

Brief report

Attenuation of the anticipatory postural adjustments in the frontal plane with the increase of the forward propulsive velocity of step initiation in humans

Taro Ito ¹⁾

Takashi Azuma ²⁾

Noriyoshi Yamashita ³⁾

Abstract

Step initiation involves anticipatory postural adjustments (APA) that propel the center of body mass (CM) forward and laterally before onset of heel off of the swing leg for the first step. It is recognized that the APA in the mediolateral direction (ML-APA) associated with step initiation can counteract lateral instability in a single support of the stance foot before onset of the primary movement. The purpose of this study is to elucidate whether and how the ML-APA, i.e. the EMG activity of postural synergists, the center foot of pressure (CP) towards the swing leg, lateral shear force on the CM for propelling the CM towards the support leg, is modulated with the lateral instability related to the forward propulsive velocity in volitional step initiation. Seven healthy subjects instructed to land on the regular swing-foot placement performed the initiation of a single step forward at two speeds (as fast as possible, FST; normal speed, NML). The anticipatory peak amplitudes of the velocity and displacement of the CM towards the stance leg at FST were significantly lower than those at NML. The present results indicate that the central nervous system may attenuate the ML-APA according to decreasing degree of the lateral instability with the increase of the forward step velocity.

Key words Anticipatory postural adjustments, Step initiation, Frontal plane, Postural instability, Propulsive velocity

1. Introduction

In volitional step or gait initiation from a bipedal stance, a stepping movement cannot be executed until the position of the center of body mass (CM) has reached a given point. Electromyographic (EMG) activities in the tibialis anteriors of both swing and stance legs in step (Ito et al., 2003; Yamashita et al., 1995) or in gait initiation (Crenna and Frigo, 1991), and the gluteus medius and the tensor fasciae latae of the swing and stance legs in step (Yamashita et al., 1995) or gait initiation (Patchay and Gahéry, 2003) were observed prior to the first heel-off, i.e., the onset of a step movement. Consequently, the center of

¹⁾ Department of Health Sciences, Osaka Aoyama University

²⁾ Shitennoji University

³⁾ Institute of Movement Science

- by antero-posterior perturbation: does anticipatory control play a role? *Gait Posture*, 9:190-198.
- Mori, S., Matsui, T., Kuze, B., Asanome, M., Nakajima, K., Matsuyama, K. (1999) Stimulation of a restricted region in the midline cerebellar white matter evokes coordinated quadrupedal locomotion in the decerebrate cat. *J. Neurophysiol.*, 82: 290-300.
- Mori, S., Matsuyama, K., Mori, F., Nakajima, K. (2001) Supraspinal sites that induce locomotion in the vertebrate central nervous system. *Adv. Neurol.*, 87:25-40.
- Nouillot, P., Bouisset, S., Do, M.C. (1992) Do fast voluntary movements necessitate anticipatory postural adjustments even if equilibrium is unstable? *Neurosci. Lett.*, 147:1-4.
- Patchay, S., Gahéry, Y. (2003) Effect of asymmetrical limb loading on early postural adjustments associated with gait initiation in young healthy adults. *Gait Posture*, 18:85-94.
- Rogers, M.W., Pai, Y.C. (1993) Patterns of muscle activation accompanying transitions in stance during rapid leg flexion. *J. Electromyogr. Kinesiol.*, 3:149-156.
- Yamashita, N., Ito, T., Azuma, T. (1995) The process of initiating rapid voluntary movement from a standing position; interrelationship between anticipation and execution components. The 4th IBRO World Congress of Neuroscience; Satellite Symposium. p25.