MARGIN OF STABILITY DURING BALANCE RECOVERY IN YOUNG AND OLDER ADULTS

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INTRODUCTION

Falls are a leading cause of morbidity and mortality in older adults. Results from a study of thirty-eight older adults that assessed recovery following a sudden forward loss of balance indicated that margin of stability (MoS) at foot contact (FC) was reduced in participants requiring multiple steps to recover compared to participants that were able to recover with a single step [1]. The purpose of this study was to assess differences in MoS between young single steppers (YSS), older single steppers (OSS) and older multiple steppers (OMS) and to investigate the mechanism(s) responsible for a reduced ability to recover. Taking into consideration the findings of Grabiner, et al. [2] it was hypothesised that trunk kinematics would be related to a reduced MoS.

METHODS

Sixteen young (8 male, 8 female) and thirty-one older (16 male, 15 female) adult participants were released from forward restraint using the tether release method [3, 4]. Kinematic data were collected at 200 Hz using an 8-camera 3D motion analysis system (Vicon Motion Systems, LA, USA).

MoS at FC in the anterior-posterior direction was calculated as: MoS = BoS – X_{CM} [5], where BoS is the anterior boundary of the base of support, X_{CM} represents the extrapolated centre of mass (CoM) calculated as:

$$X_{CM} = P_{CM} + \frac{V_{CM}}{\sqrt{g/l}}$$

P_{CM} is the horizontal component of the CoM, V_{CM} is the horizontal CoM velocity, g is the acceleration of gravity and l is the distance between the CoM and the centre of the ankle joint in the sagittal plane.

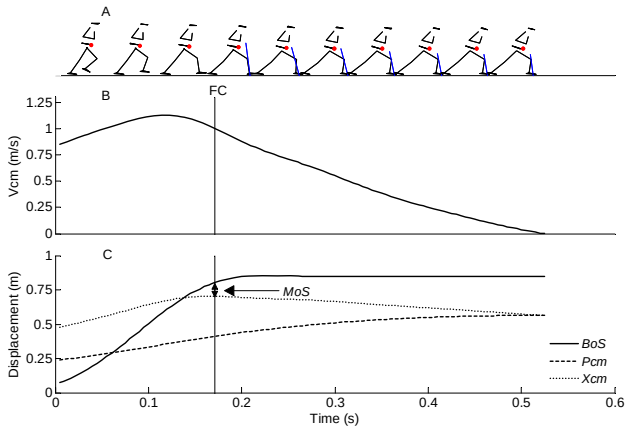

Figure 1. Biomechanical parameters collected from toe off to cessation of V_{CM} (30 year old male), FC = foot contact. (A) Sagittal plane depiction of recovery biomechanics, (B) V_{CM}, (C) BoS, P_{CM}, X_{CM}. MoS at FC = 0.078 m.

Data were analysed using Matlab (v2007a, The MathWorks, Inc., Natick, USA) and SPSS (v13, SPSS, Inc., Chicago, USA). Between-group ANOVA was used to assess group differences. Significance was accepted at $p < 0.05$.

RESULTS AND DISCUSSION

Participants were divided into three groups: young single steppers (YSS, n=16), older single steppers (OSS, n=12) and older multiple steppers (OMS, n=19). Statistical comparisons are presented in Table 1.

Table 1. MoS parameters at FC (mean ± SE) and related kinematic variables (mean ± SE).

	YSS	OSS	OMS
MoS [m]	0.07 ± 0.05	0.03 ± 0.03	-0.08 ± 0.09 *†
BoS [m]	0.80 ± 0.12	0.72 ± 0.11	0.65 ± 0.11 *
P_{CM} [m]	0.47 ± 0.06	0.46 ± 0.08	0.46 ± 0.08
X_{CM} [m]	0.73 ± 0.09	0.70 ± 0.11	0.74 ± 0.11
V_{CM} [m/s]	0.90 ± 0.12	0.85 ± 0.13	0.97 ± 0.20
Step Duration [s]	0.18 ± 0.03	0.18 ± 0.03	0.17 ± 0.02
Step Length [m]	0.72 ± 0.11	0.66 ± 0.10	0.59 ± 0.11 *
Trunk θ [deg]	22.3 ± 8.11	31.3 ± 13.6	35.8 ± 8.10 *
Trunk ω [deg/sec]	34.0 ± 26.7	59.7 ± 28.2	65.3 ± 34.5 *

*p<0.05, YSS vs. OMS, †p<0.05, OSS vs. OMS

MoS at FC differed significantly between OSS and OMS, and between YSS and OMS. In contrast to the findings of Arampatiz, et al. [1] differences between OSS and OMS could not be attributed to particular MoS parameters, suggesting a cumulative effect of multiple parameters. Although OMS took shorter steps than YSS there were no differences in the P_{CM} position due to the increased amount of trunk flexion adopted by EMS. These results are consistent with the findings of Grabiner, et al. [2] who suggested that the ability to limit trunk motion during trips and slips discriminated OMS from both YSS and OSS.

CONCLUSIONS

Differences in MoS between OSS and OMS were due to a cumulative effect of multiple parameters. In agreement with the stated hypothesis, differences in MoS between YSS and OMS were due to altered trunk kinematics and a reduced BoS.

REFERENCES

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