Basic Research for Constructing a Model of Human Posture Control

Humans control their posture by controlling the muscular activity of the whole body with the cranial nervous system using multi-sensory inputs. The construction of sensory inputs and muscular activity model has a significant meaning medically and biologically because this model leads us to understand how the brain functions. Thus, it is important to examine the relationship between senses and muscular activity as the first steps in constructing this model. Therefore, purpose of this study is obtaining changes in muscular activity by changes in sensory inputs.

To achieve this purpose the method to change sensory inputs is a challenging point. We propose a method of changing sensory inputs by inhibiting or stimulating three senses (visual, vestibular, and somatosensory senses) which are related to posture control. Concretely, A) the visual sense is inhibited by closed eyes, B) the vestibular sense is inhibited by a caloric test pouring cold water into the ear cavity, and C) the somatosensory sense is stimulated by touching a part of the body. Muscular activity is measured by electromyography (EMG) when subject's senses are inhibited or simulated by the method mentioned above. It is considered that the variety of muscular activity influenced by change in sensory inputs is observable by comparing measured muscular activities.

Experiments were performed on 5 subjects using the method mentioned above. Subjects tended to change their posture when their senses were inhibited or stimulated: A) if only the vestibular sense was inhibited, subjects were able to maintain the standing posture (Fig. 1A); B)if both visual and vestibular senses were inhibited simultaneously, subject leaned (Fig. 1B); and C) if both visual and vestibular senses were inhibited and somatosensory sense was stimulated, subject recovered its standing posture (Fig. 1C). The probability of variation of muscular activity by inhibiting or stimulating senses was calculated. The muscles which change in a probability above 0.5 compared with normal condition were colored in Fig. 2. By the difference of the visual sense, activity changes of gluteus maximus muscle in one side in uninhibiting vestibular sense and no muscle in inhibiting vestibular sense were observed. If the vestibular sense is inhibited; gluteus maximus muscle and quadriceps femoris on water-poured side, and hamstring on the other side increase their activity. By the difference of the somatosensory sense; activity changes of gluteus maximus muscles, and tibialis anterior on pouring water side were observed. Therefore, it is confirmed that changes in muscular activity by changes in sensory inputs in standing posture are observable.

Keywords: Mobiligence, posture control, sensory inhibition, standing posture.

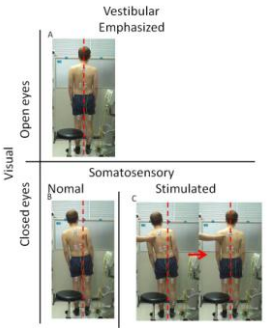

Fig.1 postural changes

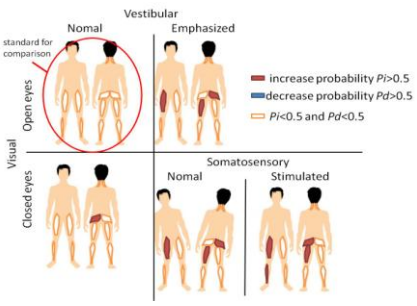

Fig.2 muscle activity compared with normal condition

References

1) Hiroaki Ogawa, Ryousuke Chiba, Kaoru Takakusaki, Hajime Asama, Jun Ota, "Research on the relationship between muscle activity and multimodality of human posture control", 11th SICE System Integration Division Annual Conference, 402/405, (2010) (in Japanese)