Basic Study for Modeling Human Posture Control

This study aims to clarify the mechanism of human posture control including the operation of the brain. We investigate the relationship of sensory input and muscular activity output for modeling. The human posture control is a very complex mechanism with multiple inputs and multiple outputs, because human, in order to move, controls several hundreds of muscular activities based on the information coming from the senses such as the sight, the sense of equilibrium and the somatic sense. Therefore, clarifying the control mechanism including the brain is very significant medically and biologically. It is necessary to construct the model because it is difficult to measure the operation of the brain directly.

We measure muscular activities in upright standing when the sight, the sense of equilibrium, and the somatic sense are obstructed or emphasized. Muscular activities are calculated using musculoskeletal simulator since using only electromyography (EMG) limits the number of measured muscles. Note that the muscles of the whole body are involved in the posture control. We calculate 94 muscular activities using musculoskeletal simulator. Specifically, we estimate non-measured muscular activities by inverse dynamics analysis from the musculoskeletal, ground reaction force, posture and measured EMG.

To verify the effectiveness of the proposed measurement, we experimented on the combinations of the sight obstruction (closed eyes), the sense of equilibrium obstruction (caloric test), and the somatic sense emphasis (contact from the outside) in upright standing. Figure 1 shows the result in the posture change (Fig.1). It is shown that a lot of muscles has activities significantly higher than other muscles not only when the posture is changed (when the sight and sense of equilibrium were obstructed as shown in Fig. 2(b) and Fig. 2(c), respectively) but also during a usual posture (when the sight and the sense of equilibrium were obstructed and the somatic sense was emphasized as shown in Fig. 2(d)). It is considered that these muscle activities are the results of the difference in the sensory input influencing the control system.

Keywords: Mobiligence, posture control model, musculoskeletal simulator, sense obstruction

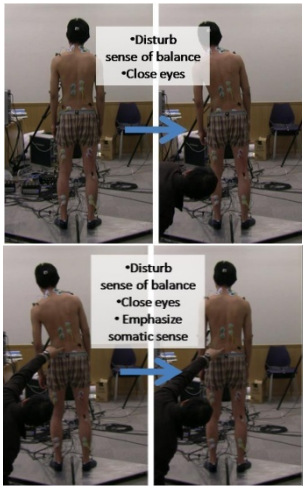

Fig.1 Postural changes under sensory input conditions

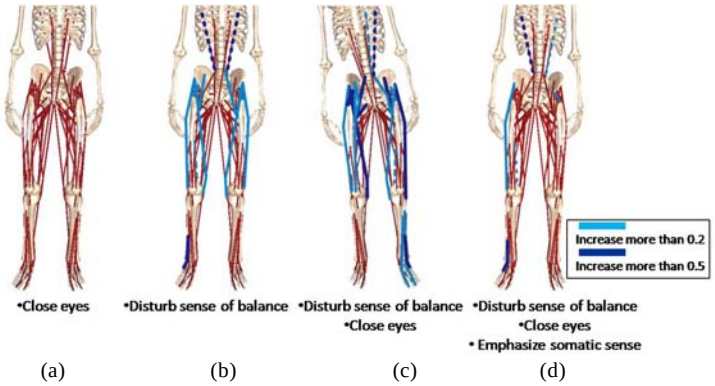

Fig.2 Muscle activity compared with normal condition