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Original Article

Physiotherapy Section

Effectiveness of Backward Walking in the Gait Performance of Stroke Patients

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ABSTRACT

Introduction: Stroke is one of the leading cause of long term disabilities. The most commonly affected activity is walking. Though conventional therapy is producing beneficial effects in the gait of stroke patients, Backward walking is proposed to be effective in improving the gait of stroke patients.

Aim: To examine the effectiveness of backward walking training on gait performance of stroke patients.

Materials and Methods: The study design was an experimental study. Thirty hemiplegic patients were selected by convenient sampling technique and divided into two groups. Subjects in both groups received 40 minutes of conventional training one session per day for two weeks. Subjects in the experimental group received additional backward training for 30 minutes. Gait performance was measured using Wisconsin gait scale. Gait parameters, cadence and walking speed were also measured before and after treatment. Statistical analysis was done using independent 't' test and paired 't' test for between the groups and within the groups respectively.

Results: After four weeks of training period, subjects in the experimental group showed much improvement than those in control group for gait performance (score: 17.42±1.53 versus 22.47±1.52) ($p<0.05$), walking speed (score: 14.4±2.11 versus 20±0.5) ($p<0.05$), and cadence (score: 114.6±3.76 versus 97.06±1.61) ($p<0.05$), all the three variables showing statistical significance.

Conclusion: Backward walking can also be supplemented along with conventional training in improving gait performance, walking speed and cadence of stroke patients.

Keywords: Cadence, Hemiplegia, Locomotion, Rehabilitation, Walking speed, Wisconsin gait scale

INTRODUCTION

According to World Health Organisation, Stroke is defined as "rapidly developing clinical signs of focal or global disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, with no apparent cause other than of vascular origin" [1]. Ischemic stroke is defined as an episode of neurological dysfunction caused by focal cerebral, spinal, or retinal infarction [2]. Stroke is the second leading cause of death and a major cause of disability worldwide. In addition, more young people are affected by stroke in low- and middle-income countries [3]. The cumulative incidence of stroke in India ranged from 105 to 152/100,000 persons per year, and the crude prevalence of stroke ranged from 44.29 to 559/100,000 persons in different parts of the country during the past decade. Ischemic stroke is more common but haemorrhagic stroke is accountable for more deaths and disability-adjusted life-years lost [4]. Some of the common clinical findings of stroke are Hemiparesis, Hemisensory loss, Hemianopia (optic tract and radiation), Dysphasia (expressive and/or receptive) if dominant hemisphere, Sensory inattention, Visual inattention and Neglect [5]. Traditional neurophysiological approaches Bobath, Brunnstrom's, PNF had demonstrated improvements in motor functions, but none of the approaches is superior than other [6]. Unfortunately stroke survivors land-up with long-term physical disabilities [7]. The most affected function by stroke is walking, with 80% cases initially loses the ability to walk [8].

The person with hemiplegia demonstrates a slower gait pattern which is mostly asymmetric [9]. The reduced velocity has higher importance in activity implications. For example, many factors like crossing signals are accelerated towards an increase in walking velocity [10]. The asymmetry in hemiplegia leads to excessive consumption of energy and increases the tendency to fall [11]. For the hemiplegics, regaining gait is of high priority [12]. Intense gait re-training is among the priorities in neurological recovery post stroke [13]. For many, however, the recovery in terms of walking remains incomplete [14]. Friedman had proved that the quicker the patients with stroke attains the potential to ambulate, faster the walking would be re-established [15].

To return to the premorbid environment gait outcome is a major factor [15]. A progress in terms of symmetry is a significant identification of betterment and functionality in clinical aspects [16]. Walking backwards is an important strategy to improve the gait of hemiplegics [17]. A hemiplegic patient when tries to increase walking velocity eventually lands up in abnormal pattern of walking. This worsening of walking could be the prime factor to be considered in rehabilitation aspects [17]. Early intervention in gait training for the hemiplegics is always beneficial [8]. Conventional therapy for the hemiplegic patients often leads to abnormality in terms of symmetry [18]. Though speed of the walk and number of steps is lesser in backward walking [19], by learning to walk backwards in a right way provides essential components to walk forwards [20] due to the unique biomechanical demand of placing the footstep backwards [21]. In a study conducted by Sang-Jin Kim had proved that the ability to walk following stroke had been improved by giving backward walking training in terms of walking speed, cadence, stride length and step length [22]. Though the parameters of gait has been improved they have failed to present the mechanism of backward walking training in stroke patients. Kyung-Hoon Kim had demonstrated that treadmill supported backward walking training had positively affected the gait ability of stroke patients [23]. This novel method of backward walking training in stroke patients towards the rehabilitation of gait is emerging in recent years and thus the need arises to examine the effectiveness of backward walking training in the gait performance of stroke patients.

MATERIALS AND METHODS

Study design was made as two groups pre-test, post-test experimental study where non probability convenient sampling technique was used for sampling. All 30 patients were explained about the study and informed consent was taken from them. After obtaining the ethical approval from the Ethical Committee (Ref: EC-FAC/18/PHY/072) thirty hemiplegic patients were allocated into two groups of 15 in each group. The study was conducted at OPD of Krupanidhi College of Physiotherapy and the duration of the study was from January 2018 to June 2018. The inclusion criteria were ischemic type of stroke, patients having Middle cerebral artery involvement, both male and female genders were included for the study. Criteria for inclusion were considered with the age limit 40 to 65 years. Patients under the category of Brunnstrom's recovery stage 3 and 4 [24] were included. The duration of the condition from onset was less than six months and the patient should be able to walk 11 meters forwards by taking assistance or independently.

Hemorrhagic and traumatic with Posterior cerebral artery, Anterior cerebral artery involvement were excluded. Patients with age below 40 years and above 65 years and Brunnstrom's recovery 1, 2, 5 and 6 were excluded for the study. Patients with cardio respiratory abnormalities perceptual and cognitive deficits and pre existing deformities of lower limb were also excluded. Brunnstrom's stages of recovery indicates the severity of the stroke. It has six stages for lower limb: Stage 1: having flaccidity, Stage 2: having minimal voluntary movements, Stage 3: where the patient is able to flex hip, knee and ankle in sitting and standing, Stage 4: where the patient can attain sitting knee flexion beyond 90°, within the foot sliding backward on the floor, voluntary dorsiflexion of the ankle without lifting the foot off the floor, Stage 5: standing isolated non-weight bearing with knee flexion and hip extension and Stage 6: standing hip abduction beyond range obtained from elevation of pelvis, inner and outward rotations at the knee [24].

The treatment was one session per day, four days a week for four weeks. The study duration was for six months, Group A was provided with backward walking along with Conventional Physiotherapy and Group B was provided only Conventional Physiotherapy.

PROCEDURE

Backward Walking

The experimental group (Group A) was given backward walking training along with conventional therapy. Patients were given instructions regarding backward walking training and demonstration was done. Kneeling at the side of the patient, the hemiplegic leg was moved in the correct pattern. With one hand, toes were held in dorsal extension and the other hand was placed over the patient's buttock to prevent patient's hip from hiking the pelvis upwards and backwards as the leg moves. Patient was instructed not to resist the movement of his leg. Total extension of leg was avoided by moving the foot back in small steps with knee flexion. To avoid plantar flexion of the spastic leg patient was instructed to keep the heel inwards during foot placement. When the patient had moved a step backwards with the hemiplegic foot, assistance was given to lower the heel to the ground as he had to take a step backwards with his sound leg. Treatment was given for 30 min with adequate rest periods in between depending on patient's comfort.

Conventional Physiotherapy

Control group (Group B) was given only Conventional therapy. Tone normalisation was done by slow sustained stretching and cryotherapy for 10-15 minutes for the spastic agonist muscles. Weight bearing posture with slow rocking movements in quadruped position and Rhythmic rotations were given to the paretic limbs. Free ranges of motion exercises with voluntary movements were encouraged. Reaching forwards, sideways with Functional reach activities in sitting and standing were given as balance training. To retrain gait weight bearing exercises through legs, active flexion of leg maximally and a minimum flexion of leg to gain control of voluntary movements were encouraged; which is a preparation for walking. Proprioceptive Neuromuscular Facilitation (PNF) technique movement patterns, D1 extension with knee flexion for the paretic leg were given.

MEASUREMENT TOOL AND METHOD

Stop Watch and measuring tape were the measurement tools. Patient was instructed to walk in his own pace and his gait parameters were assessed using Wisconsin gait scale. The distance of 11 meters was marked using measuring tape. By means of stop watch, the time taken to walk (9 meters) was measured in seconds. The first and last one meter was not included as the rate of acceleration and deceleration would vary, which in turn would alter the walking speed. The number of steps per minute (cadence) was measured by instructing the patient to walk in the straight corridor. For safety purpose patients were assisted by walking along with them.

Outcome measures

- Wisconsin Gait Scale (Gait Performance) [25]
- Walking speed
- Cadence.

STATISTICAL ANALYSIS

Statistical analysis was done using independent 't' test and paired 't' test for between the groups and within the groups respectively. The data was analysed using the SPSS version 20.

RESULTS

After analysing the data the results obtained showed that there was significant improvement in Group A (Experimental group) on the measures of Wisconsin gait scale, walking speed and cadence, [Table/Fig-1]. There was also significant improvement in Wisconsin gait scale, walking speed and cadence in group B (Control group) [Table/Fig-2]. The results obtained after the analysis of independent 't' test between the group showed that there was significant improvement in all three parameters in group A (Experimental group); Wisconsin gait scale (17.42±1.53), walking speed (14.4±2.11) and cadence (114.6±3.76), than Group B, Wisconsin gait scale (22.47±1.52), walking speed (20±0.5) and cadence (97.06±1.61) [Table/Fig-3]. Improvement was significant in the gait performance assessed using Wisconsin gait scale in experimental group with the score of 17.42 than the control group with the score of 22.47. Significant improvement was also seen in walking speed in the experimental group with the score of 14.4 than the control group with the score of 20. Improvement in cadence was seen in experimental group with the score of 114.6 steps per minute than 97.06 steps per minute of control group.

Gait variables	Pre test mean values	Post test mean values	SD	Table t value	Calculated value	p-value	Significance
Wisconsin gait scale (scores in points)	*29.29	17.42	1.53	2.145	29.96	0.00027	Highly significant
Walking speed (m/sec)	*21.06	14.4	2.11	2.145	12.21	0.00016	Highly significant
Cadence (steps per min)	90	114.6	3.76	2.145	25.24	0.00057	Highly significant

[Table/Fig-1]: Inter group comparison of mean values in the gait performance of experimental group (Group A).
The calculated value is larger than the table t value, hence gait performance, walking speed and cadence is significant in Group A. *gait performance and walking speed, lesser the values better the improvement

Gait variables	Pre test mean values	Post test mean values	SD	Table t-value	Calculated value	p-value	Significance
Wisconsin gait scale (scores in point)	*26.98	22.47	1.52	2.145	13.15	0.00006	Highly significant
Walking speed (m/sec)	*22.53	20	0.5	2.145	18.56	0.00035	Highly significant
Cadence (steps per min)	88.53	97.06	1.61	2.145	20.50	0.00068	Highly significant

[Table/Fig-2]: Inter group comparison of mean values in the gait performance of control group (Group B).
The calculated value is larger than the table t value, hence gait performance, walking speed and cadence is significant in Group B. *gait performance and walking speed, lesser the values better the improvement

Gait variables	Mean values	Group A	Group B	Table t-value	Calculated value	p-value	Significance
Wisconsin gait scale (scores in point)	Pre test mean	29.29	26.98	2.048	1.47	0.145	Not significant
	Post test mean	*17.42	22.47	2.048	3.54	0.00141	Highly Significant
Walking speed (m/sec)	Pre test mean	21.06	22.53	2.048	0.97	0.383	Not significant
	Post test mean	*14.4	20	2.048	4.12	0.00019	Highly Significant
Cadence (steps per min)	Pre test mean	90	88.53	2.048	0.79	0.432	Not significant
	Post test mean	114.6	97.06	2.048	8.86	0.00018	Highly Significant

[Table/Fig-3]: Comparison of mean values between the group in the gait performance with p-value and its significance.
*gait performance and walking speed, lesser the values better the improvement

DISCUSSION

The person with hemiplegia demonstrates a slower gait pattern [9]. Recovery remains incomplete in most of the patients [14]. Backward walking has been proposed as a feasible and important tool in the gait rehabilitation [26]. Thus the study was aimed to examine the effects of backward walking training in stroke patients. The study result after treatment showed significant improvement in group A and group B in gait performance, walking speed and cadence. When compared between the groups, experimental group (group A) showed significant difference than the conventional therapy group (group B) in all three parameters: Gait performance evaluated using Wisconsin gait scale, walking speed measured marking 11 meters excluding first and last meter as the rate of acceleration and deceleration would alter the result and cadence, which is the number of steps in one minute. In a study carried out on 27 patients by Sang-Jin Kim et al., similar results were found in the improvement of walking speed, the average value increased from 68.12 cm/s to 92.60 cm/s in the ground training group and the cadence had improved from 73.09 steps/min to 85.36 steps/min among the 13 patients of ground training group [22]. Chang-Yong Kim had demonstrated in a study on 51 subjects, with three group of 17 in each group that lateral walking is better than backward walking training in hemiplegics with the mean value of 0.42 to 0.59 m/sec in lateral walking training group than 0.44 to 0.51 m/sec in backward training group in terms of walking speed, whereas it was 97.92 steps/min to 105.87 steps/min in lateral walking training group, better than 96.89 steps/min to 103.32 steps/min in backward walking training group in terms of cadence [27]. Although there was no significant difference between forward training and backward training among 10 cerebral palsy children assigned in two groups in a study conducted by Gazbare P et al., there was improvement in walking speed in both the groups with the intervention of backward walking training for 20 mins a day 3 days per week for 8 weeks in experimental group and forward walking training for the same duration in control group. They showed the mean value of 38.4 pre test score and 42 post test after 8 weeks of backward walking training, compared to 29.4 pretest score and 32.4 post test score showing significance difference in one minute walk test in both the groups, backward walking training group and forward walking training group, but no significant difference between the two groups p>0.05 [28]. Backward walking incorporates active hip and knee extension with ankle dorsiflexion which has the benefits which breaks the extensor pattern [21]. This could be the possible reason for the improvements in gait performance. Increased cortical activation may be an advantage of backward walking training by promoting engagement of intact cortical centers or descending drives to stimulate connections and activation of damaged spinal pathway [21]. In addition, the increased cerebral activation inherent in backward walking may have better engaged damaged cerebral circuits, leading to neuroplastic recovery that generalised to gains in forward walking ability [25]. As the patients were instructed to walk on self pacing speed, it could have influenced the patient's cadence [22]. The improvements obtained in our study in the gait of stroke patients is similar to the study done by Deshmukh PD et al., which demonstrates that backward walking training is better than conventional therapy alone [29]. Studies suggest that backward walking training results in greater muscle and neural activities, higher heart rate, oxygen consumption and lower patellofemoral joint reaction forces [28]. This could be related to the number of steps increased after the sessions. Moreover backward walking had an increased oxyHb response in the supplementary motor area, pre-central gyrus and the superior parietal lobule. This suggests that walking backward had a greater burden on the medial sensorimotor cortices [30]. With the above discussed mechanisms it is proved that backward walking along with conventional therapy can result in greater walking ability in stroke patients.

LIMITATION AND SUGGESTIONS

The study was conducted in 30 subjects. In order to generalise these findings, it can be done with larger samples. The duration of the study was only four weeks. It can be carried out for longer duration to obtain better outcome. The follow-up was not studied after four weeks; long term effect of the intervention can be checked. The study can be done using modern digital gait analysers for better and accurate results.

CONCLUSION

Hemiplegic gait pattern has lesser values for speed, cadence and higher value for duration in the gait cycle. It was hypothesised that walking backwards is an effective approach in improving the walking pattern of hemiplegic patients. From the results obtained it is shown that, adding up backward walking in the rehabilitation protocol, there has been a significant improvements in the gait performance of the stroke patients. Therefore, it could be suggested that backward walking training may be an adjunct training to be incorporated with the conventional programme for improving patients' gait performance in hemiplegia.

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