EFFECTS OF 10 WEEKS TRAINING PROGRAM ON LOWER EXTREMITY STRENGTH AND VERTICAL REACTION FORCE DURING SIT-TO-STAND IN CHRONIC STROKE PATIENTS

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The purpose of this study was to investigate the effects of 10 weeks training program on lower extremity strength and vertical reaction force during sit-to-stand movement in chronic stroke patients. Maximum vertical ground reaction force, difference of vertical ground reaction force between left and right foot, COP in anteriorposterior and mediolateral direction did not show any significant time main effect. However, the difference of body weight distribution between the left and right foot was decreased in experimental group after training. The peak torque generated by the flexors of the paretic limb at 60°/sec and 180°/sec in experimental group changed from baseline, an increases of 30.23% and 24.09%, respectively. These results appear that 10 weeks training program improves sit-to-stand movement and lower extremity strength in chronic stroke patients.

KEY WORDS: sit-to-stand, stroke, isokinetic strength, reaction force

INTRODUCTION: The sit-to-stand movement is a function people use as they change from sitting to standing and walking. The ability to stand from the sitting position is an important component in maintaining independence in daily life. Stroke is the leading cause of major disability in elderly Koreans. Asymmetric dynamic posture and movement is the most prevalent locomotor deficit of stroke-related hemiparesis (Winstein et al., 1989). Hemiparetic patients rise slowly and insecurely. They tend to put more weight on the non-affected limb. During the rehabilitation, patients are encouraged by a physical therapist to put weight on both limb, to incline forward, and to avoid excessive mediolateral displacements of the head-arm-trunk segment (Hesse et al., 1994). Although most motor and functional recovery occurs in the first 3 months after stroke, hemiparetic patients need to be participated in therapeutic exercise program in order to maintain and improve performance. The purpose of this study is to investigate the effects of 10 weeks training program aimed at improving sit-to-stand movement and strength of lower extremity in hemiparetic patients.

METHODS: Two groups of chronic hemiparetic patients, experimental (age: 70.45 ± 5.26 yrs, BW: 68.6 ± 11.41 kg, onset of stroke: 5.44 ± 2.77 yrs) and control (age: 70.42 ± 6.70 yrs, BW: 64.6 ± 15.5 kg, onset of stroke: 4.02 ± 1.45 yrs), participated in this study. The experimental group participated in a 10-week training program (three sessions/wk, 1 - 1.5 hr/session) consisting of a warm-up, aerobic exercises, lower extremity strengthening, and a cool-down. The control group participated in home based exercises. Both groups were pre-and-post tested. Two force platforms (AMTI, ORG-6) were used to measure ground reaction forces. Subject's each foot was rested on each force platform. Subjects were seated on armless, backless chair, which was adjusted to the height of the subject's knee as determined as the distance from the lateral knee joint. The subjects were asked to stand with a self-selected speed with arms crossed. They performed 5 trials of sit-to-stand. Knee extension and flexion force were measured by using isokinetic dynamometer (IsoMed 2000). Subjects were asked to "push and pull" as hard as possible for five times at speeds of 60 °/sec and 180 °/sec. The average peak torque (N·m) was calculated from the three best repetitions, which was also normalized for the subject's body weight.
We defined duration of sit-to-stand movement as beginning with decrease of vertical force by more than 2.5% of feet weight and finishing with the point when the vertical force was 2.5% plus/minus body weight (Hirschfeld et al (1999) and Kralj et al (1990)). Maximum vertical force was measured as the sum of the ground reaction forces of both feet. The difference of weight bearing paretic and non paretic limb was calculated as the percentage of body weight.

The center of pressure sway for whole body was calculated (Winter et al., 1993). Repeated measures ANOVA was used to analyze the effects of training program on lower extremity muscle strength and vertical reaction force during sit-to-stand movement.

RESULTS AND DISCUSSION:

Sit-to-stand movement: A representative tracing of continuous force as a function of time during rising from a chair for one chronic stroke patient is demonstrated in Figure 1. Ground reaction force outcome measures are displayed in Table 1. The results demonstrated significant main effect for group was found for Max VGRF ($F = 4.615$, $p = 0.047$) and LR-VF-Diff (% BW) ($F = 5.545$, $p = 0.025$). Even though no significant time main effect and interactions (group x time) were not found for LR-VF-Diff (% BW), the difference of body weight distribution between the left and right foot was decreased in experimental group after 10 weeks training program. No significant differences were found for COP X and COP Y. However, the COP X and COP Y in control group were larger in posttraining than those in baseline. The greater changes of COP X and COP Y in control group indicated poor dynamic postural stability. Both the experimental and control group showed significantly longer duration in posttraining than that in baseline. It is necessary to analyze sit-to-stand movement throughout kinematic analysis.

Lower extremity muscle strength: The peak torque generated by the non paretic knee flexion at 180 °/sec ($F = 4.39$, $p = 0.042$) showed significant group main effect (Table 2). The paretic knee flexion at 60 °/sec in experimental group showed greater increase in posttraining than that in baseline. The peak torque generated by the flexors of the paretic limb at 60 °/sec and 180 °/sec in experimental group changed from baseline, an increases of 30.23% and 24.09%, respectively. Figure 2 summarizes changes in knee muscle torque production at posttraing for experimental group.

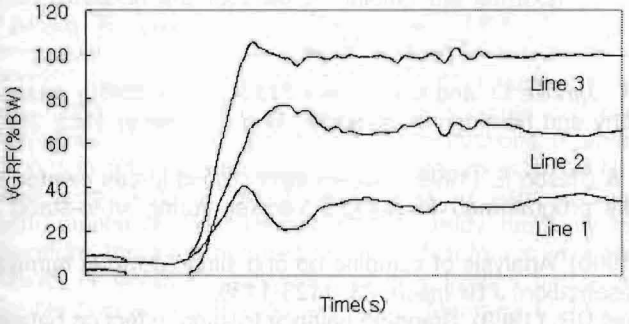

Figure 1 Representative of vertical ground reaction force change from sit-to-stand movement in one hemiparetic patient. Line 1, paretic limb; Line 2, non paretic limb; Line 3, sum of paretic and non paretic limb.

Table1 Body weight distribution and COP sway during the sit-to-stand movement in two groups.

Variables	Time	Experimental group	Control group
Duration (sec)	Baseline	3.10 ± 0.45	3.02 ± 0.45
	Posttraining	3.64 ± 0.97	4.0 ± 0.56
Max VGRF (%BW)	Baseline	69.89 ± 7.5	64.02 ± 7.45
	Posttraining	67.52 ± 6.88	63.17 ± 5.42
LR-VF-Diff (%BW)	Baseline	18.66 ± 14.47	8.36 ± 8.5
	Posttraining	16.66 ± 8.5	8.41 ± 6.93
COP X (cm)	Baseline	8.42 ± 1.81	8.74 ± 2.36
	Posttraining	9.54 ± 2.31	10.11 ± 4.11
COP Y (cm)	Baseline	5.49 ± 2.54	3.83 ± 1.55
	Posttraining	5.41 ± 2.74	6.09 ± 2.87

Abbreviations: Max VGRF, maximum vertical ground reaction force; LR-VF-Diff, vertical force difference left and right; COP X, COP in anterioposterior displacement; COP Y, COP in mediolateral displacement.

CONCLUSION: This study highlights the importance of training for chronic stroke patients. The study may provide the understanding of sit-to-stand movement and the lower extremity muscle strength in stroke patients.

Table 2 Peak torque at baseline and posttraining for two groups.

Variables	Time	Experimental group	Control group
Non paretic knee flexion at 180°/sec (N·m/kg)	Baseline	0.48±0.26	0.27±0.17
	Posttraining	0.597±0.36	0.301±0.16
Paretic knee flexion at 60°/sec (N·m/kg)	Baseline	0.23±0.17	0.21±0.11
	Posttraining	0.43±0.25	0.22±0.14

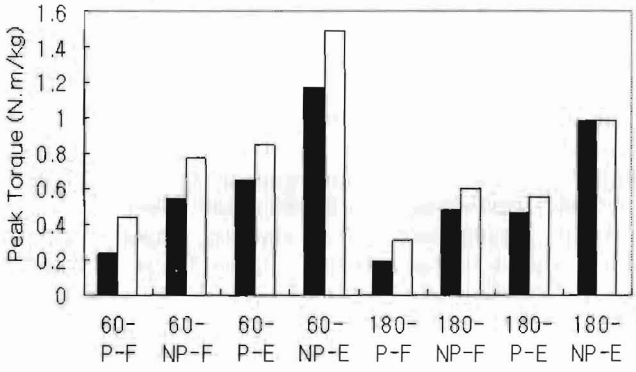

Figure 2 Peak torque at 60°/sec and 180°/sec generated by knee flexors and extensors at baseline (■) and posttraining (□) for experimental group. Abbreviations: P, paretic limb; NP, non-paretic limb; F, flexion; E, extension.

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