

### Postural Control Against Perturbation During Walking

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#### INTRODUCTION

To maintain stability of the body when the perturbation was given while moving, the postural control is required otherwise it will cause falling. Although many studies reported on postural control to perturbation in standing[1,2], few study reported on postural control against to perturbation during walking[3]. The purpose of this study was to examine postural control against perturbation during treadmill walking. In addition, we hypothesized a strategy of postural control in such a situation and suggested the effect of aging on postural control.

#### METHODS

Ten young and twenty-nine elderly subjects participated in this study. We used a separated-belt treadmill (Figure 1), and perturbations were produced by rapidly decelerating one side of the walking-belt for 500 ms while walking. To young subjects, two types of the perturbation were given five times each in three minutes walking: 50% deceleration of the initial speed (moderate perturbation) and 100% deceleration of the initial speed (strong perturbation). To elderly subjects moderate perturbations were given five times in three minutes of walking. The electromyogram responses of leg, thigh, and trunk muscles on the both sides and the acceleration at the pelvis were measured. We classified subjects from reaction patterns of muscles, and compared them.



Figure 1: Separated-belt treadmill (PW21; Hitachi, Japan)

#### RESULTS AND DISCUSSION

Four reaction patterns of muscles were observed: “ankle strategy”, “mixed ankle and hip strategy”, and others (Figure 2). Comparing the ankle strategy seen in young and elderly subjects, the response of tibialis anterior on the perturbed side after the perturbation was significantly delayed in elderly subjects ( $p < .05$ )(Figure 3).

The “mixed ankle and hip strategy” observed in this study did not change with advancing trials, although the mixed strategy in standing is defined as the transitory pattern to pure ankle strategy or hip strategy when the stimulus exceeds the control limit. We therefore concluded that the mixed strategy

observed in this study was different from the mixed strategy seen in standing. The pattern of muscle recruitment was immediate antero-distal muscle activities followed by postero-proximal muscle activities after perturbation. This pattern resembled whiplash. We suggest this mixed strategy be established as a new strategy. It is thought that the posture of a subject moves like striking a whip since this new strategy showed the ankle strategy followed by the hip strategy, and we considered this new strategy to be a “whiplash strategy”. Also, this new strategy was seen when the body shake was large, so it is suggested that it is an important strategy for subjects who have low ability of postural control.

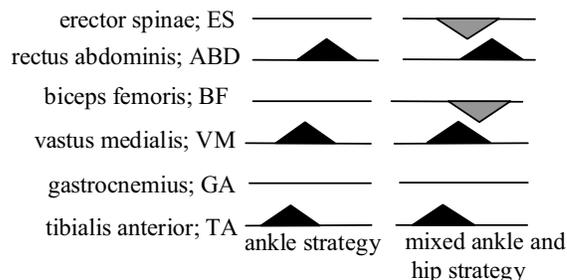


Figure 2: Reaction patterns of muscles

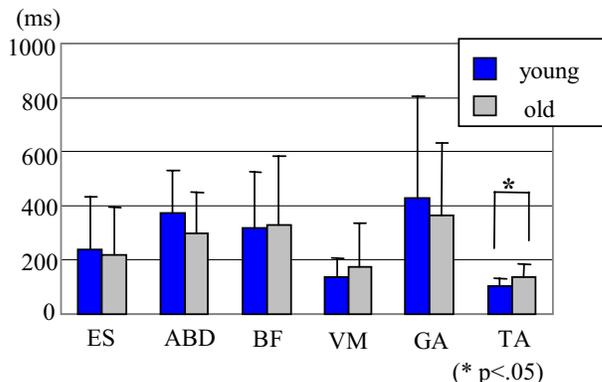


Figure 3: Comparing the ankle strategy (perturbed side) (\*  $p < .05$ )

#### CONCLUSIONS

From these results, we concluded that there is a specific postural control strategy in walking, and there are differences in postural control ability between elderly and young subjects.

#### REFERENCES

1. Horak FB, et al. *J Neurophysiol.* **55**(6), 1369-1381, 1986.
2. Nashner LM. *Exp Brain Res.* **30**, 13-24, 1977.
3. Tang PF, et al. *J Gerontol.* **54**, M89-M102, 1999.