Feasibility study of a robot-assisted complex upper and lower limb rehabilitation system in stroke survivors

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Purpose Robot-assisted gait training (RAGT) that simulates gait is a promising stroke rehabilitation treatment. Although coordination between the upper and lower limbs is considered important for locomotor training, commercially available robotic devices for gait training mainly focus on the restoration of lower limb function (Hesse et al., 2010; Kim & Lim, 2018). This study aimed to evaluate the feasibility and usability of cost-effective complex upper- and lower limb RAGT in patients with stroke using the GTR-A®, a foot plate-based end-effector type robotic device. **Method** A total of nine individuals (seven men, two women; mean age, 67.4 ± 14.7) with post-stroke gait impairment performed 30 minutes of RAGT thrice a week for six sessions. Hand grip strength (HGS), functional ambulation categories, modified Barthel index, muscle strength test sum score, Berg balance scale, Fugl-Meyer assessment, timed up and go test, and short physical performance battery were used as functional assessments. The heart rate was measured during each training session to evaluate cardiorespiratory fitness. A structured questionnaire using a 5-point Likert scale was used to evaluate the usability of RAGT. All the parameters were evaluated before and after the RAGT program. **Results and Discussion** Among the nine patients, one failed to complete the program because of right calf pain. All parameters of functional assessments between the baseline and post-training were significantly improved after RAGT, except for HGS and muscle strength test. The mean scores for each domain of the questionnaire were as follows: safety 4.40 ± 0.35, effects 4.23 ± 0.31, efficiency 4.22 ± 0.77, and satisfaction 4.41 ± 0.25. The results of this study indicate that GTR-A® is a feasible and safe robotic device for patients with gait impairment after stroke, resulting in improvement of ambulatory function and performance in activities of daily living with endurance training. Further research including various diseases and larger sample groups is necessary to verify the utility of this device.

References

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Table 1. Changes in functional outcome measures between baseline and post-training

Values are presented as mean ± SD.

*p <0.05

	Baseline	Post-training	Difference	P - value
Hand grip strength (kg)				
Affected side	23.9 ± 10.5	25.6 ± 9.3	1.8 ± 3.3	0.123
Unaffected side	27.3 ± 9.4	28.6 ± 8.2	1.4 ± 2.6	0.161
MRC sum-score	56.6 ± 3.0	57.4 ± 2.6	0.8 ± 1.2	0.109
FAC	2.6 ± 0.7	3.9 ± 0.9	1.3 ± 1.0	0.026*
BBS	43.5 ± 5.0	51.3 ± 4.5	7.8 ± 3.6	0.011*
MBI	63.0 ± 9.9	89.4 ± 7.1	26.4 + 7.1	0.012*
SPPB	7.1 ± 2.3	9.5 ± 2.4	2.4 ± 1.3	0.011*
TUG	18.0 ± 9.4	11.52 ± 5.8	- 6.5 ± 6.3	0.012*

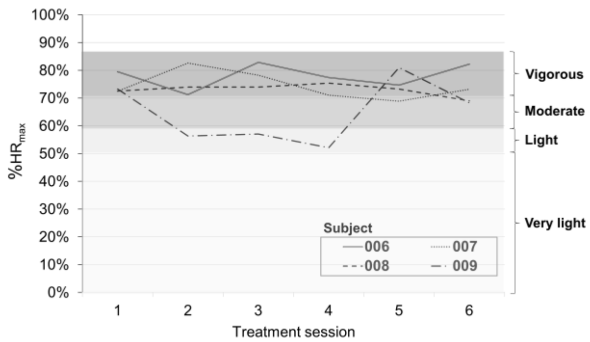

Figure 1. The mean $\%HR_{max}$ for each robot assist gait training session in four participants. The gray scale revealed the range of exercise intensity.