BALANCE AND GAIT OF ELDERLY WOMEN DURING STAIRS LOCOMOTION IN HIGH-HEELED SHOES

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INTRODUCTION

It is well known that a large number of falls occur on stairs, and females appear to be at higher risk of stair injury based on the high incidence of stair accidents in the elderly women. But, only few studies have been conducted to evaluate the specific factors that contribute to falls on stairs [1,2], or what the strategies are as one's balance is challenging during stair locomotion (SL). The high falling rate and the threatening consequences indicate important needs for the understanding of biomechanics, the identification of the risk factors and the development of preventive strategies. The purposes of this study are (1) to determine the differences in gait pattern between young and elderly females by examining the changes in temporal and kinematics parameters, and (2) to determine the balance strategies in terms of the changes in body posture, center of mass (COM), and joint position while the balance is challenging by wearing high-heeled shoes (HHS).

METHODS

A five-step wood staircase of 18x28x90 cm in dimension was used. The fifth step was created by a 60cm x 90cm platform. Twenty-five reflective markers were secured to the participant's anatomical landmarks locating on the both sides of the body. An eight-camera Eagle Motion Analysis System (Motion Analysis Corporation, Santa, CA, USA) was used to capture the three-dimensional trajectory data of the markers.

Participants were limited to the individuals who were able to ambulate without using any assistive device and ascend and descend stair without handrail. Five medium body-sized elder females (> 65 y/o) and five young women were enrolled. The participants walked from a start point about 3-5 steps away from the stair to the top platform reciprocally and descended stairs to the start point at their preferred walking speeds under two conditions: wearing low-heeled shoes (LHS) with heel height less than 2 cm and HHS with stiletto more than 5.5 cm. One stride for stair ascent (SA) began with heel contact on the second step and ended with subsequent heel contact of same foot on the step four. For stair descent (SD), one stride began with toe contact on step three and terminated with toe contact of same foot on step one. The data was analyzed utilizing repeated measures analysis of variance (ANOVA) with one within, and one between factor at the 0.05 level of significance.

RESULTS AND DISCUSSION

The temporal phases for SA and SD under two shoe conditions are listed in Table 1. The walking speed of elder females is slower to either in SA or SD. The elder females seem to gain stability by increasing the stance phase, and this tendency is more obvious while wearing HHS. In young female, the major changes of joint and segment motion while wearing HHS are the decreases in hip and knee flexion. For elder females, the most significant changes caused by wearing HHS are increases of hip internal rotation both in SA and SD, and foot varus in SD.

Table 1: Stance and swing phases in percentage and the period of one cycle in second (*Y*: 5 young females; *E*: 5 elder females)

		SA			***SD***		
		Cycle*	ST (%)**	SW (%	Cycle*	ST (%)**	SW (%)
LHS	*Y*	1.19	58.17	41.83	1.16	55.01	44.99
	E	1.58	62.12	37.88	1.59	56. 46	43.54
HHS	*Y*	1.24	60.07	39.93	1.19	55.25	44.75
	E	1.65	64.16	35.84	1.68	58.47	41.53

* The unit is in seconds; **ST: stance phase, SW: swing phase

The maximal peak-to-peak COM displacement in medial-lateral (ML), anterior-posterior (AP) and vertical (V) directions are shown in Table2. The findings in COM displacement agree with the trunk motions in Figure 1. The changes in the trunk movement are also more apparent in transverse plane and frontal plane than in sagittal plane.

Table 2: The peak-to-peak COM displacement in centimeter (*Y*: 5 young females; *E*: 5 elder females)

		SA			***SD***		
		ML	AP	V	ML	AP	V
LHS	*Y*	4.56	67.62	34.14	4.04	66.71	33.03
	E	7.41	64.73	34.22	8.36	65.62	34.13
HHS	*Y*	4.37	68.38	35.58	4.05	68.76	34.32
	E	7.00	64.96	34.84	7.31	63.64	34.05

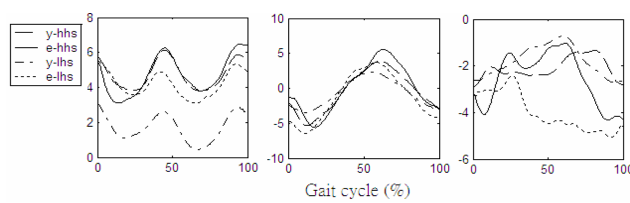

Figure 1: Trunk flexion (+)/extension (-) (right), side-bending (middle), and rotation (left) in degrees

CONCLUSION

The body is like an inverted pendulum during SL, and the elder females accommodate the temporal parameters, and the motion at proximal parts to complete the task. A decrease in maximal excursion of COM displacement in AP direction, and an increase in ML in elder group may suggest that as the elderly restrict the body motion in AP direction to prevent from confronting the risk of falls. Therefore, they need to increase body motion in transverse plane to advance to next step.

REFERENCES

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