Alterations of spinal range of motion while sitting in hemiplegic patients with or without gait available

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Abstract. [Purpose] The purpose of this study was to determine alterations of spinal range of motion while sitting, in hemiplegic patients with or without gait available. [Subjects] There was a gait group (GG) of 6 subjects, and a non-gait group (NGG) of 6 subjects, both with hemiplegia after a stroke. [Methods] The subjects in both groups were given an intervention focusing on ankle dorsi-flexion of the affected foot only once for 30 minutes. The Spinal Mouse was used to gain data of the spinal range of motion before and after the intervention and 30 minutes later for follow-up test. [Results] Only in the gait group, lumbar spinal range of motion showed a significant difference when using flexion extension. Sacral hip and inclination were both increased gradually when upright flexion and flexion extension were used. [Conclusion] Facilitating foot for ankle dorsi-flexion is effective on spinal range of motion especially sacrohip, lumbar spine and inclination only for the subjects in the gait group. The results suggested that ankle dorsi-flexion exercise influences spinal range of motion in a sitting position. 

Key words: Ankle dorsi-flexion, Hemiplegia, Trunk

INTRODUCTION

Smaller displacement of the global center of pressure with less body weight bearing on the feet results in less displacement of center of mass (COM) during trunk flexion in persons with hemiplegia1). Postural control is the capability to control the body weight by keeping COM within of the base of support (BOS)2). Patients with hemiplegia after a stroke have difficulty managing their COM with their BOS. By having the patients using a posterior pelvic tilt during trunk movements, compensatory strategies were applied. These strategies are used in the upper trunk level and the pelvis. Those factors restrain the functional performance, such as a decreased range of motion and stiffness3). The contributing factors which should be achieved are the postural tone regulation, particularly in the extensor antigravity musculature and correct foot placement1). Corticospinal system damage can generate long-term failure of the intrinsic musculature activation in the foot. So, it is necessary to gain ability to extend the toes for the selective dorsi-flexion. The soleus is another factor contributing to poor dorsi-flexion of the foot unless it is properly lengthened and strengthened as an antagonist4). So, facilitated ankle dorsi-flexion of the affected foot influences trunk range of motion when not only flexing forward, in particular, but also with the backward flexion of the trunk in a sitting position. Therefore, this study intends to reveal the relationship among ankle dorsi-flexion, spinal range of motion and gait ability.

SUBJECTS AND METHODS

In this study, there was a gait group (GG) of 6 subjects including 5 males and 1 female with the mean age of 61 years, and a non-gait group (NGG) of 6 subjects including 4 males and 2 females with the mean age of 63 years old, all participants with hemiplegia after a stroke. The subjects in the GG were able to walk by themselves but the subjects in the NGG were not. Five patients had left hemiplegia and 1 patient had right hemiplegia with a mean of 12 months of time after a stroke in the GG: Four patients had left hemiplegia and 2 patients had right hemiplegia with 27 months of it in the NGG. There were no significant differences in the homogeneity between 2 groups in general characteristics. Inclusion criteria were as follows: (1) unilateral stroke with hemiparesis; (2) medical stability; and (3) capability to comprehend the test procedures. The exclusion criteria were: peripheral neuropathy; orthopedic problems. Both groups were gathered from D hospital in Jeonjoo and this study took place from Novem-
ber 17 to December 19, 2014. The test was conducted before and immediately after the intervention and 30 minutes later. The subjects were provided informed consent documents to take part in the study prior to its commencement and this study followed the principles of the Declaration of Helsinki. The Spinal Mouse (Idiag, Volkerswill, Switzerland) was to measure the spinal range of motion. A physical therapist who had 11 years of clinical experience treated the subjects with the intervention for 30 minutes just once per each subject. All subjects were informed about the procedure to make sure of the subjects’ safety before applying the intervention. The following intervention was provided:

At first, the researchers made sure the patient would be in an optimal sitting position on a plinth. After stretching the intrinsic muscles of the affected foot, the tibialis anterior, extensor hallucis longus, extensor digitorum longus were facilitated using a combination of distraction, compression and movement of toes to get the toe extension involved. After that, the soleus was lengthened with the gastrocnemius held. The next step was making the affected knee flex and extend repeatedly with the ankle eversion plus dorsiflexion to activate the distal part of the rectus femoris. All data was analyzed using SPSS version 18 (Statistical Package for the Social Science). The Kolmogorov-Smirnov test was used for normal distributions. All data is presented as the mean with standard deviation (SD). Variations in spinal parameters obtained by Spinal Mouse within each group were tested with the Friedman test. A $\alpha=0.05$ level of significance was used for all statistical tests.

### RESULTS

The sacral hip angle in the GG increased from $32.4\pm 11.7^\circ$ in pre-test to $40.3\pm 10.9^\circ$ in post-test to $41.4\pm 9.0^\circ$ in follow-up when upright flexion was used inclination increased from $71.9\pm 7.9^\circ$ in pre-test to $78.3\pm 6.3^\circ$ in post-test to $80.5\pm 11.3^\circ$ in follow-up test in the GG. When flexion extension was used, sacral hip angle increased from $36.3\pm 9.0^\circ$ to $38.4\pm 12.7^\circ$ to $50.9\pm 13.5^\circ$ and inclination increased from $80.0\pm 7.9^\circ$ to $87.1\pm 8.3^\circ$ to $88.3\pm 14.5^\circ$ in pre, post and follow-up test in the GG. However, lumbar spine angle decreased significantly from $42.6\pm 8.8^\circ$ to $36.1\pm 12.0^\circ$ to $35.3\pm 14.1^\circ$ in pre, post and follow-up test in the GG when flexion extension was used (Table 1).

### DISCUSSION

In a previous study, spinal range of motion (ROM) tended to increase down the vertebral column in flexion extension (FE). L3–4 FE ROM was significantly greater than L1–2 and L4–5. And L5–S1 FE ROM were significantly greater than for every other level ($p<0.003$). As in the previous study, the lower part of vertebral body is much more mobile than others. Sacral hip angles in both upright flexion and flexion extension increased gradually in the GG in this study. This is because the hip joint is a main joint not only for bearing body-weight, but also for giving the most mobility when bending the trunk forward and backward while sitting. Even though the lumbar spine angle decreased by about 6.5 and 0.84 degrees little by little, the sacral hip angle compensated for the amount of the decrease by increasing 2.09 and 12.49 degrees steadily in the GG. It had the same result in upright extension as that in upright flexion in the GG. This has an important implication, in that lumbar spine angle and sacral hip angle have a close relationship to one another when trying to bend the trunk forward and backward. If the lumbar spine angle is smaller than before, then the sacral hip angle...
becomes larger than what it was for compensation. In addition, inclination in flexion extension increased gradually by 7.17 and 1.16 degrees in each test in the GG. This has two additional significant implications. First, the inclination is closely interrelated with the sacral hip angle positively which means that, as the results have shown sacral hip angle influences the extent of trunk mobility in sitting position. Second, increased total range of inclination means that the subjects have a decreased possibility of falling down when compared to subjects with a lesser range of inclination. In a previous study, the falls group has a considerably decreased mobility of spinal inclination as compared to those in the non-falls group. In clinical insight, inclination is much more important than other factors when it comes to postural stability. To create a more stable posture, we need wider stability limit which means that we have to have an ability to transfer the center of mass as far as possible without a change of base of support. Therefore, this study suggests that subjects who have bigger sacral hip range can bend their trunk forward and backward farther. As a result, more pay attention should be paid to the mobility of sacral hip in order to get better postural control in the sitting position.

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