Evaluation of changes over time in stance postural control mechanisms in stroke patients

Stroke is mainly caused by rupture or occlusion of an artery, which interrupts blood flow to the brain, resulting in a lack of oxygen. Stroke patients often have balance problems and are at increased risk of falling. Although there have been studies on the ability of stroke patients to balance while standing, there have been no studies on the control mechanism.

We investigated the characteristics of sway in the stance posture of stroke patients by using a neural controller model that we have developed. The musculoskeletal model that can represent the asymmetrical posture that stroke patients often show is controlled by the neural controller model. The control parameters were adjusted using optimization to reproduce the patient's sway features obtained from motion capture. The adjusted control parameters were subjected to dimensionality reduction by non-negative matrix factorization, and the differences in the control parameters among the groups were compared.

As a result, the dimensions of 45 control parameters were reduced to 6 dimensions. Comparing stroke patients and young healthy participants, significant differences were confirmed for two of the six components. This indicates that the proposed method can capture differences in postural sway characteristics between different groups. These two components are related to the extension of each joint, and to the suppression of rapid extension of the lumbar region and ankle.

In the future, we will investigate how the control parameters change depending on the site of injury and the number of days since the onset of injury, and aim to identify the factors that are important for effective functional recovery. In order to prevent patients from falling, it is essential to examine not only the quiet stance posture, but also how the patient maintains the stance posture when subjected to external forces. We aim to analyze both conditions using a mathematical model in conjunction with our previous postural simulations under external disturbance.

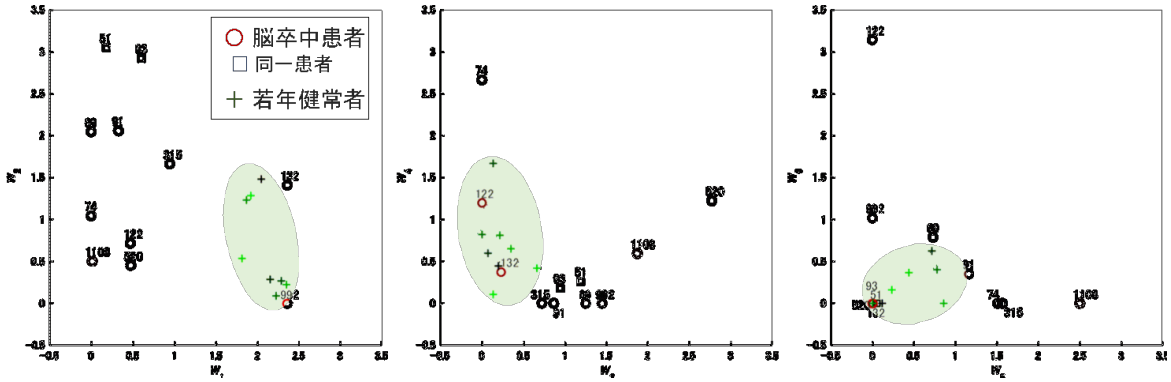

Figure 1. The control parameters fitted to the experimental data are dimensionally reduced to 6 dimensions. The green ellipse indicates the area where young healthy participants are distributed. Significant differences were observed between stroke patients and young healthy participants for components 1 and 3.

Keywords: Stroke, Musculoskeeltal model, Forward dynamics simulation

References

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