SHORT REPORT

An eight-week single-blind randomised controlled trial on dual task balance training and motor imagery practice in ischaemic stroke survivors

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Abstract

The purpose of this study was to find the effects of motor imagery on balance and mobility of stroke patients.This was a single-blind randomised controlled trial which included a total of 30 patients. These patients were assigned into two group: experimental (n=15) and control (n=15) by sealed envelope method. Functional Reach Test (FRT), Time Up and Go Test (TUGT), Berg Balance Scale (BBS), and Movement Imagery Questionnaire (MIQ) were used as assessment tools. The overall mean age of the participants was 52.63 ±8.78 years. Between groups analysis showed non-statistically significant difference ($p>0.05$) in FRT but significant difference in TUGT, BBS, and MIQ-3 ($p<0.009$) after eight weeks of training. Within group analysis showed statistically significant difference ($p<0.05$) for all outcome measures. This study concluded that motor imagery is an effective treatment strategy for improving balance and mobility in stroke patients and brings better results as compared to conventional treatments.

Keywords: Stroke, Motor imagery, Dual task, Balance, Gait.

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Introduction

Stroke is the leading cause of disability worldwide.[1] Basic activities of daily living in patients who suffer a stroke are limited due to the impairments in sensory, motor, balance gait, and cognitive deficits. Independent walking is a prerequisite in many activities of life. Stroke patients always have difficulty in restoring this function and gait has long been recognised as a key goal in rehabilitation.[2] Various neurological rehabilitation protocols are widely being used by physical therapists in the treatment of gait and balance problems in stroke patients.[3] The goal of applying different concepts is to promote motor learning for efficient motor control in various environments, thereby improving participation and function. Motor imagery is a patient-centred approach in which the patient actively engages through cognition and mental imaginationMotor imagery (MI) is the envisioning of an activity without its physical execution; it is an active process where the representation of an activity is internally replicated inside working memory without any performed action.[4] It has been reported in numerous studies that motor imagery, when used in combination with traditional treatment, makes a difference in relearning the tasks and improves motor skills.[5] According to recent literature, the gait capability of stroke patients has been noted to have progressed after motor imagery training.[6] Therefore, this study aimed to determine the combined effects of motor imagery and dual task training on balance and gait in stroke patients.

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Method and Results

This was a randomised control trial (RCT), done at Abuzar Medical and Diagnostic Centre, Rawalpindi from April 2020 to october 2020 and registered in clinical trial.gov identifier: NCT04086004. The sample size was calculated using G*power version 3,with effect size 0.9, power 0.8 and alpha (α) error 0.05 for a priori power analysis, while using one-tail t test for the difference between two independent means.[7] Non-probability convenient sampling technique was used. A total of 30 participants were recruited for the study and 29 completed the intervention (Figure 1) .Patients were enrolled after taking the informed consent. Inclusion criteria were: patients having modified ranking disability level scale 2-3, chronic and sub-acute patients, capability of walking on the ground for at least ten metres with or without using an assistive device, intact cognition, insignificant visual or body spatial hemi-neglect and acceptable level of capability for functioning imagery (at least 32 or greater score on the Revision of Movement Imagery Questionnaire).[8] Those who fulfilled the inclusion criteria were randomly assigned into experimental (n=15) and control group (n=15) by sealed envelope method. Baseline assessment was done at 0 week, in fourth week and post-intervention i.e. eighth week. A trained physical therapist who was not aware of the subjects' group assignment evaluated the patients. No adverse effects were observed during the intervention. Balance was

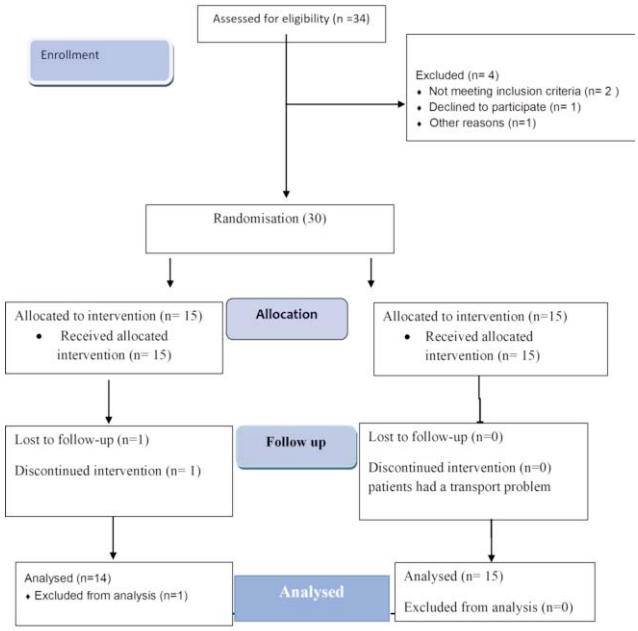

Figure-1: Consolidated standards of reporting trials (CONSORT) flow diagram

Experimental Group (Each task for 4 min) 7task x 4min =28 min session	Control Group (Each task for 4 min) 7task x 4min =28 min session
Dual task training involves • 30 times sit to stand Exercise with bottle putting on floor and on table. • To stand on an unstable balance pad and perform head movements in all directions., • Forward / backward walking with counting • Sideways walking with catching and throwing a ball. • While standing on an even floor patient was instructed to shift weight to both sides. • Tandem walk with counting backward. • To stand on one leg for five seconds with tray holding. • For balance training motor imagery will be implemented in patients in the experimental group. This study will use five stage protocols: Progressive relaxation stage, external imagery, problem identification internal imagery (first-person perspective), and mental rehearsal. 1. In progressive relaxation stage, the patients were guided to relax, unwind themselves and take deep breaths for 2 minutes. 2. For external imagery stage the patients watched a videotape to analyse their movement 3. In problem identification stage, patients recognized the mistake they made while performing the moving and compared it with reference video. 4. During Internal imagery patients imagined themselves performing a task and they watched the video. 5. The participant were inquired to mentally perform again from the external imagery stage to the problem identification stage of the five-stage convention. (47)	,Dual task training involves • 30 times, sit to stand Exercise with bottle putting on floor and on table. • To stand on an unstable balance pad and perform head movements in all directions., • • Forward /backward walking with counting. • Sideways walking with catching and throwing a ball. • While standing on an even floor patient was instructed to shift weight to both sides. • Tandem walking with counting backward • Standing on one leg for 5 seconds with tray holding

Figure-2: Group wise interventional programme.

assessed through Functional Reach Test and Berg Balance Scale, for mobility and gait Time Up and Go Test was used and for motor imagery, Movement Imagery Questionnaire was used.[9-11] The details of intervention protocol are listed in figure 2. In the experimental group seven tasks were designed and each task was performed for four minutes with maximum repetitions along with motor imagery practice. In the control group, the same intervention was given except motor imagery.(figure 2)

IBM Statistics SPSS v21.0. (IBM Corp. Armonk. NY, USA) was used for statistical analysis. Shapiro Wilk Test was used to check the normality of the data. The data was not normally distributed ($p<0.05$) so non-parametric tests were applied for analysis. To find between the group differences Mann Whitney U test was applied. Friedman Test was used for within the group analysis and to see the difference at different time intervals Wilcoxon sign rank test was used. 0.05 alpha level of significance was maintained.

The current study sample with a mean age of 52.63 ± 8.78 in experimental group and 52.56 ± 7.78 years in control group comprised both males and females. There was one dropout in the experimental group. Table 1 shows the

Table-1: Baseline Demographic Characteristics of the Control and Experimental Group

Variable	Experimental Group	Control Group
Mean Age (years)	52.63 ±8.78	52.56±7.78
Stroke onset (months)	5.51 ±2.87	5.81 ±3.31
Gender		
Male	8 (53.3)	6 (40)
Female	7 (46.7)	9 (60)
Type		
Infarct	10 (66.6)	12 (80)
Haemorrhage	5 (33.3)	3 (20)
Hemiplegia		
Right	8 (53.3)	10 (66.6)
Left	7 (46.7)	5 (33.3)
Area Involved		
MCA	4 (26)	6 (40)
ACA	10 (66.6)	7 (46.6)
PCA	1 (6.6)	2 (13.3)
Phase of stroke		
Subacute	10 (66.6)	8 (53.3)
Chronic	5 (33.3)	7 (46.7)

Values are mean± SD, frequency (percentage)
MCA: Middle cerebral artery
ACA: Anterior cerebral Artery
PCA: Posterior cerebral artery

group means for age and stroke onset and the frequency counts for gender and hemiparetic side. There were no statistically significant differences between the groups at baseline on all variables. For between the group analyses, the TUGT, BBS, and Movement Imagery Questionnaire (internal imagery) final assessment shows significant difference between the experimental and control groups

Table-2: Between group analysis for FRT, TUGT and BBS and MIQ 3.

Variable	Group	Mean ±S.D	Mean Rank	Median(IQ)	P-value
FRT at baseline	Experimental	4.83±1.71	13.69	4.00(1.4)	
	Control	4.92±1.24	17.57	4.89(1.7)	0.221
FRT at 4th week	Experimental	6.20±1.03	15.28	6.00(2.68)	0.884
	Control	5.93±1.13	15.75	5.55(0.88)	
FRT at 8th week	Experimental	7.75±1.61	16.69	7.80(4.04)	0.429
	Control	6.75±1.43	14.14	6.60(1.59)	
TUGT at baseline	Experimental	18.62±1.21	13.88	18.09(11.08)	0.279
	Control	19.21±1.12	17.36	19.50(2.84)	
TUGT at 4th week	Experimental	15.61±1.34	13.63	14.78(10.17)	0.212
	Control	17.88±1.25	17.64	18.75(3.2)	
TUGT at 8th week	Experimental	12.01±1.62	12.63	10.55(7.69)	0.05*
	Control	15.97±1.41	18.79	15.80(2.58)	
BBS at baseline	Experimental	35.72±1.31	15.38	36.00(5.5)	0.932
	Control	35.61±1.02	15.64	36.00(9.6)	
BBS at 4th week	Experimental	42.81±1.23	16.94	43.50(9.25)	0.337
	Control	40.61±1.62	13.86	42.00(10.2)	
BBS at 8th week	Experimental	48.23±3.21	18.44	52.00(12.75)	0.05*
	Control	44.53±2.45	13.93	46.50(10.75)	
MIQ 3 (Internal Imagery)Baseline	Experimental	4.21±1.21	15.69	3.00(1.5)	0.9
	Control	2.65±1.03	15.29	2.75(1.38)	
4th week	Experimental	3.54±1.10	18.31	3.250(2.68)	0.05
	Control	4.12±1.23	12.29	4.00(0.68)	
8th week	Experimental	5.61±1.12	18.63	5.62(1.71)	0.03*
	Control	4.51±1.26	11.93	4.50(1.25)	
MIQ3 (external Imagery)Baseline	Experimental	3.31±1.04	15.38	3.25(2.68)	0.93
	Control	3.21±1.25	15.64	3.00(1.25)	
4th week	Experimental	5.12±1.31	18.16	5.00(2.18)	0.07
	Control	4.13±1.61	12.46	4.00(1)	
8th week	Experimental	5.74±1.74	18.63	6.00(1.81)	0.037*
	Control	4.61±1.52	11.93	4.50(1.75)	
MIQ3(Kinesthetic)Baseline	Experimental	4.71±1.62	16.72	3.90(2.5)	0.416
	Control	3.32±0.51	14.11	3.25(0.63)	
4th week	Experimental	5.14±1.52	17.78	5.25(2.44)	0.126
	Control	3.61±1.13	12.89	4.62(1.13)	
8th week	Experimental	6.34±1.14	19.81	6.37(1.18)	0.004**
	Control	4.81±1.21	10.57	5.00(1.5)	
MIQ 3 Total score at baseline	Experimental	9.72±0.34	15.69	9.62(6.75)	0.9
	Control	9.43±0.24	15.29	8.52(3.13)	
MIQ 3 Total score at 4th week	Experimental	14.83±1.34	18.63	14.87(5.5)	0.03
	Control	11.91±1.41	13	12.6(4.5)	
MIQ 3 Total score at 8th week	Experimental	17.17±1.62	19.44	17.50(3.92)	0.009*
	Control	14.2±1.32	11.00	14.00(4.25)	

Mann- whitney U test. FRT-Functional reach test:
TUGT:Time up & go test. BBS: Berg balance scale
MIQ: Motot imagery questionnaire:

after the intervention, whereas the results were non-significant (p>0.05) for FRT which shows that both the groups improved equally in forward reach test. MIQ3 (External imagery) shows significant (p<0.05) results in the fourth and eighth week between the two groups. The kinesthetic imagery group of MIQ 3 shows significant improvement after the intervention. The total score of MIQ3 showed statistically significant difference between both the groups.(Table 2) Within the group analysis for FRT, TUGT, BBS, and MIQ3 showed statistically significant (p<0.05) results.(Table 3) The results of the current study demonstrated that patients' mobility (TUGT), dynamic balance (BBS), and risk of fall (TUGT) was greatly reduced in experimental group as compared to the control group.

Discussion

The current study determines the additional effects of motor-imagery practice with the training of dual tasking in stroke patients. Motor imagery (MI) aims to produce body's internal picture of movements without generating any motor output.[12] This technique helps in improving functional performance, neuro plasticity through neural and cortical reorganisation in post-stroke patients. Motor imagery training(MIT) also has an important role in improving cognitive abilities of the patients because when the patient imagines that he is performing different tasks, it affects cortex motor activity.[13] Stroke impairs the gait and mobility of the patient due to spasticity. It is commonly observed that patients had difficulty in maintaining the balance while walking, due to which the risk of fall increases two-fold. It was observed that motor imagery training and task specific exercises reduces spasticity and improves lower limb motor functions.[14] In this study the outcome measures used for mobility and balance assessment were TUGT and BBS; the mean score of both the tests increased at the end of the intervention. Results reported a statistically significant (p<0.05) improvement after treatment in both the groups and even better results when related to the motor imagery training . The study reported that patients can actively perform sit–to-stand and stand-to-sit tasks. These findings are similar to those reported previously in the literature, claiming that combined motor imagery training of lower extremity promotes relearning of rising, sitting tasks, and symmetrical use of lower limb muscles during sit-to-stand tasks in post-stroke hemiparesis.[15] Many studies in literature reported that task-specific

Table-3: Within Group Analysis for FRT, TUGT and BBS and MIQ 3.

Variables Experimental Group	Mean±SD	Median (IQ)	P-value
FRT			
Baseline	4.83±1.71	4.00(1.4)	<0.001***
4th week	6.20±1.03	6.00(2.68)	
8th week	7.75±1.61	7.80(4.04)	
TUGT			
Baseline	18.62±1.21	18.09(11.08)	<0.001***
4th week	15.61±1.34	14.78(10.17)	
8th week	12.01±1.62	10.55(7.69)	
BBS			
Baseline	35.72±1.31	36.00(5.5)	<0.001***
4th week	42.81±1.23	43.50(9.25)	
8th week	48.23±3.21	51.00(12.75)	
MIQ 3 (Internal Imagery)			
Baseline	4.21±1.21	3.00(1.5)	<0.001***
4th week	3.54±1.10	3.250(2.68)	
8th week	5.61±1.12	5.62(1.71)	
MIQ3 (external Imagery)			
Baseline	3.31±1.04	3.25(2.68)	<0.001***
4th week	5.12±1.31	5.00(2.18)	
8th week	5.74±1.74	6.00(1.81)	
MIQ3 (Kinesthetic)			
Baseline	4.71±1.62	3.90(2.5)	<0.001***
4th week	5.14±1.52	5.25(2.44)	
8th week	6.34±1.14	6.37(1.18)	
MIQ 3 Total			
Baseline	9.72±0.34	9.62(6.75)	<0.001***
4th week	14.83±1.34	14.87(5.5)	
8th week	17.17±1.62	17.50(3.92)	
	Control Group		
FRT			
Baseline	Mean ±S.D	4.89(1.7)	<0.001***
4th week	4.92±1.24	5.55(0.88)	
8th week	5.93±1.13	6.60(1.59)	
TUGT			
Baseline	6.75±1.43	19.50(2.84)	<0.001***
4th week	19.21±1.12	18.75(3.2)	
8th week	17.88±1.25	15.80(2.58)	
BBS			
Baseline	15.97±1.41	36.00(9.6)	<0.001***
4th week	35.61±1.02	42.00(10.2)	
8th week	40.61±1.62	48.50(10.75)	
MIQ 3 (Internal Imagery)			
Baseline	2.65±1.03	2.75(1.38)	<0.001***
4th week	4.12±1.23	4.00(0.68)	
8th week	4.51±1.26	4.50(1.25)	
MIQ3 (external Imagery)			
Baseline	3.21±1.25	3.00(1.25)	<0.001***
4th week	4.13±1.61	4.00(1)	
8th week	4.61±1.52	4.50(1.75)	
MIQ3(Kinesthetic)			
Baseline	3.32±0.51	3.25(0.63)	<0.001***
4th week	3.41±1.13	4.62(1.13)	
8th week	4.81±1.21	5.00(1.5)	
MIQ 3 Total			
Baseline	9.43±0.24	8.50(3.13)	<0.001***
4th week	11.91±1.41	13.00(2.19)	
8th week	14.2±1.32	14.00(4.25)	

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Friedman test. FRT:Functional reach test: TUGT: Time up & go test. BBS: Berg balance scale: MIQ: Motot imagery questionnaire

training speed up the body's recovery process, especially the lower limb dexterity, thus reducing long-term disability and associated socio-economic burden.[16,17]

Limitations: This study has few limitations which need to be considered; the results of this study cannot be generalised due to small number of patients in both groups. After intervention various neurophysiological changes took place in the brain which were not measured through any tool. Another drawback is that the retention effects of motor imagery technique was not measured.

Recommendations:It is recommended that future research should be conducted via larger-scale studies, exploring the effects of motor imagery in different stroke types and phases, and investigating the long-term retention of the intervention effects.

Conclusion

This study concluded that motor imagery is an effective treatment strategy for balance and mobility in stroke patients and brings better results as compared to conventional treatments.

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Conflict of Interest: None.

Source of Funding: None.

References

1. Cho HY, Kim JS, Lee GC. Effects of motor imagery training on balance and gait abilities in post-stroke patients: a randomised controlled trial. Clinical Rehabilitation. 2013; 27:675-80. doi: 10.1177/0269215512464702
2. Fishbein P, Hutzler Y, Ratmansky M, Treger I, Dunsky A. A preliminary study of dual-task training using virtual reality: influence on walking and balance in chronic poststroke survivors. J Stroke Cerebrovasc Dis. 2019; 28:104343. doi: 10.1016/j.jstrokecerebrovasdis.2019.104343.
3. Bin Song G, Cho Park E. Effect of dual tasks on balance ability in stroke patients. J Phys Ther Sci. 2015; 27:2457-60. doi: 10.1589/jpts.27.2457.
4. Scrivener K, Dorsch S, McCluskey A, Schurr K, Graham PL, Cao Z, et al. Bobath therapy is inferior to task-specific training and not superior to other interventions in improving lower limb activities after stroke: A systematic review. J Physiother. 2020; 66:225-35. doi: 10.1016/j.jphys.2020.09.008.
5. Nicholson V, Watts N, Chani Y, Keogh JW. Motor imagery training improves balance and mobility outcomes in older adults: A

systematic review. J Physiother. 2019; 65:200-7. doi: 10.1016/j.jphys.2019.08.007.
6. Bello UM, Winser SJ, Chan CC. Role of kinaesthetic motor imagery in mirror-induced visual illusion as intervention in post-stroke rehabilitation. Rev Neurosci. 2020; 31:659-74. doi: 10.1515/revneuro-2019-0106.
7. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 2007; 39:175-91. doi: 10.3758/bf03193146.
8. Park SW, Kim JH, Yang YJ. Mental practice for upper limb rehabilitation after stroke: a systematic review and meta-analysis. Int J Rehabil Res. 2018; 41:197-203. doi: 10.1097/MRR.0000000000000298.
9. Mihara M, Fujimoto H, Hattori N, Otomune H, Kajiyama Y, Konaka K, et al. Effect of neurofeedback facilitation on poststroke gait and balance recovery: A randomized controlled trial. Neurology. 2021; 96:e2587-98. doi: 10.1212/WNL.0000000000011989.
10. Fishbein P, Hutzler Y, Ratmansky M, Treger I, Dunsky A. A preliminary study of dual-task training using virtual reality: influence on walking and balance in chronic poststroke survivors. J Strok Cerebrovascul Dis. 2019; 28:104343. doi: 10.1016/j.jstrokecerebrovasdis.2019.104343.
11. Iqbal M, Arsh A, Hammad SM, Haq IU, Darain H. Comparison of dual task specific training and conventional physical therapy in ambulation of hemiplegic stroke patients: A randomised controlled trial. J Pak Med Assoc. 2020; 70:7-10. doi: 10.47391/JPMA.10443.
12. Williams SE. Comparing movement imagery and action observation as techniques to increase imagery ability. Psychol Sport Exer. 2019; 44:99-106. doi.org/10.1016/j.psychsport.2019.05.005
13. Rosa MV, Perracini MR, Ricci NA. Usefulness, assessment and normative data of the Functional Reach Test in older adults: a systematic review and meta-analysis. Arch Gerontol Geriatr. 2019; 81:149-70. doi: 10.1016/j.archger.2018.11.015
14. Kudlac M, Sabol J, Kaiser K, Kane C, Phillips RS. Reliability and validity of the Berg balance scale in the stroke population: a systematic review. Phys Occup Ther Geriatr. 2019; 37:196-221. doi.org/10.1080/02703181.2019.1631423
15. Carrasco DG, Cantalapiedra JA. Effectiveness of motor imagery or mental practice in functional recovery after stroke: a systematic review. Neurología. 2016; 31:43-52. doi: 10.1016/j.nrl.2013.02.003.
16. Bovonsunthonchai S, Aung N, Hiengkaew V, Tretriluxana J. A randomised controlled trial of motor imagery combined with structured progressive circuit class therapy on gait in stroke survivors. Scient Rep. 2020; 10:1-6945. doi: 10.1038/s41598-020-63914-8.
17. Choppala MM, Sri Thulasi PR, Prakash PK, Apparao P, Chintada PS, Tanavarapu B. A Comparative Study on Mirror Therapy and Motor Imagery on Improving Gait in Post Stroke Subjects. Executive. Indian J Physiother. Occup. Therapy. 2019;13: 23-28

Authors' Contributions

MZ: Data collection, questionnaire design, article writing, drafting, data analysis, interpretation, accountable for all aspect of work.

MG: Concept, design, data analysis, interpretation, critical reviewing of article, accountable for all aspect of work.

SJ: Literature review, drafting, data interpretation, critical reviewing of article, accountable for all aspect of work.