3D UPPER BODY ACCELERATION MAGNITUDE FOR SELF-SELECTED AND FAST WALKING SPEEDS IN YOUNG AND OLDER ABLE-BODIED ADULTS

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INTRODUCTION

Changes in the aging neuromuscular system contribute to the decline of the functional capacity of the elderly with serious implications with respect to increased frequency of falls [1]. Quantification of the trunk/head kinematics (passenger of the locomotion system) during gait for different age groups, under various conditions may help identify potential degenerations in the control of the head [2]. A significant body of research exists examining trunk motion during gait, however, most of it includes a small number of subjects and a limited number of it includes head kinematics in 3D [2,3]. The purpose of this study was to assess whether any age or speed-related differences exist in the acceleration magnitude of the head and pelvis during self-selected normal and fast walking speeds.

METHODS

A total of 162 healthy adults/elderly participated in the present study. These subjects were classified in three age groups (G1, N=54, 24.4±5.8 yr; G2, N=60, 49.7±5.4 yr; G3, N=48, 70.4±5.7 yr). Subjects were asked to walk with a steady velocity of progression across a 10 m walkway at self-selected normal and fast walking speed, while 5 gait trials were collected at each speed using a 6-camera VICON system. A full-body marker set was used (31 markers) for gait analysis. The 3D location of the center of the pelvis and center of the head were determined. Velocity of progression, cadence, and stride length were determined. The instantaneous acceleration patterns for the pelvis and head in 3D (laboratory coordinate system) were derived using finite differences. The magnitude of the 3D accelerations: antero-posterior (AP), medio-lateral (ML), and vertical (VER) for pelvis and head were calculated using the root mean square (RMS) of the waveform patterns over the gait cycle. Univariate two-way repeated measures ANOVA was used to test for differences between age-groups (between effect) and between walking speeds (within effect).

RESULTS AND DISCUSSION

The older group walked with slower velocity of progression than the 2 younger groups for both speed conditions (Table 1). The average increase in velocity between speed conditions was 18.3% (normal, 1.32 m/s; fast, 1.56 m/s). There were no group differences in percent velocity of progression increase.

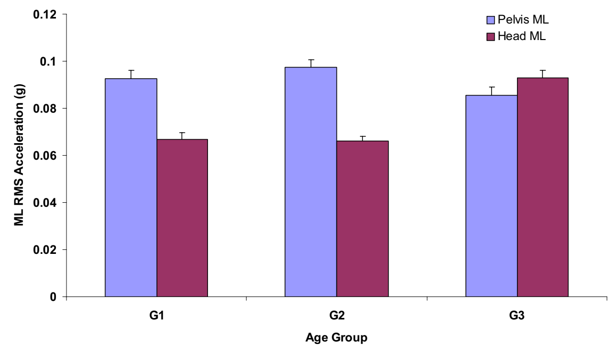

Figure 1: Mean (±SE) of pelvis and head acceleration magnitude (RMS) in the ML direction for all three groups.

The acceleration magnitude in all directions increased with speed, as expected. Between groups differences in acceleration magnitude were found for the pelvis in the AP direction ($p < .001$) and for the head in the ML direction ($p < .001$). There were no group differences in the VER direction. The elderly group walked slower than the younger groups and for both speed conditions exhibited greater head acceleration magnitude in the ML direction. Interestingly, the magnitude of the ML acceleration for the head in the older group was significantly higher than the ML acceleration magnitude of their pelvis ($p < .05$) for both speed conditions (Figure 1). This data suggests that, while accelerometric 3D analysis is a promising tool in accessing dynamic balance for older adults, the dual reference point (pelvis, head) techniques can provide further insights in the control of the head motion for vestibular and visual field stability.

CONCLUSIONS

The musculoskeletal structures of the trunk in the elderly are unable to filter locomotion perturbations in the ML direction. The younger subjects use their trunk effectively to adjust the disturbances introduced by the locomotion to the pelvis.

REFERENCES

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2. Menz HB, et al. *Gait & Posture* **18**, 35-46, 2003
3. Moe-Nilseen R. *Clin Biomech* **13**, 320-7, 1998

Table 1. Descriptive statistics of the spatio-temporal gait parameters for normal and fast self-selected speed for the 3 age groups.

	Normal Speed			Fast Speed		
Age Groups	Velocity (m/s)	Stride Length (m)	Cadence (steps/min)	Velocity (m/s)	Stride Length (m)	Cadence (steps/min)
G1: 20–39 yrs	1.32 (±0.14)	1.33 (±0.13)	119.2 (±5.2)	1.59 (±0.17) †	1.48 (±0.14)	128.5 (±7.7) †
G2: 40–59 yrs	1.35 (±0.12) †	1.39 (±0.12) †	117.0 (±8.3)	1.58 (±0.14) †	1.51 (±0.14) †	126.6 (±8.9)
G3: 60–79 yrs	1.26 (±0.19)	1.31 (±0.14)	115.8 (±9.5)	1.48 (±0.21)	1.44 (±0.17)	123.7 (±9.5)
	p < .019 *	p < .005 *	NS	p < .002 *	p < .041 *	p < .021 *

NS = no significant group effect, * Significant univariate group effect, † Significant different from G3