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Research Article

EFFECT OF ADDITIONAL BACKWARD WALKING TRAINING ON GAIT PERFORMANCE IN HEMIPARETIC STROKE PATIENTS

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ABSTRACT

Aim: To evaluate the Gait outcomes after additional backward walking training in hemiparetic stroke patients.

Objective: To compare the effects of backward walking training program along with conventional gait re-education and conventional gait re-education alone on velocity, cadence & step length in hemiparetic stroke patients.

Methodology: 20 hemiparetic patients who satisfied the inclusion criteria were randomly distributed in experimental group and control group. Experimental group received conventional gait re-education program of 40min along with additional backward walking training of 30 min, on alternate day for 3 weeks. The control group received only conventional gait re-education program of 40 min on alternate day for 3 weeks. The step length, velocity and cadence were measured before & after the intervention.

Result: Student's 't' test was used to find out the significance. Velocity, Cadence & Step length was found to be improved in both the groups after the intervention. But the experimental group showed significant difference in velocity & cadence as compared to control group.

Conclusion: This study concluded that adding a backward walking to a conventional gait re-education program can improve walking speed, cadence & step length in hemiparetic stroke patients.

INTRODUCTION

Loss of walking ability is a major problem after stroke [1,2]. The gait of the person with hemiplegia has been described as slow and asymmetric.[5,6,34] As compared to normal individual, there is a diminished velocity, cadence and step length. Hemiparetic gait is characterized by slow and asymmetric steps with poor selective motor control, delayed and disrupted equilibrium reactions and reduced weight bearing on the paretic limb[19, 11-16, 32] Smooth and symmetric forward progression of the body is impaired with a large variation in gait patterns.

Well-controlled intra-limb and inter-limb coordination is replaced by mass limb movement patterns (synergies) on the paretic side requiring compensatory adjustments of the pelvis and non-paretic side. Patients with poor selective motor control walk with synergistic mass patterns of the affected lower leg rather than isolated joint movements. Simultaneous activation of the quadriceps with the gluteus maximus causes a mass extension pattern during the stance phase. Then the mass flexion pattern causes synergistic contraction of the hip flexors, knee flexors, and ankle dorsiflexors during the swing phase[29]. Impaired motor control produces the patterned limb movement and inhibits normal progression during walking.

Compensatory movements necessary for ambulation, produce abnormal displacement of the center of gravity, resulting in increased energy expenditure[18,19],risk of falls & functional difficulties such as going to the toilet, cooking in the kitchen, crossing the road etc because these activities require a much faster walking velocity. Hence improvement in symmetry provides an important clinical marker of recovery and functionality [19,20,21,27,28]

Friedman; (1990) showed that sooner the individual with a history of stroke attains the ability to ambulate, the more likely to re-establish the independent walking. Gait re-education alone is not sufficient to correct an asymmetrical gait pattern in many patients with stroke[18,19].

Hence it has been suggested that backward walking may offer some benefits beyond those experienced through forward walking alone. Learning to walk backwards correctly has been recommended to improve the movement components required for walking forwards[20].

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Flaynn TW *et al* (1994) showed that Backward walking also improves an oxygen consumption, metabolic and cardiorespiratory responses than forward walking[25].

Winter DA *et al* (1989) has proved that backward walking appears to create more muscle activity as compared to forward walking[24]. Backward walking combines hip extension with knee flexion and is particularly useful for patients with hemiplegia to break the synergic pattern in the lower extremities[26].

Backward walking has several benefits such as; it provides more erect posture (less trunk inclination) than during forward walking. It increases cadence, decreases stride length and increases support time; It reduces overall range of motion at the hip joint (greater flexion and lesser extension); Increases active functional range of motion at the knee joint. It provides combined maximum knee extension with hip flexion (greater hamstrings activation with hip flexion) to breakdown the synergic pattern, Electromyographical (muscle) activity of the lower extremities is greater in backward versus forward walking[22,23]

Hence Backward walking has been promoted as a treatment strategy to improve gait by improving proprioception.

Need For Study

Stroke is one of the leading causes of disability that results into variety of impairments which compromise quality of life. Impaired gait is a major problem that affect the Activities of Daily Living (ADLs). Recovery of walking ability is a priority goal for the patient.

It has been proved that sooner the individual with a history of stroke attains the ability to ambulate, the more likely to re-establish the independent walking. Hence Conventional gait reeducation program is used to improve the gait performance. But it is not sufficient to improve gait performance as it doesn't focus on the movement components that are required to breakdown the synergic pattern.

Backward walking training is not routinely used because of the risk of fall & very few evidences evaluated specifically the effects of backward walking training. But it can be used to improve the components that are required for walking forwards. Hence the study needs to be carried out to prove the effectiveness of backward walking on gait outcome in hemiparetic stroke patients.

Aim

To evaluate the Gait outcomes after additional backward walking training in hemiparetic stroke patients.

Objective

To compare the effects of backward walking training program along with conventional gait reeducation & conventional gait reeducation on velocity, cadence & step length in hemiparetic stroke patients.

Research Question

Will there be a difference in 20 hemiparetic stroke patients when treated with additional backward walking training along with conventional gait reeducation and only conventional gait reeducation over a period of 3 weeks on improving velocity, cadence & step length?

Research Hypotheses

Null hypothesis (Ho): There will be no significant difference between the gait outcomes of Control Group & experimental group after additional backward walking training.

Alternate Hypothesis (H_1): There is a significant difference between the gait outcomes of Control Group & experimental group after additional backward walking training.

RESEARCH DESIGN & METHODOLOGY

Study Design: A Randomised Controlled study.
Study Setting: Department of Physiotherapy

Sampling Method: Convenient Sampling method

Sample Size: 20

Criteria for sampling

Inclusion criteria

- First occurrence of stroke
- Lower extremity voluntary control grade 3 to 4
- Ability to walk atleast 11 m with or without a walking aid or orthosis
- Stable medical condition to allow participation with testing protocol and intervention
- Ability to understand instructions and follow commands.

Exclusion Criteria

- Any uncontrolled health condition like uncontrolled hypertension, Myocardial infarction for which exercise is contraindicated
- Subjects with Orthopaedic and other gait-influencing diseases like recent fractures of lower limbs, amputation or recent surgery

Outcome Measures

Observational gait analysis

Dependent Variables

- Velocity
- Cadence
- Step length

Independent Variables

Backward walking

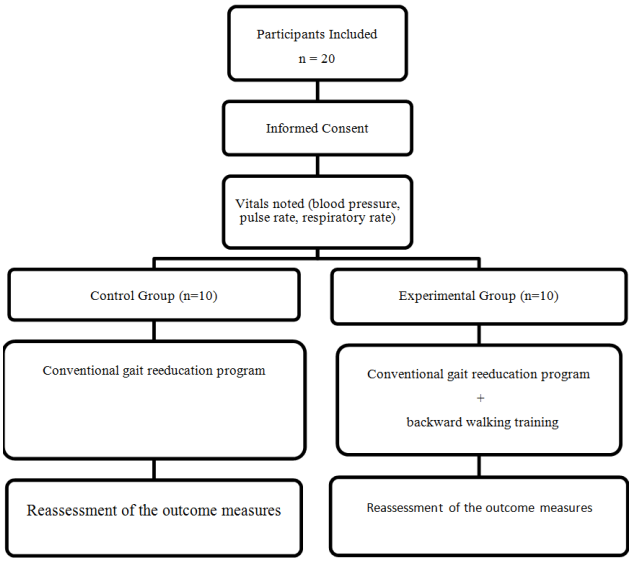
Materials Used for Study

- Pen
- Paper
- Stopwatch
- Measuring tape
- Parallel bars & postural mirror

Procedure

Prior to data collection, the purpose and procedures were fully explained, written informed consents were obtained & vitals

(Blood pressure & Pulse Rate) were noted. 20subjects were identified as potential participants for this study. Participants were divided into the Control Group & the experimental group before starting the intervention. All subjects were evaluated before commencement of training (pre-training) and at the end of the three-week training period (post-training). 10 subjects in the Control Group received the conventional gait reeducation program. They did not receive any additional backward training & another 10 subjects in the experimental group received the conventional gait reeducation program along with backward walking training. Vitals were monitored throughout the treatment.



Flow chart of procedure

Interventions

Subjects in both groups participated in 40 min of conventional gait reeducation, 3 times a week for 3 weeks. Tonal management for both upper & lower limbs, perambulation training in mat, and mobility activities are also given along with conventional gait reeducation.

Conventional gait reeducation program includes forward walking, sideways walking, walking on specific marks, spot marching & obstacle walking. All the exercises are carried out within the parallel bars & in front of postural mirror & so the patient gets visual feedback.

The Subjects in the experimental group received conventional gait reeducation along with additional 30 min of backward walking training for 3 weeks at a frequency of 3 times per week.

1. The subject was asked to take a step backwards within parallel bars and can support him or herself with the unaffected hand as required. The therapist provides assistance to move the subject's leg in the correct pattern.sWhen the subject can move the leg back with the correct pattern, the therapist gradually reduces the amount of assistance.
2. As the movement components have been practiced, and the subject has taken over actively with only slight help, the therapist facilitates walking backwards within parallel bars
3. Then, the subject walks backwards actively away from the parallel bars. Finally, the distance and speed of walking backwards is progressively increased.

Measurement

The measurement was taken before & after completion of treatment session (after 3 weeks). A smooth, flat 11-m walkway was marked out on the floor in the physical therapy department. All subjects were requested to walk at a self selected, comfortable walking speed. For safety reasons there was standby supervision throughout the process although no physical assistance was provided. Each test session included trial of walking a distance of 11m. The total time (in minutes) was obtained with a stopwatch and total number of steps during trial was obtained by counting heel-strikes. Gait speed was calculated as the distance (11 m) divided by the time, and cadence was calculated as the number of steps divided by the time. Was obtained by measuring the distance between first heel strike of one foot & the next similar heel strike of the opposite foot.

RESULTS

Statistical analysis was done by trial version of GraphPad InStat (v 3.06) software. The data was entered into an excel spread sheet, tabulated and subjected to statistical analysis. Various statistical measures such as mean, standard deviation (SD) and test of significance such as paired‘t’ test and unpaired ‘t’ test were utilized to analyze the data.Paired‘t’ test was used to compare the differences of scores before and after the exercise programs of 3 weeks. Unpaired‘t’ test was used to compare the differences of scores in Control group and Experimental group. The results were concluded to be statistically significant with $p < 0.05$.

The results of the study showed that there was a significant change in velocity, cadence and step length after the exercise program in both the groups. When both the training groups were compared, velocity & cadence was found to be significantly increased in experimental group. But no significant difference was found in the when the two groups were compared.

Data Analysis and Interpretation

Velocity: The pre interventional mean score for Control group was 4.16 and for Experimental group was 3.85. At the end of 3rd week, score for Control group was 5.44 and for Experimental group was 6.57. There was statistically significant difference in the mean score of Velocity after 3 weeks of training in both the groups [Table No.1]

Cadence: The pre interventional mean score for Control group was 24.95 and for Experimental group was 23.84. At the end of 3rd week, score for Control group was 35.56 and for Experimental group was 45.87. There was statistically significant difference in the mean score of Cadence after 3 weeks of training in both the groups [Table No.2]

Step Length: The pre interventional mean score for Control group was 0.714 and for Experimental group was 0.733. At the end of 3rd week, score for Control group was 0.633 and for Experimental group was 0.61. There was statistically significant difference in the mean score of Cadence after 3 weeks of training in both the groups [Table No.3]

Table No 1 Comparison of Mean pre training and post training values of Velocity between Control Group & Experimental Group

Velocity (meters/min) Mean	Pre score	Post score (after3weeks)	'p' value	't' value	Result
Control Group	4.16	5.44	0.0058	-3.59	Significant
Experimental group	3.85	6.57	0.00015	-6.212	Highly significant

Table No 2 Comparison of Mean pre training and post training values of Cadence between Control Group & Experimental Group

CADENCE (steps/min) Mean	Pre score	Post score (after 3weeks)	'p' value	't' value	Result
Control Group	24.95	35.56	0.0013	-4.57	Significant
Experimental group	23.844	45.87	0.00005	-7.115	Extremely Significant

Table No 3 Comparison of Mean values of Step Length of Control Group & Experimental Group

(meter) Mean	Pre score	Post score (after 3 weeks)	'p' value	't' value	Result
Control Group	0.714	0.633	0.00019	-6.020	Highly Significant
Experimental group	0.733	0.61	0.00007	-6.827	Extremely significant

Comparison of Mean difference values of Velocity: The mean difference score for Control group was 1.239 ± 1.130 and for Experimental group was 2.725 ± 1.387. There was a statistically significant difference in the mean difference score of Velocity between Control group and Experimental group.[Table no.4]

Table No 4 Comparison of Mean difference values of Velocity between Control Group & Experimental Group

Velocity	Mean difference	Standard deviation	'p' value	't' value	Result
Control Group	1.239	±1.130	0.0209	2.531	Significant
Experimental group	2.725	±1.387			

Comparison of Mean difference values of Cadence: The mean difference score for Control group was 10.558 ± 7.411 and for Experimental group was 22.028 ± 9.790. There was a statistically significant difference in the mean difference score of Cadence between Control group and Experimental group. [Table.5]

Table No 5 Comparison of Mean difference values of Cadence between Control Group & Experimental Group

Cadence	Mean difference	Standard deviation	'p' value	't' value	Result
Control Group	10.558	±7.411	0.0085	2.954	Very Significant
Experimental group	22.028	±9.790			

Comparison of Mean difference values of Step Length: The mean difference score for Control group was 0.081 ± 0.046 and for Experimental group was 0.123 ± 0.052. There was no statistically significant difference in the mean difference score of Step Length between Control Group and Experimental Group [Table 6]

Table No 6 Comparison of Mean difference values of Step Length between Control Group & Experimental Group

	Mean difference	Standard deviation	'p' value	't' value	Result
Control Group	0.081	±0.046	0.078	1.868	Not Significant
Experimental group	0.123	±0.052			

DISCUSSION

Overview of Results

Stroke is one of the leading causes of disability that results into variety of impairments which compromise quality of life. Loss of walking ability is a major problem after stroke [1,2]. The gait of a person with hemiplegia has been described as slow and asymmetric.[5,6,7.] As compared to normal individual, there is a diminished velocity, cadence and step length. Hemiparetic gait is characterized by slow and asymmetric steps. Compensatory movements are necessary for ambulation resulting into increased energy expenditure& risk of falls. Gait re-education program alone is not sufficient to correct an asymmetrical gait pattern in many patients with stroke[20].

The aim of the study was to examine the effects of backward walking training along with conventional gait reeducation are more beneficial than only conventional gait reeducation. All subjects were evaluated for velocity, cadence & before commencement of training (pre-training) and at the end of the three-week training period (post-training).

The results after the treatment showed significant improvement in walking velocity, cadence and step length in hemiparetic stroke patients of both the groups but velocity and cadence was found to be significantly improved in experimental group when compared to Control Group.

Similar results were found in a favor of backward walking training in a study done by Yea-Ru Yang Institute & Faculty of Physical Therapy (2005). In hemiparetic stroke patients, the extensor synergy predominates in the lower extremity. Hip extension with knee flexion was emphasized by Bobath to break up the synergy pattern[7.] Isolated movements of the knee alternating flexion with extension were repeatedly practiced in the backward walking training and may contribute to improve neuromuscular control in hemiparetic stroke patients with synergy influence in the lower extremities. Moreover, Winter *et al*. concluded that backward walking was a near mirror image of forward walking.[25] They reported that in order to produce the muscle activation patterns involved in forward walking the temporal cycling of the muscle contractions in backward walking is simply reversed.[25] Many sources note that improvements in walking speed are strongly correlated with improvements in walking ability in patients with hemiparesis. This is also a possible reason for the improved gait performance after additional backward walking training.

From the study it is proved that the Additional Backward walking along with conventional gait reeducation can result in superior walking ability in hemiparetic stroke patients as compared to conventional gait reeducation without backward walking.

CONCLUSION

Additional backward walking training has shown statistically significant improvements in gait outcomes of Hemiparetic Stroke Patients as compared to Conventional gait reeducation program. Although no statistical significant changes were found in Step Length, both the training methods seem to improve gait outcomes in Hemiparetic Stroke Patients. Therefore, it can be said that, adding a backward walking to Conventional gait reeducation program can result in significantly improved gait outcomes in Hemiparetic Stroke Patients. Hence Backward Walking training additional to Conventional gait reeducation program can be used in day to day practice of physiotherapy as a treatment protocol for a positive effect on Hemiparetic Stroke Patients.

Limitations of study

- The sample size selected was small consisting of 20 subjects.
- The study was carried out without using the digital gait analyzer.
- There are chances of manual errors.

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