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To find out effectiveness of backward walking training in improving dynamic balance and gait in stroke patients

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Abstract
Background and Objectives: To examine the effectiveness of backward walking training in improving dynamic balance and gait in stroke patients
Study Design: Randomised controlled trail
Study Setting: Rehabilitation centres in Pune
Outcome Measures: Dynamic gait index (DGI), Speed test (ST), Berg balance scale (BBS).
Method: 20 subjects were selected on the basis of inclusion and exclusion criterias, randomly allocated to two groups, control (n = 10), experimental (n =10). Control group was given 30 mins of forward walking and Experimental group was given 30 mins of backward walking. Each session included 3o mins 3 times of walking with a rest period of 3-5 mins, each week they were treated for 4 days.
Result: The study showed significant changes in gait and balance in stroke patients. The comparison of pre and post scores of ST, DGI, BBS scales shows extremely significant differences.

Keywords: Stroke, gait, balance, berg balance scale, speed test, dynamic gait index, parallel bar

Introduction

The WHO defines stroke as "focal neurological impairment of sudden onset lasting more than 24hrs and presumed vascular origin and interruption of blood circulation to brain. Stroke can occur due to the lack of blood supply to the brain or haemorrhage".

- **Gait & balance:** Since loss of walking and balance is a major problem after stroke, recovery of walking and balancing is a priority goal for most patients.
  The gait of the person with stroke has been described as slow and asymmetric, velocity is diminished as compare to normal, has been reported repeatedly along with associated limitation in cadence, stride length and gait cycle.
- The velocity decrement has been described as potentially important implication. For example, many environmental factors, such as signals at a pedestrain crossing, are geared towards a much faster walking velocity. This slow walking velocity has traditionally been attributed to decrease joint movement amplitude and steps length as well as an inability to produce selective movement in the joints of the lower limb and poor balance. Attempts to increase walking velocity by hemiplegic subjects may result in problems of safety and a more abnormal gait pattern. This deterioration of performance appears to be worthy of consideration as an important rehabilitation concern. The typical hemiplegic gait is characterized by asymmetry of timing in single-limb support phase on the affected and unaffected legs. The asymmetrical gait pattern leads to increased energy expenditure and risk of falls. Consequently improvements in symmetry provide an important clinical marker of recovery. Conventional gait training alone often leads to an asymmetrical gait pattern in many patients with stroke.
- **Balance:** Balance is a prerequisite for all functional activities and depends on the integrity of the Central nervous system. Stroke subjects sometimes faces difficulty to perform sit to stand activity. Where those who manage to stand or sit, have delayed and disrupted Equilibrium reactions exaggerated postural sways, reduced weight bearing on paretic limb and risk of falls. Balance is essential for sitting, standing, walking.
- Dynamic balance is controlled in the body by several system working together sending signals and receiving signals from brain and peripheral. In stroke patient these system affect together.

First the sensory system must able to inform the central nervous system about the body position in space.

- Second central nervous system must be able to perceive or interpret the sensory information.
- Third the body must be able to respond quickly and effectively when dynamic balance is disturbed.
- Finally these three has to work together for dynamic balance and response. But in stroke patients the three system are affected individually or all 3 together. When central nervous system threat to dynamic balance it programmes a quick effective balance response. A group of muscles are signaled to respond quickly in particular order. Stroke often affects these responses as well as sequence. The common reason for dynamic balance problem is weakness of muscles which results from inability of central nerve system to control muscle activity.
- Dynamic balance is altered by direct affection of brain or inter relation failure of sensory system. In stroke patients disturbed equilibrium reactions and exaggerated postural sways are also identified. Stroke subjects experience unsteadiness and increase risk of fall. Which in turn, leads to the problem while moving or in daily activities.

All the above reasons affects stroke patients gait speed and dynamic balance and patient will become less ambulatory and become dependent in ADL activities**.**

Objectives

To evaluate the effectiveness of backward walking training in improving gait and dynamic balance.

Hypothesis

Null hypothesis (H0): Backward walking training is no effective in improving gait speed and dynamic balance in stroke patients.

Research hypothesis (H1): Backward walking training is effective in improving gait speed and dynamic balance in stroke patients.

Review of literature

- Y-R Yang *et al*. (2004) [1] conducted study on Gait outcomes after additional backward walking training in patients with stroke: a randomized controlled trial.
- Barry T. Batters, Janet (2005) [2] conducted a study on forward and backward walking benefits and the results suggest that backward walking will facilitate the neuromuscular function, muscle power, balance and proprioception.
- Glen Myatt, Richard E (1995) [3], conducted a study to find out the relation between oxygen consumption and backward walking and they found aerobic fitness is maintained during backward walking.
- Li-Yuanchenforng-Chin (2000), conducted study on kinematics and E.M.G. analysis of backward walking treadmill training in 16 subjects authors suggest muscular activity is more in backward walking.
- Silver Khs, Macko RF, Forrester LW, Goldberg AP, Smith GV (2000), conducted study to find out effectiveness of aerobic treadmill training on gait velocity, cadence, and gait symmetry in chronic hemiparetic stroke.
- Winter DA, Pluck N, Yang JF (1989), Backward walking: a simple reversal of forward walking.
- Thomas MA, Fast A (2000). Conducted study on one step forward and two steps backwards in therapy.
- Heart disease and stroke statistic-(2017), from the American heart association CHP 14 Pg 230

Methodology

- Study design- experimental study.
- Sample size- 20.
- Sampling design- simple random sampling.
- Study setting- various hospitals and clinics in and around city.
- Duration of study- 2 weeks.

Inclusion & exclusion criteria

Inclusion criteria	Exclusion criteria
Age 35-55 years of both gender.	Recent fractures of lower limbs or other musculoskeletal problem affecting gait.
First episode of stroke.	History of other neurological conditions other than stroke like spinal cord injury, parkinsonism, traumatic brain injury.
3 months to 1 year after stroke.	Cardiac surgery, uncontrolled blood pressure
Brunnstorms voluntary control grade 3-4 Of lower limb.	Uncontrolled diabetes mellitus.
Patient who can walk 10 metres.	
Poor dynamic gait index, score below 19	

Materials

- Count down timer
- Parallel bar
- Inch tape
- Cones

Outcome measures

Dynamic Gait Index: Dynamic gait index scale has 8 components and each 8 components has 3 sub components. Patient will be made to do different activities which are given in the assessment tool. According to the patients performances the score will be obtained from each sub components. Total score of dynamic gait index is 24 and score of 19 or less is related to increase incidence of fall.

Speed test: First therapist will make the one mark on the floor then calculate the distance between the first marking point to second marking point which has to come 10 M distance. Subjects were then asked to walk the 10 M distance with his/her maximum speed. Therapist walk along with the patient to avoid risk of falls, When patient start to walk from one pointed mark to second marked point. After completing the distance with maximum speed of patient performances therapist will note the how much time taken time between the 1M to 10 M distance.

Berg balance scale: BBS was developed to measure balance among older people with impairment in balance functional task.14 items scale designed to measure balance of the older adult in a clinical setting. Interpretations: 41-56= low risk of fall, 21-40=medium risk of fall, 0-20=high fall risk.

Procedure

The subjects from the study setting were approached and initial interview was conducted. They were screened for the inclusion and exclusion criteria. The subjects filling the selection criteria were described in detail about purpose procedure and intervention of the study. They were informed that they might fall under either experimental or control group for the study both of which would receive gait training two weeks of study duration. They were assured that if they want to change treatment it would be provided after completion of study and details of the both groups will be given but changing of groups during the study were not entertained. Inform consent forms obtained.

The selected 20 subjects randomly allocated to either groups. Both control and experimental group included 10 each subjects. For all subjects clear instructions about study test performance were given and the test was demonstrated.

The subjects in the experimental group received backward walking training, which was followed by instructions and demonstration. Manual assistance was given whenever required.

The subjects in the control group received forward walking training, which was followed by instructions and demonstration. Manual assistance was given whenever required. All subjects were assessed for gait speed and Dynamic balance for pre and post intervention.

Intervention

Total 20 patients who had stroke 3 months to 1year screened by inclusion and exclusion criteria & were divided into two equal groups by randomized allocation under intervention.

Control Group received Forward walking gait training

First therapist measured the 10 M distance then therapist demonstrated how to walk. After measuring the 10 M distance patient was instructed to walk 30 M distance forward with in the marked area. After completion of the 30 M distance patient were given rest for 3 to 5 minutes. After taking rest patient was again made to walk two more sets. Total 10 patients of this group received forward gait training. Patient walked totally 90 m distance in one sitting. When patient is walking therapist gave instructions to the patients to walk correctly as much as possible. When patients are walking therapist gave the instructions to the patients., try to avoid dragging of the foot, try to lift the foot and place forward, avoid the circumductory movements and try to do the knee ankle range of movements normal range. If necessary therapist gave assistance to the patients while walking forward.

Experimental Group Back ward walking

First therapist measured the 10 M distance. After measuring the 10 M distance Patient was instructed to walk 30 M distance back ward within the marked area. First therapist demonstrated to the patient how to walk back ward. After completion of the 30 M distance patient was asked to take rest for 3 to 5 minutes. After taking rest patient were again made to walk two more sets. Total 10 patients of this group received back ward walking Patient walked 90 m distance in one sitting in one day. When patient walks the therapist gives instructions to the patients, to make them to walk correctly as much as possible. When patient walking back ward instructions were given by therapist as, first tell the patient try to place the foot back ward after placing the foot back ward extend the hip and knee flexion. If necessary therapist gives assistance to the patients while walking back ward.

Duration

Total 20 Subjects were given back ward walking training, forward walking training for a period of 2 weeks. Each week they were treated for 4 days. Each session included 30M 3 times of walking with a rest period of 3 to 5 minutes.

Data and statistical analysis

Statistical analysis was conducted using INSTAT™ for Windows.

The difference in pre and post treatment value was compared using paired t test and post data treatment value of control group and experimental group was compared using unpaired t test.

Data analysis

Control group

Table 1: Dynamic Gait Index: Pre and post data is compared using paired t test

Data	Mean ±SD	T value	P value
Pre	13.9±2.602	9.000	0.0231
Post	16.3±2.359		

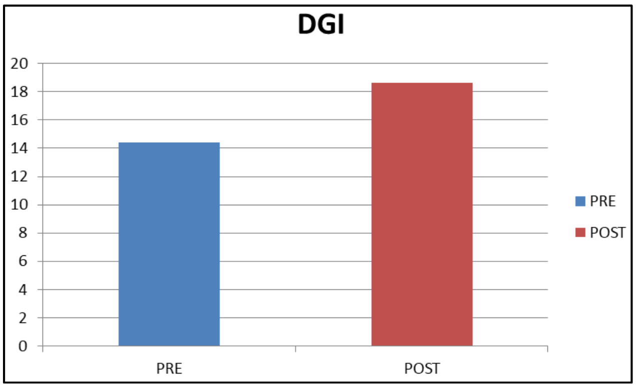


Table 2: Berg Balance Scale Pre and post data compared using paired t test:

Data	Mean ±SD	T value	P value
Pre	15.6±2.366	8.143	0.0001
Post	17.5±2.461		

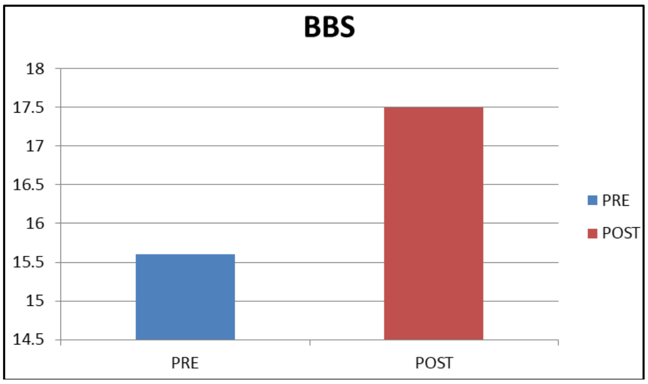
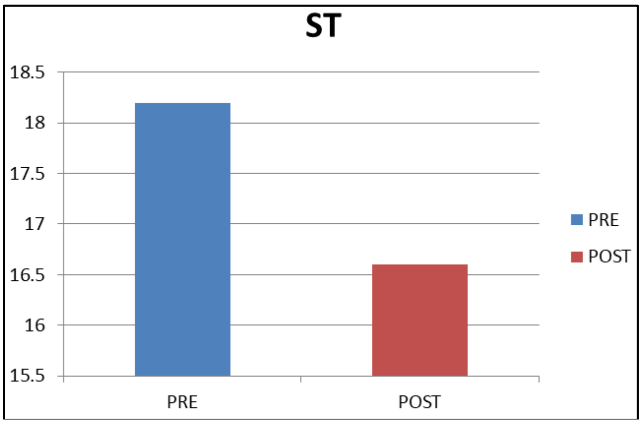


Table 3: Speed Test Pre and post data is compared using paired t test

Data	Mean + SD	T value	P value
Pre	18.2+2.004	7.236	0.0001
Post	16.6+2.319		



Experimental group

Table 1: Dynamic Gate Index Pre and post data is compared using paired t test

Data	Mean +SD	T value	P value
PRE	15.2+2.741	7.236	0.0001
POST	16.8+2.700		

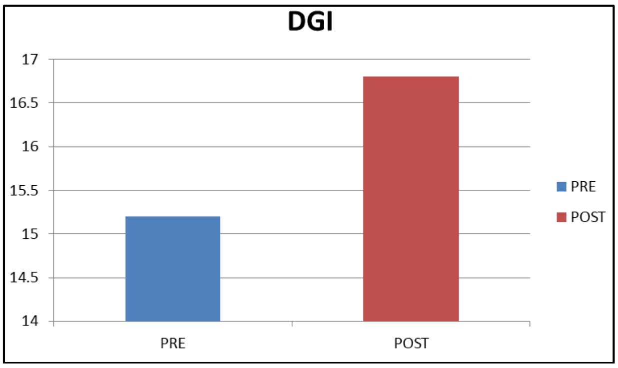


Table 2: Berg Balance Scale Pre and post data is compared using paired t test

Data	Mean +SD	T value	P value
Pre	15.1+2.767	5.014	0.0007
Post	16+2.539		

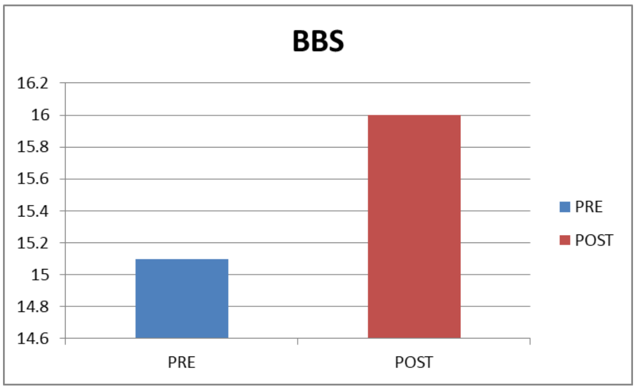
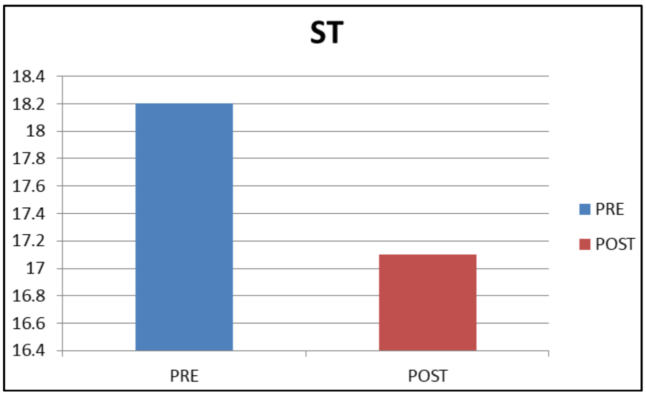


Table 3: Speed Test Pre and post data is compared using paired t test

Data	Mean +SD	T value	P value
Pre	18.2+2.004	6.128	0.0002
Post	17.1+2.424		



Post data comparison of group 1 and group 2

Table 1: Dynamic Gate Index Post data compared using unpaired t test

Data	Mean +SD	T value	P value
Post G-1	16.2+2.384	2.192	0.0417
Post G-2	18.9+3.107		

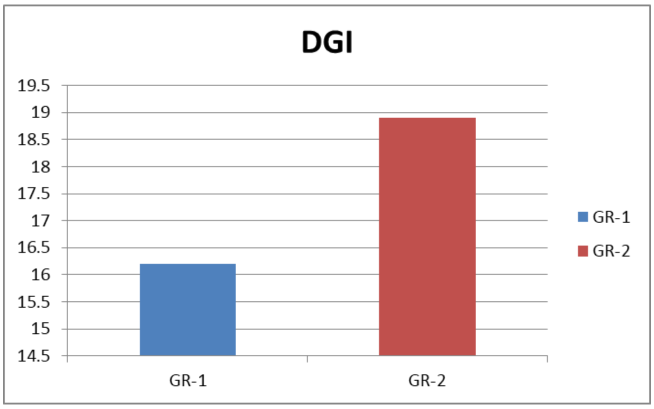


Table 2: Berg Balance Scale Post data compared using unpaired t test

Data	Mean +SD	T value	P value
Post G-1	17.5+2.461	2.284	0.0348
Post G-2	19.9+2.234		

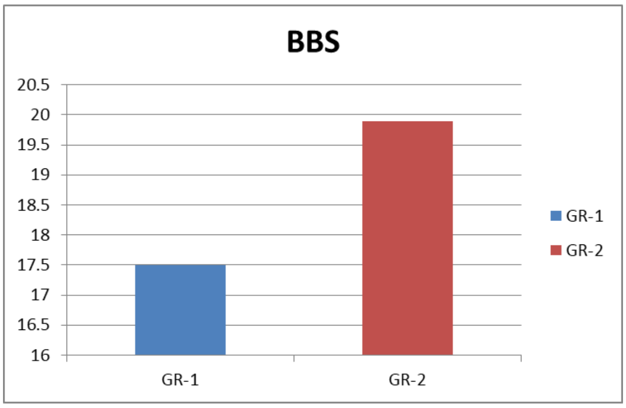
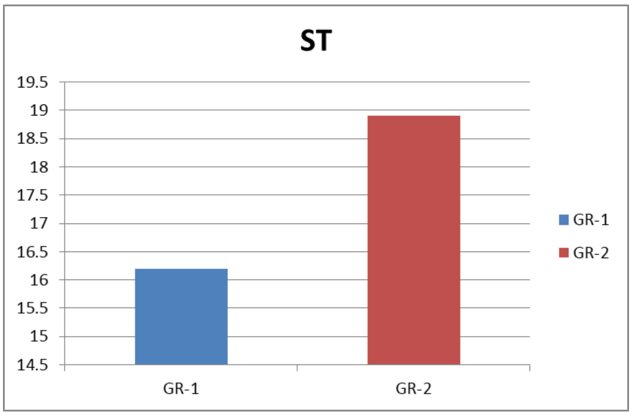


Table 3: Speed Test Post data compared using unpaired t test

Data	Mean ±SD	T value	P value
Post G-1	16.6±2.319	3.291	0.0041
Post G-2	13.6±1.713		



Result

- The present study was conducted to find out the effectiveness of backward walking training in improving gait and dynamic balance in stroke patients.
- The statistical analysis was done using Instat software inter group analysis was done using t test (paired t test and unpaired t test).
- The DGI was analysed using paired t test within the group with p value= o.o231, t value 9.000 and analysed among group 1 and group 2 with p value=0.0417,t value=2.192 using unpaired t test.
- The BBS was analysed using paired t test within the group with p value=0.0001, t vale=8.143 and among group 1 and group 2 with p value=0.0348, t value2.284 using unpaired t test.
- Speed Test was analysed within the group using paired t test with p value=0.0001, t value=7.238 and analysed among group 1 and group 2 using unpaired t test with p value=0.0041, t value=3.291.

Discussion

- It has been cited, but unproven, that the indications for backward walking therapy include difficulty with weight shift, balance and gait in patients with hemiparesis and hemiparesis with a strong lower limb synergy pattern. The results of this randomized trial suggest that additional backward walking training may help improve walking abilities in individuals with hemiparetic stroke [1].
- Asymmetry was one of the most obvious features of the abnormal gait of patients with stroke. The mean temporal symmetry index for single-limb support phase was significantly high (/10%), indicating that marked asymmetries are present. The majority of patients showed an asymmetrical gait pattern with less time spent on the affected leg during single-limb support than on the unaffected leg. One of the specific goals in gait training is the restoration of gait symmetry, in order to regain a physiological gait pattern. The present study demonstrated that patients with hemiparesis can benefit in having their gait symmetry improved from receiving additional backward walking therapy. This is more effective than just conventional training alone. Therefore, it could be suggested that backward walking training may be an appropriate training modality to add to the conventional programme for improving patients' asymmetric gait pattern and balance.[1]
- In contrast to normal subjects the hemiplegic gait pattern is characterized by low values for velocity, cadence and stride length and high value for gait cycle duration. Many sources note that improvements in walking speed are strongly correlated with improvements in walking ability in patients with hemiparesis. The results of this study concur with this viewpoint. In addition to speed gains, it has been observed that cadence, stride length, gait cycle and gait symmetry were significantly improved in the experimental group, and that cadence and gait cycle were greatly improved in the control group.
- Moreover, for patients with reduced walking ability, increasing walking speed results in giving that patient a greater behavioural repertoire in everyday life. Changes in walking speed as low as 6 m/mi are probably the smallest clinically worthwhile effect worth detecting. This is a small but clinically relevant gain in this patient group. In the control group, the mean difference for walking speed was below.
- There are several limitations of this study. First the number of subjects in this trial was limited which means that care should be exercised in the interpretation of the results. However, this may somewhat be compensated by the homogeneity of the groups. Second, due to limited resources this study did not use a blinded assessor. Any potential for unbinding to bias the study results was minimized by the use of standard instructions during testing. Third, we did not have a control for the additional therapy. The participants in the control group did not receive any 'placebo' intervention. It has been suggested that intensive rehabilitation programmes are often of great benefit. The significant improvement on walking speed was also observed following parallel bar or task-related circuit training in similar groups of patients. Therefore, additional forward walking therapy or other approaches might also help. Future studies should control these potential sources of bias
- This study demonstrates that backward walking is an effective and safe approach. It can result in superior walking ability in ambulatory hemiparetic patients comparing with running mere conventional rehabilitation programmes without backward walking. Thomas and Fast presented two cases in which walking backwards during physical therapy resulted in a fall and considerable morbidity. They therefore doubted the safety of walking backwards. In this study, none of our subjects fell down during backward walking training. Backward walking requires a greater reliance on neuromuscular control, proprioception and protective reflexes because of the elimination of visual cues. It is important that adequate safeguards should be provided when backward walking is prescribed.

Limitation and future study scope

There are several limitations of this study. First the number of subjects in this trial was limited which means that care should be exercised in the interpretation of the results. However, this may somewhat be compensated by the homogeneity of the groups. Second, due to limited resources this study did not use a blinded assessor. Any potential for unbinding to bias the study results was minimized by the use of standard instructions during testing. Third, we did not have a control for the additional therapy. The participants in the control group did not receive any 'placebo' intervention. It has been suggested that intensive rehabilitation programmes are often of great benefit. The significant improvement on walking speed was also observed following parallel bar or task-related circuit training in similar groups of patients. Therefore, additional forward walking therapy or other approaches might also help. Future studies should control these potential sources of bias.

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