AMTI force plates. Joint kinematics and kinetics were calculated using an inverse dynamics model (Thelen et al., 1997) in order to determine the effects of age and step length of the biomechanics of maximal length stepping.

RESULTS AND DISCUSSION

Young subjects stepped 38% farther than the old subjects ($p<0.0001$) with only one old subject stepping within the range of the young (Table 1). The young used twice the ankle plantarflexion torque and power ($p<0.04$) to perform the MSL and the ankle rotated faster (PF=13% & DF=24%, $p<0.02$) for longer steps. The young women attained 31% greater knee extension velocities during the double support phase between landing the "step out" and lifting off for the "step in". Also during this "pushback" phase the young reached their peak knee extension torques during knee flexion, while the old reached their peak knee extension torque during the later knee extension just before step-in foot lift off (Figure 1). Hip joint kinematics and kinetics increased with step length ($p<0.0005$) regardless of age.

Table 1: Mean (SD) subject characteristics and maximum step length (MSL)

	Young Women	Older Women
N	11	10
Age (years) [a]	24 (3)	73 (5)
Height (m)	1.63 (0.07)	1.60 (0.05)
Weight (kg) [b]	55 (5)	68 (14)
BMI (kg/m^2) [b]	21 (2)	27 (6)
MSL (m) [a]	1.28 (0.09)	0.93 (0.15)
MSL range (m)	1.13-1.43	0.66-1.20

[a] indicates $p < 0.0001$ and [b] indicates $p < 0.01$

SUMMARY/CONCLUSIONS

MSL test performance is most strongly related to peak hip kinematics and kinetics. Age, but not step length, was responsible for the delay in peak knee extension torque and reduced peak plantarflexion torque and power used during the double support phase of the MSL test. The correlation between these age-related changes and an inability to prevent a fall using a step should be examined in future research.

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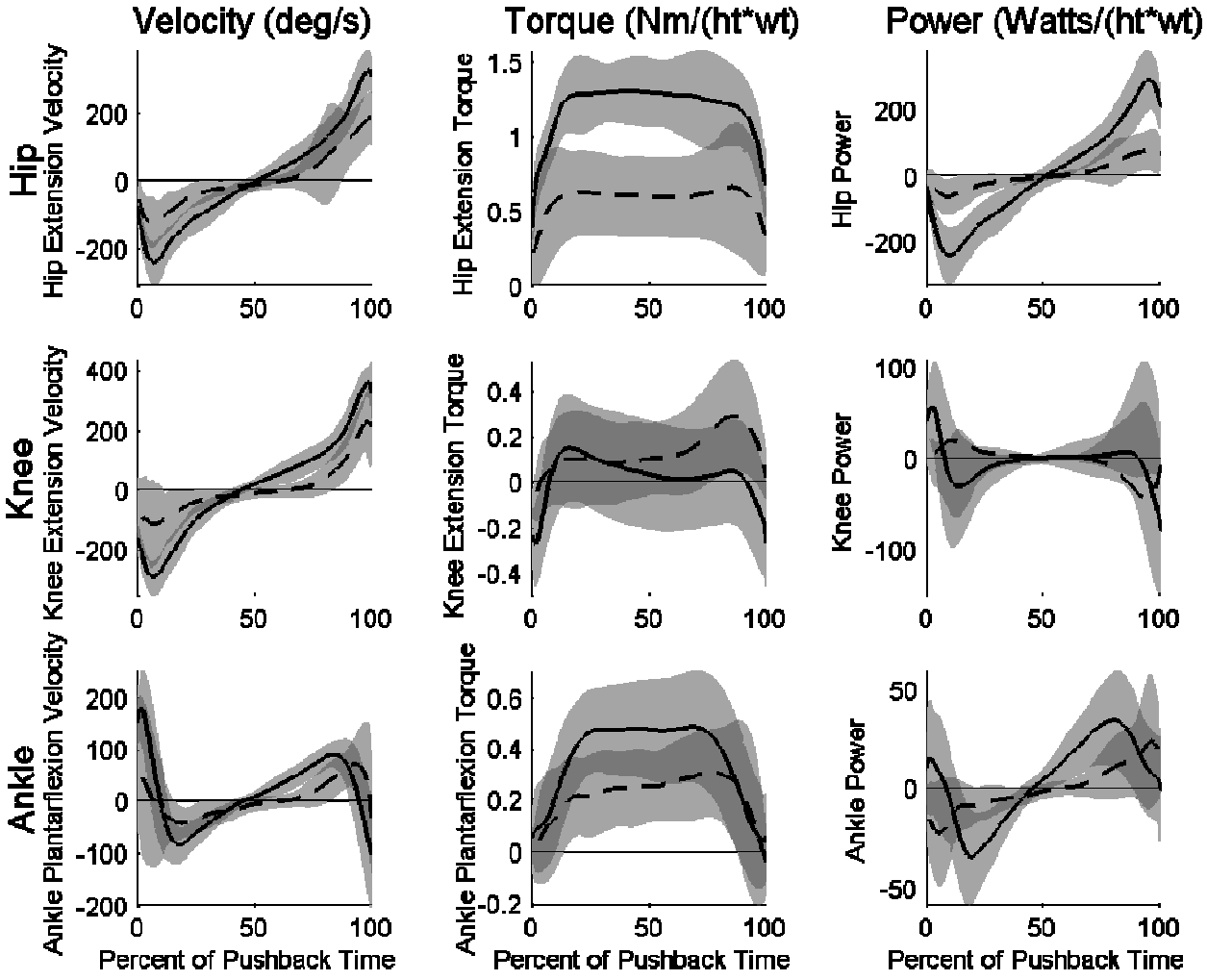

Figure 1: Mean hip (top row), knee (middle row), and ankle (bottom row) velocity (left column), torque (middle column), and power (right column) profiles during the 'pushback' (dual support with feet apart) phase of the MSL test for young (solid line) and older (dashed line) women averaged across all subjects. Shaded area represents ±1SD. Time is normalized to duration of pushback. Torques and powers are normalized to subject weight and height.