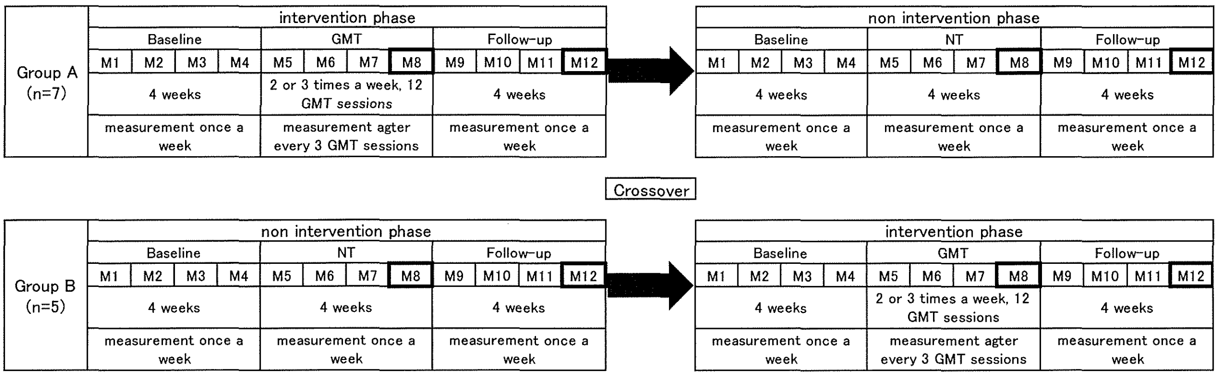

Figure 2: Study Protocol.
GMT: Gait Master training, NT: non training, M1-12: measurement number 1-12.

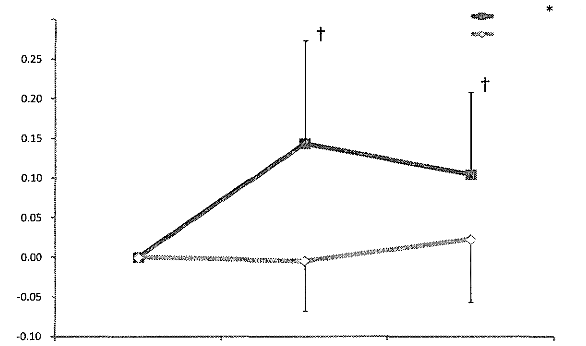

Figure 3: Change of maximum gait speed Box line graph shows median change of maximum gait speed and SE. Gray boxline shows change of maximum gait speed in intervention phase and white box line shows change of maximum gait speed in non intervention phase. GMT: Gait Master training, NT: Non Training. M8: measurement number 8 in intervention ornon-intervention. M12: measurement number 12 in intervention or non-intervention. ℵ:p<0.05, Friedman test. ℵ: p<0.05, Mann-Whitney U test, intervention phase vs. non intervention phase.

	Group A	Group B
n	5	5
Age (yeras)	59.6 ± 10.0	60.2 ± 8.5
Post-stroke interval (months	65.6 ± 39.6	65.4 ± 66.9
BRS		
III	1	1
IV	3	4
V	1	0
Intial gait speed (m/s)	0.62 ± 0.41	0.86 ± 0.16
Intial muscle strength (k/g)		
practice side		
hip flexion	8.56 ± 3.63	10.26 ± 6.61
extension	6.60 ± 3.19	6.54 ± 3.05
non practice side		
hip flexion	17.56 ± 7.96	22.80 ± 6.41
extension	17.22 ± 12.46	11.86 ± 4.32

BRS: Burnnstrom recovery stage

Table 1: Clinical data intial assessment data for both groups.

in figure 2 (M8) as a representative measurement for 'after GMT' or 'after NT,' and we used measurement number 12 in figure 2 (M12) as a representative of the follow-up. The Friedman test was used to compare the values within the intervention phase and the non-intervention phase, respectively. The Mann-Whitney U-test was used to compare the measurements at M8 and M12 between the intervention phase and the non-intervention phase and to compare the characteristics between groups A and B. Correlations of muscle strength and gait speed after GMT were calculated using Pearson's correlation coefficient. All statistical analyses were performed using SPSS (Version 20.0). Significance was set at $p<0.05$.

Results

No significant differences were observed in the clinical data, initial muscle strength, and initial gait speed at the study onset between groups A and B (Table 1).

On the Gait Master4, three of the subjects required the help of a physical therapist to control the trunk and knee at study onset, and the other seven subjects did not require this help.

Figure 3 shows the changes in maximum gait speed. During the intervention phase, there was a significant increase in gait speed (Friedman test, p=0.006), whereas during the non-intervention phase, there was no significant increase in gait speed (Friedman test, p=0.905). We found a significant difference in the change in maximum gait speed at both M8 and M12 between the intervention and non-intervention phases (M8: p=0.002; M12: p=0.035).

Figure 4 shows the changes in lower limb muscle strength. During the intervention phase, there were significant changes in paretic hip flexion strength (Friedman test, p=0.045), paretic hip extension (Friedman test, p=0.014) and non-paretic hip extension (Friedman test, p=0.025), but no significant change in the strength of non-paretic hip flexion (Friedman test, p=0.202). During the non-intervention phase, there were no significant changes in the strength of paretic hip flexion (Friedman test, p=0.548), paretic hip extension (Friedman test, p=0.905), non-paretic hip flexion (Friedman test, p=0.150) or non-paretic hip extension (Friedman test, p=0.067). Between the intervention and non-intervention phases, we found significant differences in the change in strength in paretic hip flexion (M8: p=0.035), non-paretic hip flexion (M8: p=0.004), and paretic hip extension (M8: p=0.035).

Figure 5 shows the correlations between muscle strengths and gait

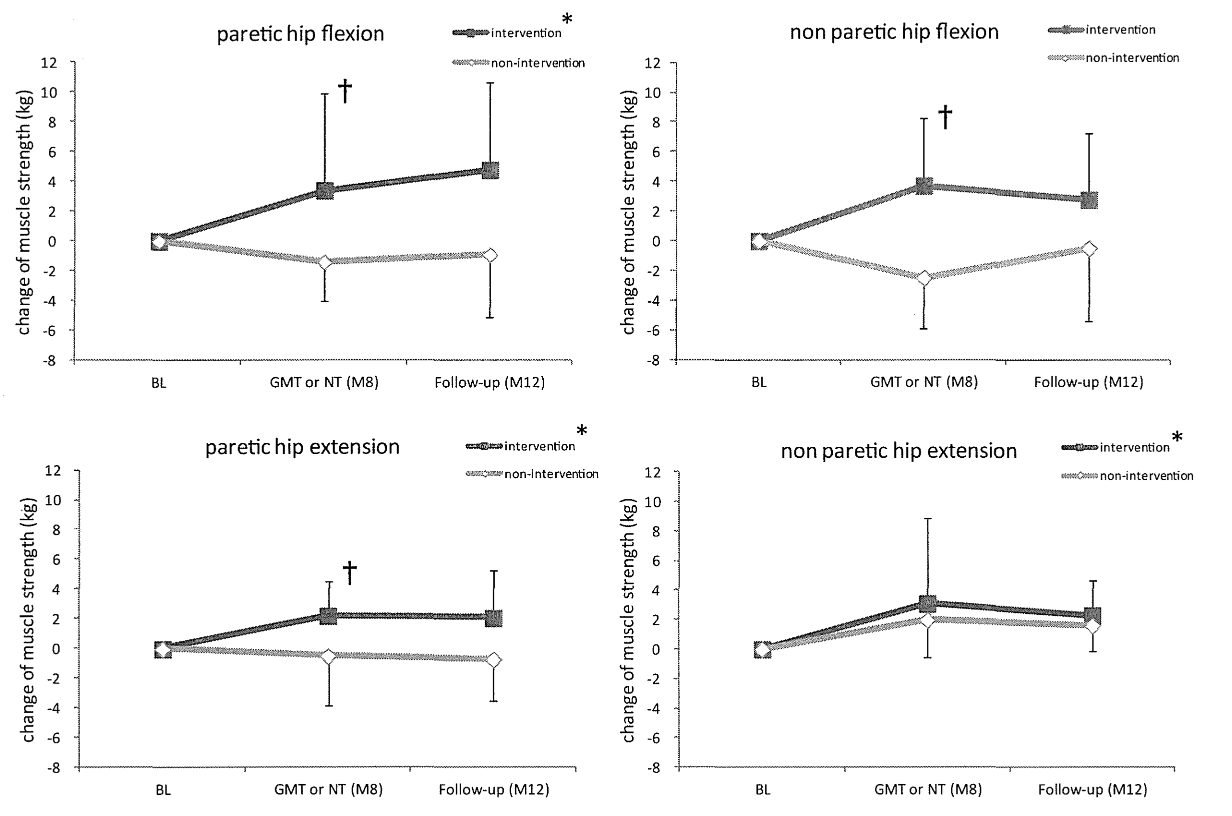

Figure 4: Change of muscle strengths.
Box line graph shows median change of muscle strengths and SE. Gray box line shows change of muscle strengths in intervention phase and white box line shows change of muscle strengths in non intervention phase. GMT: Gait Master training, NT: non training. M8: measurement number 8 in intervention or non-intervention. M12: measurement number 12 in intervention or non-intervention. ℵ: p<0.05, Friedman test: p<0.05, Mann-Whitney U test, intervention phase vs. non intervention phase.

speed and between the changes of muscle strength and the change of gait speed; no significant correlations were revealed.

Discussion

In the present study, improvements in lower-limb muscle strength and gait speed were observed when the Gait Master- a footpad-type, small-sized and inexpensive locomotion interface !—! was used for the gait training of chronic stroke patients. The results suggest that the Gait Master is effective for improving both muscle strength in the paretic limbs and gait ability.

Previous studies reported that improvement of gait ability is correlated with improvement of muscle strength of the hip flexion and extension in paretic limbs [28,29]. In the present study, significant improvements of gait speed and muscle strength of hip flexion and extension were observed after GMT, but improvement of gait speed and muscle strength were not significantly correlated. In gait training using gait devices, hip extension seems to be important for the activation of central pattern generator to improve gait ability [3]. Additionally, recent studies reported that improvement of gait ability depended on the high-profile plasticity of the brain caused by repetitive movement, constrained movement, and pelvic assist during gait movement [30-33]. Therefore, the improvement of gait ability by the Gait Master training might be due to reorganization of the neural network and/or to the improvement of muscle strengths. In light of the present results and the findings described above, we propose that the Gait Master may be useful for chronic stroke patients, because uniform repetitive gait movement, constrained gait movement, pelvic rotation, and hip extension and flexion are characteristic gait-like movements achieved with the Gait Master.

It is notable that the present subjects' muscle strengths were significantly improved after BMC Nursing of only 12 training sessions, since according to National Strength and Conditioning Association (NSCA) Guidelines, strength training should be implemented for 9 to 20 weeks to produce optimal strength gains. We also found that gait speeds were improved after 12 sessions of Gait Master intervention, whereas previous studies using other gait devices required 6 to 8 weeks for improvement [6,7,9,10,17,18]. Our results suggest that Gait Master4 might be faster at rehabilitating gait in post-stroke patients compared to other devices.

In conventional gait rehabilitation for stroke patients, a physical therapist can assist only one stroke patient at a time, and he or she may have difficulty helping a patient move the lower limbs and trunk at the same time, or difficulty assisting with long rehabilitation sessions. Similarly, the simultaneous efforts of two or three physical therapists are appropriate for the safe gait rehabilitation of a single patient using body weight-support treadmill training. In the present study, in contrast, the Gait Master made gait rehabilitation achievable with little or no assistance from a physical therapist. Since the gait-like

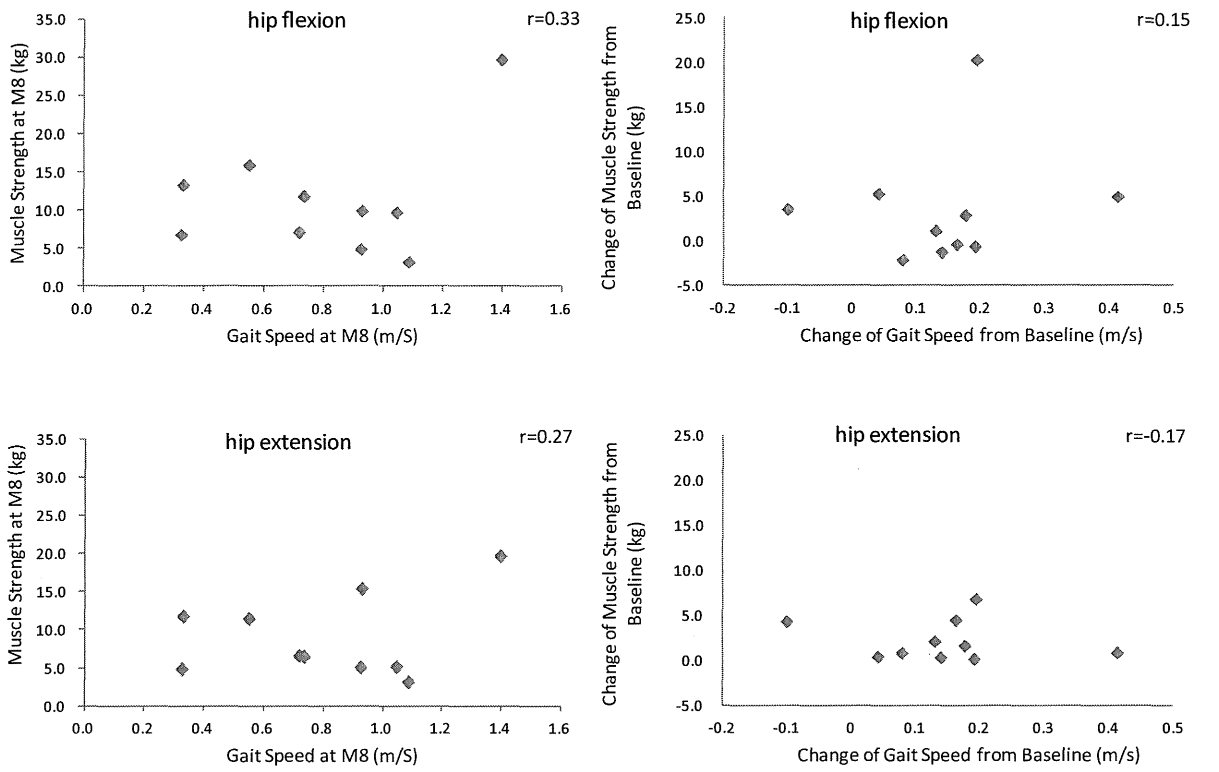

Figure 5: Correlations of muscle strength in paretic limb and gait speed, and change of muscle strength in paretic limb and change of gait speed after GMT (M8) Left side figures showed correlations of muscle strength and gait speed. Right side figures showed correlations of change of muscle strength and change of gait speed. Pearson's coefficient of correlation.

movement produced with the Gait Master is controlled by a computer, the physical therapist is free to help the patient move his or her trunk and lower limbs, thus enabling long rehabilitation sessions.

These findings indicate that gait rehabilitation using the Gait Master can not only provide a more effective gait rehabilitation environment for stroke patients but can also reduce the burden on physical therapists. Because the present subjects' gait rehabilitation using the Gait Master showed quick improvements, we propose that the Gait Master can provide a new approach for a short-time intensive model for chronic stroke patients.

In conclusion, gait rehabilitation using the Gait Master improved gait ability and the strength of both hip extension and flexion in chronic stroke patients. Using the Gait Master, patients can perform gait exercises with little support from a physical therapist. In addition, the Gait Master requires fewer physical therapists than body weight-support treadmill training. We therefore feel that gait rehabilitation using the Gait Master is effective training for chronic stroke patients. Its main advantages are its characteristic gait-like movement, the reduced effort on the part of physical therapists, its small size and its reasonable cost compared with other electromechanically assisted devices (e.g., the Lokomat is 4,000 dollars). Further studies are warranted to compare gait rehabilitation using the Gait Master with conventional gait rehabilitation and with body weight-support treadmill training and other electromechanically assisted devices.

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