BIOMECHANICAL ANALYSIS OF SIT-TO-WALK FREQUENTLY OBSERVED IN DAILY LIVING: EFFECT OF SPEED ON HEALTHY ELDERLY PERSONS

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INTRODUCTION

There has not been enough biomechanical research done about how motions occur in a series and about task-oriented motions. In particular, biomechanical characteristics of the sit-to-walk component of the Timed Up and Go Test have not been accounted for [1], although this series of motions is observed most frequently in daily living. Additionally, there is not enough intervention done to improve the sit-to-walk sequence. We often see people with physical disorders stand up and initiate gait unstably, and we often treat patients who have a history of falls and fractures from attempting to stand up and initiate gait.

The purpose of this study was to clarify the normal characteristics of this series of motions for healthy elderly people.

METHODS

At first, as a pilot study we researched the patterns of the sit-to-walk for healthy elderly people [2]. We asked 18 healthy elderly people to stand up and walk as fast as possible, and we found that there are two patterns for this series of motions. One pattern involved small movements of the lower extremities, which is advantageous for fast motion. The other included large movements of the lower extremities, which are advantageous for stability, in spite of slower motion.

We defined these two motion patterns as the fast motion and the slow motion. In the present study, we analyzed the biomechanical characteristics of these two motions, while constraining the speed of the motions. The characteristics of 8 healthy elderly people (69.8±3.9 years old) were obtained.

Kinematic data was obtained by VICON 512 3D motion capture system (Oxford Metrix Ltd.). Kinetic data was obtained using two Kistler force plates. Ground reaction force (GRF) data was represented as *Fx,* right-left (left is plus), *Fy*, anterior-posterior (anterior is plus), and *Fz*, vertical (upper is plus).

Table 1: Difference between fast and slow motion

		fast	slow
GRF	*Fx* [N]	64.7±12.8	61.6±11.9
	Fy [N]	163.2±27.4	115.7±33.3
	Fz [N]	592.1±70.3	605.2±75.5
COM - CFP inclination			
First toe off [deg]		89.4±4.5	83.2±4.3
First heel contact [deg]		105.5±5.9	93.8±5.7

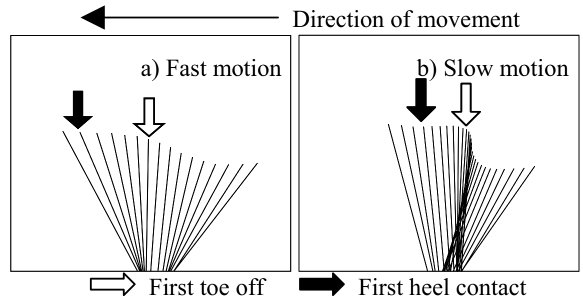

Figure 1: Movement of COM and CFP at y-z plane from starting movement of the head to first heel contact

RESULTS AND DISCUSSION

The maximal value of GRF is indicated in Table 1. Only the component of *Fy* was significantly different between the fast and the slow motions (p<.001). Inclination of the center of the body mass (COM) to the center of the foot pressure (CFP) at the first toe off and the first heel contact was larger in the fast motion than in the slow motion (more than 90 deg; forward inclination, less than 90 deg; backward inclination) (p<.001) (Table 1). During the fast motion, the OFP barely moved at stand up, and then gradually moved forward. During the slow motion, the CFP moved forward at stand up, then moved backward and the first toe off was achieved (Table 1).

In the first swing of the sit-to-walk series, the maximal values of the vertical and lateral GRF of the stance leg were not different for both fast and slow motions. But the forward GRF was significantly larger in the fast motion. GRF means acceleration of COM. So only forward acceleration was larger in the fast motion. In the fast motion, the CFP moved forward gradually and constrained the forward movement of the COM, because the COM moved faster. In the slow motion, the CFP moved forward at stand up in order to constrain the COM movement. COM movement was slower in the slow motion, so the CFP moved backward in order to induce a forward COM movement. We believe that the forward GRF shows a force couple on the sole of foot, and the COM-CFP movement shows a reverse pendular model.

We did not analyze the motions that subjects actually carried out in daily living. This point is a limit of this study. But we think it is important to analyze sit-to-walk as a series of motions.

REFERENCES

1. Janssen WG, et al. *Phys Ther* **82**, 866-79, 2002.
2. Kouta M, et al. Proceedings of the First Asian Pacific Conference on Biomechanics, 109-110, 2004