Bangabandhu Sheikh Mujib Medical University Journal 2025;18(4):e84607
ISSN 2074-2908 | eISSN 2224-7750 |

RESEARCH LETTER

Preliminary effects of robotic-assisted gait training in post-stroke patients: A pilot study

Iyyappan Manickavasagam[1] | Vignesh Srinivasan[1] | Yamini Umasankar[1] | Jagatheesan Alagesan[2]

[1]Department of Neurosciences, Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India
[2]Department of Paediatrics, School of Paramedical Allied and Health Care Sciences, Mohan Babu University, Tirupati, India

Correspondence
Vignesh Srinivasan
vigneshphysio1989@gmail.com

Publication history
Received: 24 Sep 2025
Accepted: 25 Dec 2025
Published online: 29 Dec 2025

Responsible editor
M Mostafa Zaman
0000-0002-1736-1342

Reviewers
A: Md. Israt Hasan
0000-0002-5484-4968
B: Md. Abdus Shakoor
0000-0001-6801-9179
C: Farooq Azam Rathore
0000-0002-4759-0453

Keywords
assistive technology, disability, health, quality of life, stroke rehabilitation

Ethical approval
Approved by Dubai scientific research ethics committee (Ref. no.: DSREC-SR-10/2024_02, Dated 11 Nov 2024)

Funding
None

Trial registration number
Not available

Published by Bangladesh Medical University (former Bangabandhu Sheikh Mujib Medical University)

Stroke remains a leading cause of long-term disability worldwide, with gait impairment and balance dysfunction being among the most disabling sequelae affecting independence and quality of life [1, 2]. Restoration of walking ability is therefore a primary goal of post-stroke rehabilitation. Conventional physiotherapy remains the cornerstone of gait rehabilitation; however, variability in training intensity, therapist fatigue, and limited opportunities for high-repetition, task-specific practice may limit optimal recovery [3]. Robotic-assisted gait training (RAGT) has emerged as a promising adjunct, enabling repetitive, controlled and task-oriented walking practice in a safe and standardised environment [4, 5]. Despite growing interest, evidence regarding its feasibility and preliminary clinical effects in routine rehabilitation settings remains heterogeneous, particularly in low- and middle-income contexts. This research letter reports the preliminary findings of a randomised pilot study comparing robotic-assisted gait training with conventional physiotherapy in individuals recovering from stroke.

This hospital-based pilot randomised study was conducted at a neurorehabilitation centre, with institutional ethical approval obtained in line with the declaration of Helsinki. Written informed consent was obtained from all participants before enrollment. Ten individuals with first-ever ischemic or hemorrhagic stroke, aged 30–60 years, were recruited and randomly allocated to either robotic-assisted gait training (RAGT group, n=5) or conventional physiotherapy (control group, n=5) using a sealed-envelope method. All participants had mild to moderate lower-limb spasticity (Modified Ashworth Scale ≤ 2), Brannstrom stages II–IV, Mini-Mental State Examination scores ≥ 24 and functional ambulation category scores between 2 and 4. No participants were lost to follow-up.

The RAGT group received treadmill-based robotic gait training using the Lokomat system with partial body-weight support, three sessions per week for 12 weeks. Training parameters such as walking speed and body-weight support were progressively adjusted according to participant tolerance and clinical judgment. Each session lasted approximately 40 minutes and focused on repetitive, task-specific gait practice under guided robotic assistance. The control group received conventional physiotherapy three times per week, consisting of breathing exercises, facilitatory techniques, bed mobility training, lower-limb stretching, balance activities and overground gait training, with progressive advancement over the intervention period. All interventions were delivered by licensed physiotherapists experienced in neurorehabilitation. No adverse events were reported in either group.

Balance, motor recovery and gait performance were assessed at baseline and after 12 weeks using validated clinical outcome measures: The Berg Balance Scale, Fugl–Meyer Assessment for Lower

Key messages

Restoration of gait is central to post-stroke independence and functional recovery. This small pilot study demonstrates that robotic-assisted gait training adds value to maintaining balance, motor function and mobility compared with conventional therapy in the rehabilitation of people with stroke. However, adequately powered studies for longer-term follow-up are warranted.

Extremity, Functional Gait Assessment and Timed Up and Go test. Data were analysed using Wilcoxon signed-rank test for within-group changes (P <0.01) and Mann–Whitney U test for between-group differences (P < 0.05).

Both groups demonstrated statistically significant improvements across all outcome measures over the 12-week intervention period. However, participants in the RAGT group consistently showed greater preliminary mean improvements in balance, motor recovery and functional mobility compared with those receiving conventional physiotherapy. The most notable between-group differences favored RAGT for Berg Balance Scale, lower-limb motor recovery Fugl–Meyer Assessment for Lower Extremity, dynamic gait performance and functional mobility Timed Up and Go test. A consolidated summary of outcome changes is presented in Table 1.

These preliminary findings suggest that robotic-assisted gait training may offer additional benefits over conventional physiotherapy in improving balance, gait and mobility following stroke. The observed improvements may be attributed to the high-repetition, task-specific nature of robotic training, which facilitates motor relearning and may enhance neuroplastic adaptation through consistent sensory feedback and guided movement patterns [6, 7]. Previous studies have highlighted the importance of intensive, repetitive gait practice in promoting functional walking recovery after stroke, and robotic systems provide a practical means of delivering such training with reduced therapist burden [8].

Table 1 Comparison of mean changes (post minus pre) between robot-assisted gait training and conventional therapy according to outcome measures

Outcome measure	Group for each (n=5)	Mean change (95% confidence interval) [a]
Berg balance scale	Robot-assisted gait training	21.2 (18.7–23.7)
	Conventional	5.4 (4.0–6.8)
Fugl–Meyer assessment	Robot-assisted gait training	6.6 (6.1–7.3)
	Conventional	2.4 (1.9–2.9)
Functional gait assessment	Robot-assisted gait training	4.4 (4.1–4.7)
	Conventional	1.6 (1.4–1.8)
Timed up and go	Robot-assisted gait training	8.1 (7.5–8.7)
	Conventional	3.7 (3.4–4.0)

[a] All P values for within group comparisons are significant at 1% level (according to the Wilcoxon signed-rank test). Between-group mean changes are significantly different at the 5% level (Mann–Whitney U test).

Improvements in balance, as reflected by higher Berg Balance Scale scores in the RAGT group, are clinically meaningful, given the strong association between balance deficits and fall risk in stroke survivors [9]. Similarly, greater gains in Fugl–Meyer Assessment for Lower Extremity scores indicate enhanced lower-limb motor recovery, likely driven by repetitive practice of near-normal gait kinematics. Enhanced Functional Gait Assessment and reduced Timed Up and Go test times further suggest superior improvements in dynamic gait control and functional mobility, which are essential for safe community ambulation.

Robotic-assisted gait training improved balance, motor recovery, and gait in individuals with stroke more effectively than conventional physiotherapy. Nevertheless, these findings must be interpreted cautiously. Given the pilot study's small sample size, the results are exploratory and not powered to establish definitive efficacy. The absence of a blinding and reliance on clinical outcome measures limit generalisability. Additionally, long-term retention of gains and cost-effectiveness of robotic-assisted training were not evaluated. Despite these limitations, the study demonstrates feasibility and safety, thereby justifying adequately powered randomised controlled trials.

Acknowledgements

We sincerely acknowledge the developers of clinical measures for providing validated tools that made this research possible. We extend our heartfelt gratitude to all the patients who participated in this study for their time, cooperation, and commitment. We also thank our co-authors and research team members for their valuable guidance, support, and contributions throughout the study.

Author contributions

Conception or design of the work; or the acquisition, analysis, or interpretation of data for the work: IM, YU. *Drafting the work or reviewing it critically for important intellectual content:* IM, VS, YU, JA. *Final approval of the version to be published:* IM, VS, YU, JA. *Accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved:* IM, VS, YU, JA.

Conflict of interest

We do not have any conflict of interest.

Data availability statement

We confirm that the data supporting the findings of the study will be shared upon reasonable request.

Supplementary file

None

References

1. Murphy SJ, Werring DJ. Stroke: Causes and clinical features. Medicine: Acute neurology. 2020 Sep 1;48 (9):561-566. https://doi.org/10.1016/j.mpmed.2020.06.002
2. Jambi LK, Hamad A, Salah H, Sulieman A. Stroke and disability: Incidence, risk factors, management and impact. Journal of Disability Research. 2024 Sep 5;3 (7):20240094. doi: https://doi.org/10.57197/JDR-2024-0094
3. Latham NK, Jette DU, Slavin M, Richards LG, Procino A, Smout RJ, Horn SD. Physical therapy during stroke rehabilitation for people with different walking abilities. Archives of physical medicine and rehabilitation. 2005 Dec 1;86(12):41-50. https://doi.org/10.1016/j.apmr.2005.08.128
4. Bonnyaud C, Zory R, Boudarham J, Pradon D, Bensmail D, Roche N. Effect of a robotic restraint gait training versus robotic conventional gait training on gait parameters in stroke patients. Experimental Brain Research. 2014 Jan;232(1):31-42. doi: https://doi.org/10.1007/s00221-013-3717-8

5. Zhu YH, Ruan M, Yun RS, Zhong YX, Zhang YX, Wang YJ, Sun YL, Cui JW. Is Leg-Driven Treadmill-Based Exoskeleton Robot Training Beneficial to Poststroke Patients: A Systematic Review and Meta-analysis. American Journal of Physical Medicine & Rehabilitation. 2023 Apr 1;102(4):331-339. doi: https://doi.org/10.1097/PHM.0000000000002098

6. Jones TA. Motor compensation and its effects on neural reorganisation after stroke. Nature Reviews Neuroscience. 2017 Mar 23;18(5):267-280. doi: https://doi.org/10.1038/nrn.2017.26

7. Pichardo A, Malovec M. Enhancing Post-Stroke Gait Rehabilitation with Robot-Assisted Therapy: A Focus on Step Repetitions and Neuroplasticity. Archives of Clinical and Biomedical Research. 2025;9:212-219. doi: https://doi.org/10.26502/acbr.50170453

8. Nadeau SE, Wu SS, Dobkin BH, Azen SP, Rose DK, Tilson JK, Cen SY, Duncan PW; LEAPS Investigative Team. Effects of task-specific and impairment-based training compared with usual care on functional walking ability after inpatient stroke rehabilitation: LEAPS Trial. Neurorehabil Neural Repair. 2013 May;27(4):370-380. doi: https://doi.org/10.1177/1545968313481284

9. Chen K, Zhu S, Tang Y, Lan F, Liu Z. Advances in balance training to prevent falls in stroke patients: A scoping review. Front Neurol. 2024 Feb 5;15:1167954. doi: https://doi.org/10.3389/fneur.2024.1167954