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Effectiveness of Cognitive Dual Task Gait Training versus Conventional Gait Training on Gait Parameters in Chronic Stroke: A Randomized Controlled Trial

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ABSTRACT

Stroke survivors typically experience motor and cognitive impairments, both of which independently and significantly influence gait performance. Walking-related cognitive-motor interference can constrain community ambulation and functional independence. This study aimed to compare the impact of two types of gait training — Cognitive Dual Task Gait Training (CDTGT) and Conventional Gait Training (CGT) — on the gait of patients who had suffered a chronic stroke. Sixty-four chronic stroke patients were randomly assigned to one of two groups (CDTGT, n = 32, or CGT, n = 32) in a randomized controlled trial. For four weeks, both groups received training six days a week. The study assessed the following gait parameters: step length, stride length, cadence, and gait speed using the 10-Meter Walk Test and the footprint method before and after the intervention. CDTGT included cognitive and gait task training in addition to gait training (CGT). All groups showed significantly higher gait parameters following the intervention ($p < 0.001$). The between-group analysis indicated that CDTGT resulted in better performance than CGT. As a result, the CDTGT group had significantly larger improvements in gait speed ($p = 0.001$) and cadence ($p = 0.041$). The CDTGT group also had favorable trends for step length and stride length, but the results did not reach statistical significance. In conclusion, cognitive dual-task gait training helps chronic stroke patients more in terms of cadence and gait speed than traditional gait training. Incorporating cognitive tasks in addition to gait rehabilitation should be taken into account in routine physiotherapy protocols for stroke survivors, as this can improve functional mobility.

Keywords: Chronic Stroke, Dual task training, gait training, physical therapy, Functional mobility.

1. INTRODUCTION

Stroke is a leading cause of mortality and morbidity worldwide. Stroke can frequently result in impaired mobility, and it is estimated that 30% of all stroke survivors are unable to walk independently. Gait speed is an objective measure of walking function that has been shown to be an accurate reflection of an individual's ability to move about in the community. Studies demonstrate that faster walking speeds correlate with enhanced physical capabilities and higher quality of life levels (Kooncumchoo et al., 2021). Nagano et al. (2015) found that in comparison to healthy individuals, stroke patients with a gait impairment seemed to walk markedly slower on the 10-meter walk test and demonstrate reduced endurance on the 6-minute walk test (6 MWT) compared to healthy controls, with many unable to complete the latter due to persistent deficits in the chronic phase (≥6 months post-stroke). The three extensive categories of gait training methods consist of conventional overground gait training along with staircase gait training, and device-assisted gait training. One of the most popular interventions for stroke survivors is overground gait training.

This training method involves physical therapists directing gait patterns and related exercises without the use of sophisticated assistive technology (Yeung et al., 2021). Staircase gait training, on the other hand, is suitable for patients who have good dynamic balance and is also used to improve cardiovascular endurance. However, patients with poor dynamic stability require assistive technology, like partial weight support belts (Seo et al., 2015).

Mounting evidence demonstrates that preserved cognitive functions, particularly attentional control and decision-making, are fundamental facilitators of motor recovery. The strength of this association has been measured in studies, showing a significant, quantifiable difference in gait and balance (Pichierri et al., 2011). With such a strong association, a rehabilitation program that incorporates both cognitive and motor training would be ideal in order to facilitate the best recovery from stroke. Since many activities of daily living (ADLs) require the performance of motor and cognitive tasks simultaneously, the interaction between these domains is essential to achieving functional recovery (Zhang et al., 2024).

Neurorehabilitation protocols now use more dual-task training—completing a motor task and a cognitive task at the same time—to achieve functional gains in both domains. Studies in Parkinson's and Alzheimer's disease have already shown the benefits of therapies that combine cognitive and motor tasks (Fritz et al., 2015). This is especially true for stroke rehab, as safe, efficient walking—which is a primary goal of most stroke rehab programs—is highly dependent on cognitive abilities like attention and executive function (Zheng et al., 2021). A key problem is "dual-task interference," which occurs when a patient is asked to perform a cognitive task while walking. Dual-task interference reliably and consistently disrupts a patient's gait, slowing their gait speed, reducing their cadence, and making their stride length more variable. The most concerning aspect is that this particular deficit persists after patients have finished traditional physical therapy (Plummer et al., 2008). In daily life, people regularly perform cognitive activities—such as talking to people, remembering directions, and making decisions—while walking. Due to decreased gait velocity and stability, these combined demands can severely limit mobility and participation in social and community activities. In this context, the addition of cognitive demands to gait training aiming to reproduce aspects of real-life walking is a potentially useful approach to improve community mobility and overall quality of life of stroke survivors (Szturm et al., 2021).

Research confirms that traditional physiotherapy—which includes mat exercises, stretching, strengthening, and standard gait training—effectively improves general motor function in stroke survivors. Adhering to this standard care protocol, it is well known that task-specific training, such as stair-climbing and forward/backward walking, can improve gait ability (Eng et al., 2007).

However, as noted by the following studies, walking during a concurrent cognitive task remains a critical limitation, as this deficit may continue to persist even following this standard of care rehabilitation. In other words, patients may improve their walking capacity without a cognitive dual task, but reach a functional “plateau” that prevents further improvement and ultimately limits the degree of recovery. The clinician may try to overcome this plateau by increasing the complexity of the gait training with the addition of cognitive challenges. Dual-task training aimed at motor and cognitive impairments at the same time, results in a larger functional improvement, allowing survivors to regain their safe and confident community participation (Tasseel et al., 2023).

2. METHODOLOGY

Study Design and Setting

A randomized controlled trial was carried out in the outpatient physiotherapy department on chronic stroke patients.

Participants

Inclusion criteria included Chronic stroke patients (≥6 months), both male and female patients, patients diagnosed with 1st episode of stroke, patients with a Mini-Mental State Examination score ≥ 24, patients able to walk 10m independently with or without an assistive device, and patients willing to participate in the study.

Exclusion criteria included patients with aphasia, visual impairment, or auditory impairment; those with a known history of any neurological condition affecting gait other than stroke; and those with a history of musculoskeletal conditions interfering with gait. Withdrawal criteria included participants who were unable to tolerate the treatment sessions or those who did not complete the 4-week treatment duration for any reason (e.g., loss to follow-up).

Sample Size Consideration

The sample size calculation followed Yang et al., (2019), with parameters derived from mean stride length values: conventional physical therapy (M = 1.6, SD = 6.3) and cognitive dual-task gait training (M = 5.9, SD = 5.9).

Formula for sample size

$$n = \frac{2(Z\alpha/2+Z\beta)^2\, SD^2}{(x_1-x_2)^2}$$

Where,

$Z\alpha$ = standard normal variant at $\alpha/2$ level,
$Z\beta$ = standard normal variant at the β level,
Sd = standard deviation,
X1 represents the stride length of conventional physical therapy,
X2 represents the stride length of cognitive dual-task gait training,
where: α= 5%, β= 20%
The study required a total sample size of 64 participants, with 32 participants per group.

Study Procedure and Data Collection

A total of 64 patients were randomized equally into two groups (A and B) using the odd-even method. The study employed Simple blocked randomization to prevent prediction of the intervention assignment sequence. In this single-blinded randomized controlled trial, patients were unaware of their treatment allocation. The patients walked at a comfortable pace along a smooth, horizontal 10-meter walkway after ink was applied to their feet using an ink pad for gait analysis. The protocol examined only the middle five steps of the walk to exclude variations in the start and finish of the gait. The 10-meter walk test (10MWT) measured walking speed. Stride length measurement used the linear distance between two consecutive contacts of the same foot, while step length measurement used the linear distance between successive footprints of opposite feet. The calculation of cadence used the multiplication of the number of steps completed during the 10MWT by the time taken. The study included all tertiary care center patients with chronic stroke. A straightforward alternating method allocated patients to groups: even-numbered patients to Block B (Conventional Gait Training) and odd-numbered patients to Block A (Cognitive Dual Task Gait Training).

Group A: Cognitive dual task gait training (Experimental group)

This group performed cognitive tasks while walking. The protocol progressed sequentially through seven tasks: walking forward while repeating phrases; walking backwards while counting numbers forward in ascending order; walking on an S-shaped path while counting backward; side walking while executing a word chain; obstacle course walking while category naming; stair climbing while talking; and step-up/step-down while doing serial subtraction.

Group B: Conventional gait training (Controlled group)

Patients in this group received conventional gait training, sequentially performing forward walking, backward walking, side walking, S-shaped path walking, walking on an obstacle course, and stair climbing. Both groups received the intervention protocol 6 days/week for 4 weeks under the supervision of a therapist. During the intervention period, the participants were allowed a 2-minute rest pause whenever they desired. Besides the experimental protocol, all participants received a standardised physiotherapy programme (gait training, trunk stability, functional re-education and lower limb strengthening).

Statistical Analysis

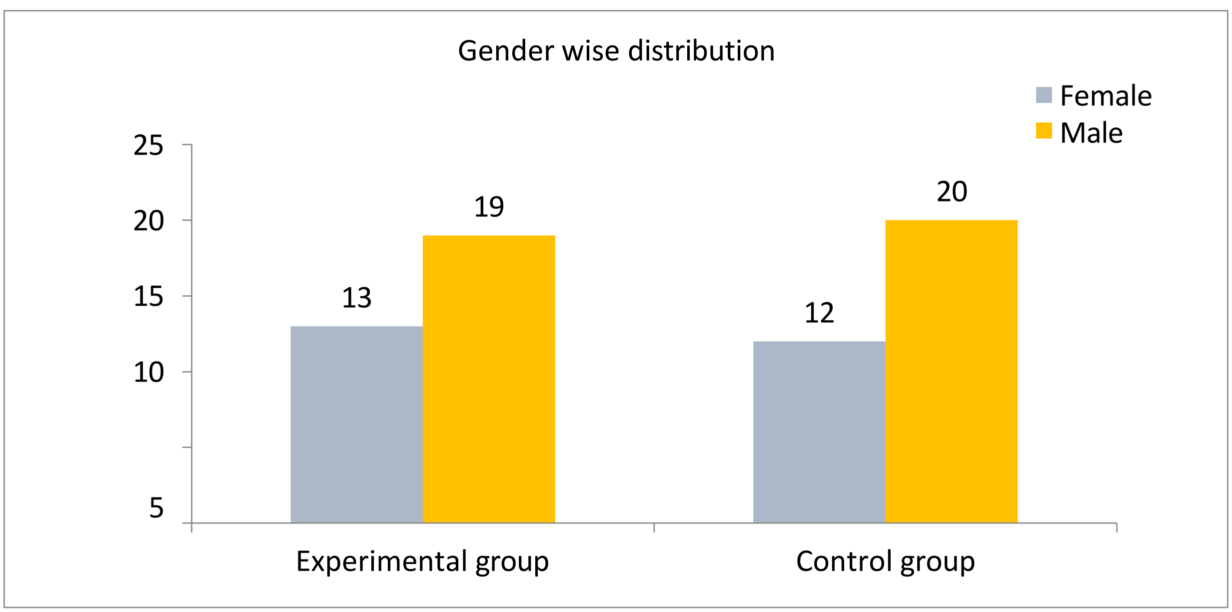
The statistical analyses in this study were performed with STATA 10.1. Quantitative variables are shown as means ± SD. A P-value of < 0.05 was considered to indicate a significant difference between means. Paired and independent t tests were used to evaluate differences within and between groups, respectively.

3. RESULTS

The trial randomly assigned 64 chronic stroke participants to either an experimental group (CDTGT, n = 32) or a control group (CGT, n = 32). Step length, stride length, cadence, and gait speed were primary outcomes (Table 1).

Table 1: Age-wise distribution of patients in years

Age Group			Group		Total
			Experimental	Control	
Age (in years)	35-44	Frequency	3	1	4
		Percent	9.4%	3.1%	6.2%
	45-54	Frequency	13	10	23
		Percent	40.6%	31.2%	35.9%
	55-64	Frequency	9	14	23
		Percent	28.1%	43.8%	35.9%
	65-74	Frequency	7	7	14
		Percent	21.9%	21.9%	21.9%
Total		Frequency	32	32	64
		Percent	100.0%	100.0%	100.0%

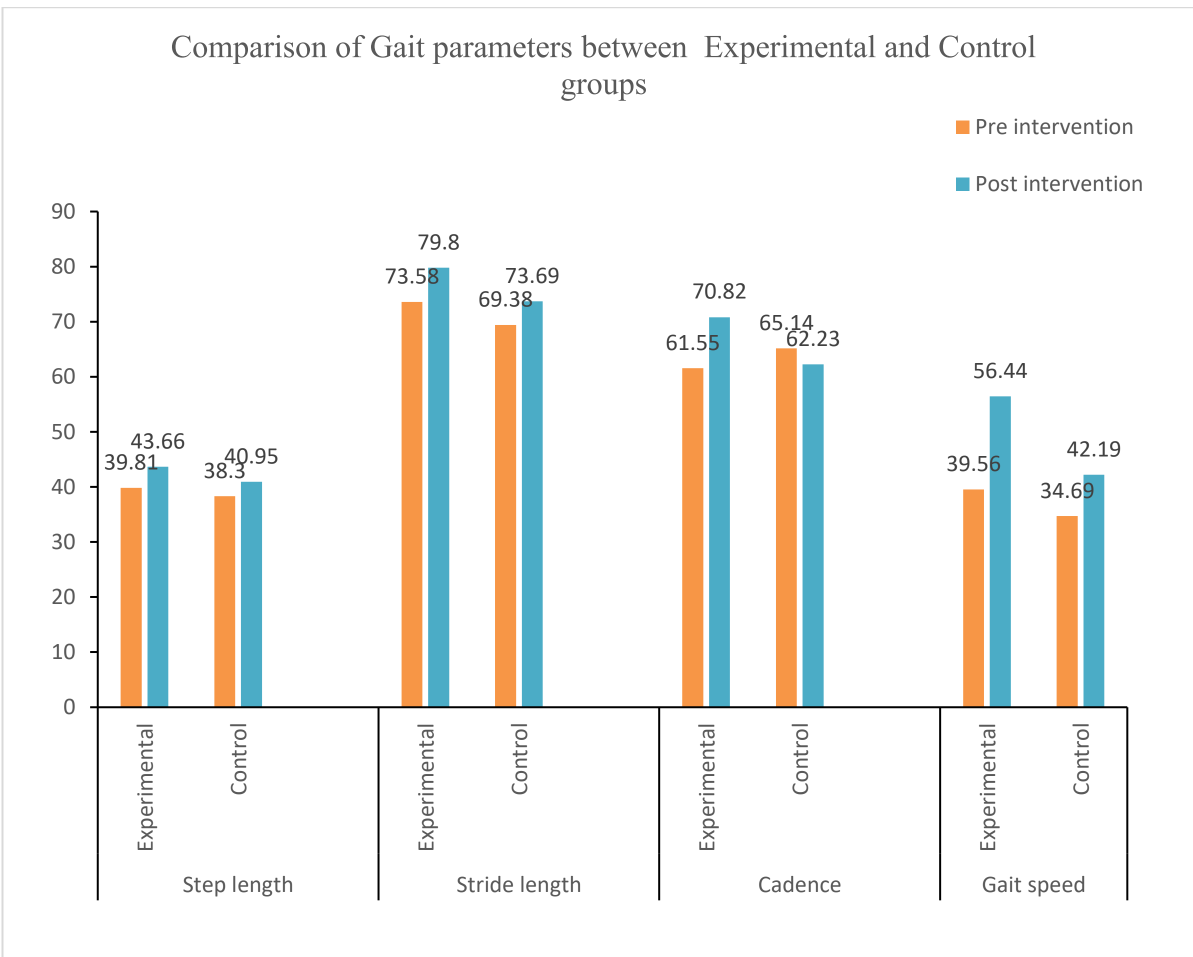


Graph 1: Gender wise distribution of patients

The participant gender breakdown, displayed in Graph 1, shows a similar distribution across groups. The experimental group was 40.6% female (n=13) and 59.4% male (n=19), compared to the control group, which was 37.5% female (n=12) and 62.5% male (n=20).

Table 2: Comparison of gait parameters between Experimental and Control groups

Gait parameters	Group	Mean		P value
		Pre-intervention	Post-intervention	
Step length	Experimental	39.81	43.66	0.261
	Control	38.3	40.95	
Stride length	Experimental	73.58	79.8	0.207
	Control	69.38	73.69	
Cadence	Experimental	61.55	70.82	0.041
	Control	65.14	62.23	
Gait speed	Experimental	39.56	56.44	0.001
	Control	34.69	42.19	



Graph 2: Comparison of gait parameters between Experimental and Control groups

Table 2 and Graph 2 show significant improvement in most of the gait parameters in both groups post-intervention, except for a decrease in cadence in the control group. Patients trained with Cognitive Dual-Task Gait Training (CDTGT) for a period of 4 weeks had statistically greater improvement across the majority of key gait measures when compared to the CGT group.

4. DISCUSSION

The RCT findings after a 4-week intervention showed that the CDTGT group and CGT group both significantly increased the measured gait parameters, including step length, stride length, cadence, and gait speed (Table 2 and Graph 2) in chronic stroke patients (Yang et al., 2019). The CDTGT group was also found to have significantly better outcomes than the CGT group, with the largest effects found for gait speed ($p = 0.001$) and cadence ($p = 0.041$) (Table 2). This was a good reinforcement of the mechanistic framework that underlies this method and is directly involved in ameliorating gait upon the introduction of cognitive load during motor training (Joya et al., 2023).

The emphasis of the training on the dyadic relations between cognition and motor control for the CDTGT group led to such pronounced performance. The inclusion of cognitive components within motor tasks training that mirror the real-world situations of parallel tasking, such as executive function and attention, contributed to the successful locomotion outcomes (Mack et al., 2023). The evidence also supports the intervention working via the induction of neuroplasticity, which in turn optimizes motor planning, coordination, and the engagement of higher-order cortical regions. The control group showed significant improvement as well, with the most prominent changes recorded in step length, stride length, and gait speed; however, cadence was also reduced (Graph 2). This is likely an outcome of the comparatively low cognitive engagement in this group's regimen (Sheridan et al., 2007). The findings also hint at traditional training not being as effective in ameliorating the interference effect on locomotion in a real-world context, seen in stroke patients (Plummer et al., 2013).

Dual-task training, as its name suggests, utilises the concurrent activation of both domains. The orchestrated engagement of cognitive and motor networks is hypothesized to potentiate neuroplastic changes, the functional consequences of which are the observed superior attentional modulation, improved movement economy, and the reclamation of adaptive flexibility. The optimized management of cognitive load during locomotion thus translates to improved and more durable rehabilitation outcomes, as has been observed in the current literature (Tuena et al., 2023). To ameliorate real-world walking performance in this patient population and further promote independent functional mobility, the inclusion of cognitive dual-task gait training as an adjunct to stroke rehabilitation is recommended (Hofheinz et al., 2016).

5. CONCLUSION

The current study concludes that CDTGT, as well as conventional gait training, can improve gait parameters in chronic stroke survivors. Analytical comparison demonstrates that CDTGT outperforms conventional methods. In fact, the CDTGT group demonstrated significantly larger improvements in gait parameters, particularly in terms of important functional parameters such as gait speed and cadence. In addition, this study has shown that CDTGT directly trains cognitive-motor processing related to community ambulation, which is often not addressed in conventional rehabilitation programs. Therefore, to take the next step in optimizing the standard of care, dual-task training needs to be adopted. This new approach is important for ensuring that stroke survivors can better meet the multitasking demands of walking in the community and can move around safely, confidently, and independently.

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Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study.

Ethical approval

The study was approved by the Medical College Ethics Committee (Ethical Approval Code: VSPMs COPT/IEC/NEURO-PG10/2022).

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Conflict of interest

The authors declare that they have no conflicts of interest, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Data and materials availability

All data associated with this study will be available based on a reasonable request to the corresponding author.

REFERENCES

1. Eng JJ, Tang PF. Gait training strategies to optimize walking ability in people with stroke: a synthesis of the evidence. Expert Rev Neurother 2007;7(10):1417-36.
2. Fritz NE, Cheek FM, Nichols-Larsen DS. Motor-cognitive dual-task training in persons with neurologic disorders: a systematic review. J Neurol Phys Ther 2015;39(3):142-53.
3. Hofheinz M, Mibs M, Elsner B. Dual task training for improving balance and gait in people with stroke. Cochrane Database Syst Rev 2016;10:CD012403.
4. Joya J, Kinnaird C, Carey J. The role of cognitive load in motor rehabilitation: a dual-task paradigm for gait recovery post-stroke. J NeuroEngineering Rehabil 2023;20(1):45.
5. Kooncumchoo P, Namdaeng P, Hanmanop S, Rungroungdouyboon B, Klarod K, Kiatkulanusorn S. Gait improvement in chronic stroke survivors by using an innovative gait training machine: a randomized controlled trial. Int J Environ Res Public Health 2021;19(1):224.
6. Mack M, Stojan R, Bock O, Voelcker-Rehage C. The association of executive functions and physical fitness with cognitive-motor multitasking in a street crossing scenario. Sci Rep 2023;13(1):697.
7. Nagano K, Hori H, Muramatsu K. A comparison of at-home walking and 10-meter walking test parameters of individuals with post-stroke hemiparesis. J Phys Ther Sci 2015;27(2):357-9.
8. Pichierri G, Wolf P, Murer K, de Bruin ED. Cognitive and cognitive-motor interventions affecting physical functioning: a systematic review. BMC Geriatr 2011;11(1):29.
9. Plummer P, Eskes G, Wallace S, Giuffrida C, Fraas M, Campbell G. Cognitive-motor interference during functional mobility after stroke: state of the science and implications for future research. Arch Phys Med Rehabil 2013;94(12):2565-74.
10. Plummer-D'Amato P, Altmann LJ, Saracino D, Fox E, Behrman AL, Marsiske M. Interactions between cognitive tasks and gait after stroke: a dual task study. Gait Posture 2008;27(4):683-8.
11. Seo K, Park SH, Park K. The effects of stair gait training using proprioceptive neuromuscular facilitation on stroke patients' dynamic balance ability. J Phys Ther Sci 2015;27(5):1459-62.
12. Sheridan PL, Hausdorff JM. The role of higher-level cognitive function in gait: executive dysfunction contributes to fall risk in Alzheimer's disease. Dement Geriatr Cogn Disord 2007;24(2):125-37.
13. Szturm T, Kolesar TA, Mahana B, Goertzen AL, Hobson DE, Marotta JJ, et al. Changes in metabolic activity and gait function by dual-task cognitive game-based treadmill system in Parkinson's disease: Protocol of a randomized controlled trial. Front Aging Neurosci 2021;13:680270.
14. Tasseel-Ponche S, Roussel M, Toba MN, Sader T, Barbier V, Delafontaine A, et al. Dual-task versus single-task gait rehabilitation after stroke: the protocol of the cognitive-motor synergy multicenter, randomized, controlled superiority trial (SYNCOMOT). Trials 2023;24(1):172.
15. Tuena C, Borghesi F, Bruni F, Cavedoni S, Maestri S, Riva G. Technology-assisted cognitive motor dual-task rehabilitation in chronic age-related conditions: systematic review. J Med Internet Res 2023;25:e44484.
16. Yang YR, Cheng SJ, Lee YJ, Liu YC, Wang RY. Cognitive and motor dual task gait training exerted specific training effects on dual task gait performance in individuals with Parkinson's disease: A randomized controlled pilot study. PLoS One 2019;14(6):e0218180.
17. Yeung LF, Lau CC, Lai CW, Soo YO, Chan ML, Tong RK. Effects of wearable ankle robotics for stair and over-ground training on sub-acute stroke: a randomized controlled trial. J NeuroEngineering Rehabil 2021;18(1):19.
18. Zhang L, Ma J, Liu X, Jin A, Wang K, Yin X. Cognitive-motor dual-task training on gait and balance in stroke patients: meta-analytic report and trial sequential analysis of randomized clinical trials. J NeuroEngineering Rehabil 2024;21(1):227.
19. Zheng Y, Meng Z, Zhi X, Liang Z. Dual-task training to improve cognitive impairment and walking function in Parkinson's disease patients: A brief review. Sports Med Health Sci 2021;3(4):202-6.