

Therapeutic Effects of Overground Exoskeleton Gait Training in Late Chronic Stroke Patients

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Objective

To investigate the clinical efficacy of an intensive, 4-week overground robot-assisted gait training (RAGT) program using a wearable joint-torque-assisting exoskeleton on the physical and functional recovery of patients in the late chronic phase of stroke.

Subjects and Method

Subjects

(1) Study Population: 14 male patients hemiplegia secondary to a single supratentorial ischemic stroke

(2) Patient Selection: Extracted from an initial cohort of 156 patients applying strict exclusion criteria: Hemorrhagic/infratentorial stroke, duration < 2 years, FAC < 2 or > 3, and severe cognitive or physical impairments

Methods

(1) Study Design: Retrospective observational study (Jan 2021 – Dec 2023)

(2) Intervention protocol: 4-week intensive overground robot-assisted gait training (RAGT), 20 sessions

(3) Blinded Assessment: All clinical evaluations were independently conducted and recorded by a blinded physical therapist who was not involved in the RAGT intervention.

Main outcome measures

(1) Gait & Balance: 6MWT, 10MWT, TUG, BBS, FAC

(2) Motor & Function: MI, mFRT, MBI, MFT, TIS

Statistical Analysis: Exact permutation method for the Wilcoxon signed-rank test

Results

Table 1. Characteristics of the participants

Variable	Values
Mean age	74.71 ± 2.52
Sex (Male : Female)	14 : 0
Height (cm)	167.14 ± 5.23
Weight (kg)	71.36 ± 12.93
Post-stroke duration (mon)	84.64 ± 46.2
Hemiplegic side (Right : Left)	6 : 8
K-MMSE	24.43 ± 6.35
MBI	76.86 ± 7.12
MAS	0.64 ± 0.50

Values are presented as mean ± standard deviation for continuous variables or number for categorical variables. K-MMSE, Korean version of Mini-Mental State Examination; MAS, Modified Ashworth Scale; MBI, Modified Barthel Index; mon, Months

Figure 1. Angel Legs M20; Angel Robotics Co., Ltd., Seoul, Republic of Korea

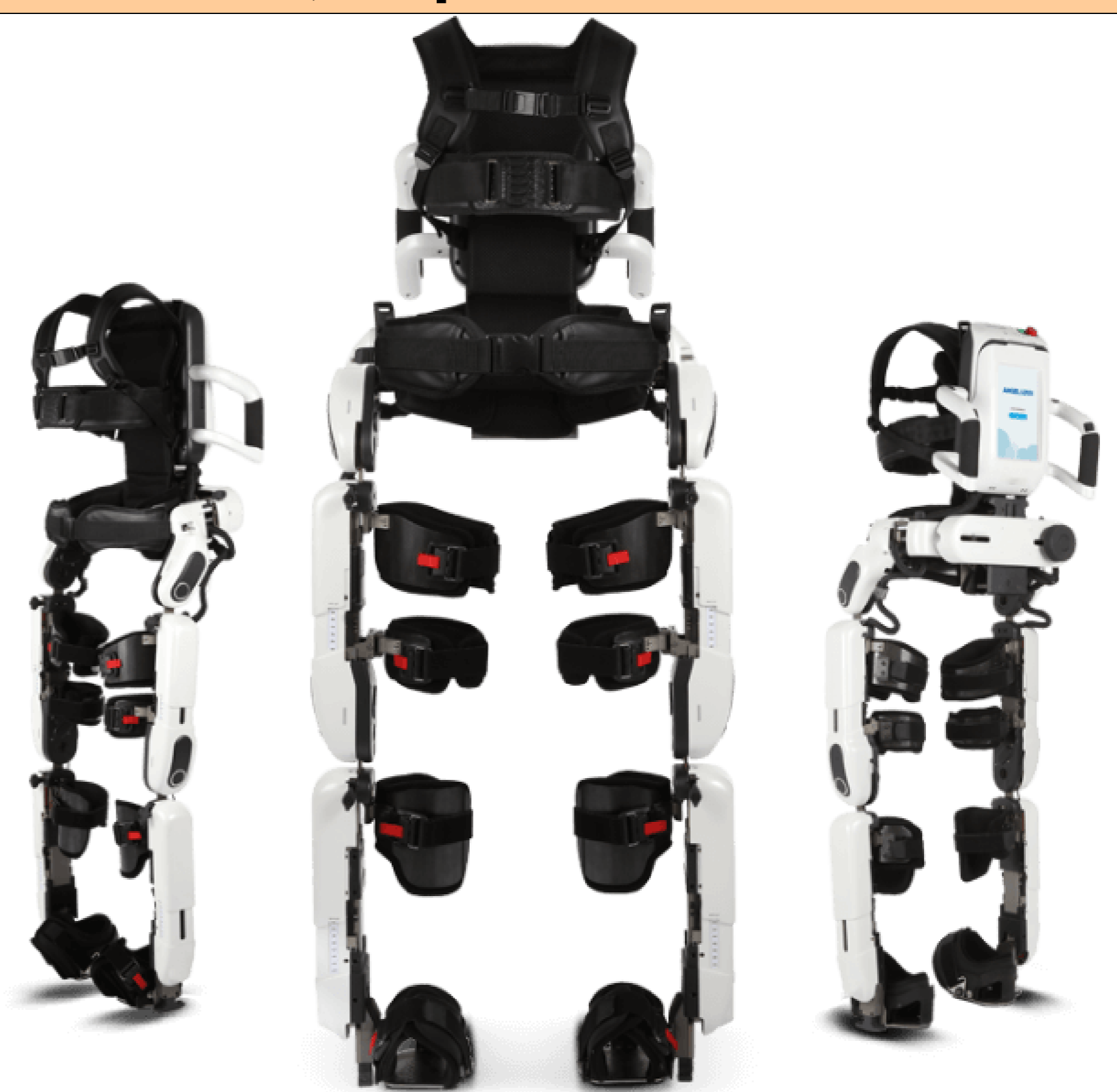


Table 2. Changes in physical and functional outcomes

Variable	Pre-intervention	Post-intervention	Z-value	P-value	Effect Size (r)
6MWT (m)	181.79 ± 143.66	197.14 ± 135.10	-3.015	0.031*	0.57
10MWT (sec)	24.79 ± 10.71	21.57 ± 5.83	1.969	0.063	0.37
BBS	32.36 ± 9.85	37.79 ± 6.46	-2.823	0.002†	0.53
FAC	2.71 ± 0.47	3.00 ± 0.68	-2	0.125	0.38
mFRT (cm)	7.00 ± 4.49	9.43 ± 5.24	-2.296	0.023*	0.43
MBI	76.86 ± 7.12	79.00 ± 8.46	-2	0.125	0.38
MFT	19.64 ± 6.26	21.07 ± 6.29	-2.236	0.063	0.42
MI	61.43 ± 7.01	64.50 ± 8.02	-2.88	0.016*	0.54
TIS	11.50 ± 3.96	12.57 ± 4.09	-2.021	0.188	0.38
TUG (sec)	28.14 ± 10.90	23.64 ± 7.22	2.64	0.008†	0.50

Values are expressed as mean ± standard deviation.

P-values were calculated using the exact permutation method for the Wilcoxon signed-rank test. Z-values for FAC, MBI, and MFT were approximated using the Sign test due to a high number of ties.

* $P < .05$, † $P < .01$

6MWT, 6-Minute Walk Test; 10MWT, 10-Meter Walk Test; BBS, Berg Balance Scale; FAC, Functional Ambulation Category; mFRT, modified Functional Reach Test; MBI, Modified Barthel Index; MFT, Manual Function Test; MI, Motricity Index; TIS, Trunk Impairment Scale; TUG, Timed Up and Go

Conclusion

Overground RAGT using a wearable exoskeleton significantly enhances dynamic balance, walking endurance, and motor capacity in late chronic stroke. These findings demonstrate that high-dosage, active overground navigation can harness prolonged neuroplasticity, challenging the assumption of a narrow early recovery window, despite inherent delays in translating physical capacity to real-world behavioral independence.