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RESEARCH ARTICLE

Effectiveness of aerobic exercise and balanced diet for motor and functional recovery of stroke survivors with and without diabetics and post stroke diabetics

Rajalaxmi V[1], Selvam A P[2], Padmini Priyadarshini M[3], Senthil Nathan C V[1], Mohan Kumar G[1], Veena Kirthika S[1]

[1]Faculty of Physiotherapy, Dr. M.G.R. Educational & Research Institute University, Velappanchavadi, Chennai, Tamil Nadu, India, [2]Department of Surgery, ACS Medical College and Hospital, Dr. M.G.R. Educational & Research Institute University, Velappanchavadi, Chennai, Tamil Nadu, India, [3]Consultant Physiotherapist, PV Physiotherapy and Rehab Clinic, Villivakkam, Chennai, Tamil Nadu, India

Correspondence to: Rajalaxmi V, E-mail: rajalaxmi.physio@drmgrdu.ac.in

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ABSTRACT

Background: Diabetes is a strong risk factor for stroke, it is unsettled stroke is different in patients with and without diabetes. Hyperglycemia has been observed after an acute stroke and is associated with poor prognosis. Stroke patients with diabetes mellitus appear to have a worse prognosis in term of both mortality and residual disability. **Aims and Objective:** The study aims to prospectively characterize stroke in the diabetic patients in stroke population. To determine the time course of recovery and prognosis in stroke patients with diabetes and the relation between non-diabetes, pre diabetes, and post diabetes. **Materials and Methods:** A total of 65 subjects were enrolled for the study from the Outpatient Department of ACS Medical College and Hospital. 30 patients after exclusion were subjected for the therapeutic session under 3 groups of 10 each, such as non-diabetic, diabetic before stroke and diabetic after the stroke, and each group comprising males and females. The treatment session of 3 months comprised aerobic exercises, neurological rehabilitation, and prescribed diet. Pre- and post-test using, Scandinavian stroke scale (SSS), Barthel's Index (BI), and random blood glucose level. Data were analyzed using two-tailed *t*-tests, delineated as a mean ±standard deviation and the level of significance was set at $P < 0.01$ for SSS, $P < 0.005$ for BI, and $P < 0.005$ for random glucose level (RGL). **Results:** Pre- and post-intervention data of SSS and BI of all the three groups of subjects recorded significant increase at $P < 0.01$ and $P < 0.05$, respectively, indicating the positive impact of the treatment session on mitigation of disabilities. The RGL data of both diabetic groups recorded a significant reduction in the post-treatment estimation, confirming the effectiveness of the treatment regimen in regulating the blood glucose level as well. **Conclusion:** This study has demonstrated the positive impact of physical activity; particularly the aerobic exercise and nutritional alterations in successful intervention of the disabilities of stroke survivors with and without diabetes.

KEY WORDS: Aerobic Exercise; Barthel's Index; Diabetes; Prognosis; Scandinavian Stroke Scale; Stroke

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INTRODUCTION

Approximately 17 million deaths, one-third of all mortalities across the globe, are attributed to heart ailments including stroke according to a report by the World Health Organization. It has been predicted that by 2020 the major causes of disability and death will be stroke and heart diseases.[1] 50% of stroke survivors are left with a permanent

disability, despite the high incidence and burden of stroke on health-care services, very little attention has been focused on stroke treatment. Ischemic stroke is the most common type of stroke and accounts for about 88% of all strokes. The cause of ischemic stroke is characterized by a low supply of blood in the brain, resulting in the loss of neurological functions. The incidence of hemorrhagic stroke has been observed to be less common than ischemic stroke and accounts for only about 12% of all strokes.[2] It is well documented that diabetes mellitus is a risk factor for cerebrovascular disease and that previously unrecognized hyperglycemia increases the risk of stroke and transient ischemic attacks (TIA). Despite current preventive therapies, patients with TIA and ischemic stroke remain at high risk for recurrent brain disease and cardiovascular events. In an effort to develop new therapies, abnormal glucose tolerance has recently been proposed as an interventional target.

There are several risk factors related to stroke, the major ones are age, heredity, race and habitual practices such as smoking. The incidence of stroke has been found to be higher in African-Americans than other races.[3] Physical inactivity and obesity can increase the level of blood cholesterol, cause high blood pressure, diabetes which in turn poses a potential risk of stroke incidence. Thus, it is essential to maintain an active lifestyle incorporating physical exercises daily.[4] Rehabilitation is an important factor to observe progress in functional abilities and make the patients more independent with their day-to-day activities.[5] Recent studies have shown that aggressive rehabilitation process comprising of treadmill exercises with or without body weight support may improve the aerobic capacity and sensory motor functions.[6] Numerous studies have emphasized the potential impact of physical activity and exercise training in stroke patients and indicated the importance of physiological, psychological, and functional strength endurance and sensorimotor effects of various types of exercise.[7] Also, several studies have shown the positive effects of regular physical activity on various cardiovascular risks including stroke.[8,9]

Among persons not known to be diabetic, impaired glucose tolerance, and diabetic glucose tolerance are each associated with an increased risk for incident vascular disease, vascular disease mortality, and all-cause mortality. There may be a pre-existing diabetes mellitus, or there may be stress induced hyperglycemia following a stroke. Out of these two, the hyperglycemia due to stress response seems to have a more adverse effect than the pre diabetes and nondiabetes (ND).[10] The hypotheses have been postulated predicting the impact of exercise on motor control and functional recovery and regulation of neurotrophins and insulin. The aim of this study is to investigate the impact of neurological rehabilitation and aerobic training in stroke survivors and blood glucose levels.

MATERIALS AND METHODS

Subjects

A total of 65 subjects were enrolled for the study from the Outpatient Department of ACS Medical College and Hospital. The subjects were informed about the study and procedures employed verbally and subsequently; written consent forms were obtained from all subjects recruited in the study. The subjects were further scrutinized using Scandinavian stroke scales (SSS) (>10) for neurological deficits, Barthel index (BI) (>20) for functional ability and modified as worth scale (grade 0-3) for inclusion. Diabetic after stroke onset, both the sex are included. Subjects with a history of intermittent claudicating, history of heart conditions such as myocardial infarctions and ischemic heart diseases, history of neurological conditions such as severe contracture and epilepsy, heavy smokers and alcohol consumers and subjects with a SSS ≤10, and BI ≤20 were excluded from the study. On employing the exclusion criteria, out of 65 subjects willing to participate in the study were selected for further assessment.

Exercise Intervention

The subjects were recruited randomly and divided into three groups: Non-diabetic stroke (ND-S) patients, patients with diabetes before stroke (DB-S) and patients who developed diabetes after stroke (DA-S). The intervention included consecutive individual and group sessions in the therapy hall at ACS Medical College and Hospital. The subjects exercised twice a day for the period of 3 months with diet as requested by the physiotherapist. The subjects started with their warm up exercises for 5 min and marching with mild music. Then, the subjects carried out series of balancing exercises for postural correction, back strengthening, pelvic strengthening, and pelvic bridging. Upper extremity exercises consisting of hand and shoulder joint movement's wrist mobilization for functional corrections. Likewise, lower extremity including hip, leg, ankle mobilization, ankle rotation, and obstacle clearance.

Along with therapeutic sessions, subjects were taught a series of home exercises as well. These included flexibility/stretching exercise. Throughout this 3 month period gradually the exercises were increased by repetitions, intensity, duration, and toughness. Likewise, home exercises also progressed.

Dietary Regulations

The dietary tips prescribed to the subjects were morning juice rather than tea or coffee, baked vegetables, and greens rather than frying them. Mixed fruit salads including apple, carrots, broccoli, mixed vegetables, spinach, and green salads. To keep blood pressure under control low salt diet was recommended along with avoidance of high sodium content food sources. In addition, patients with diabetes were restricted from consuming sugar and high starch items.

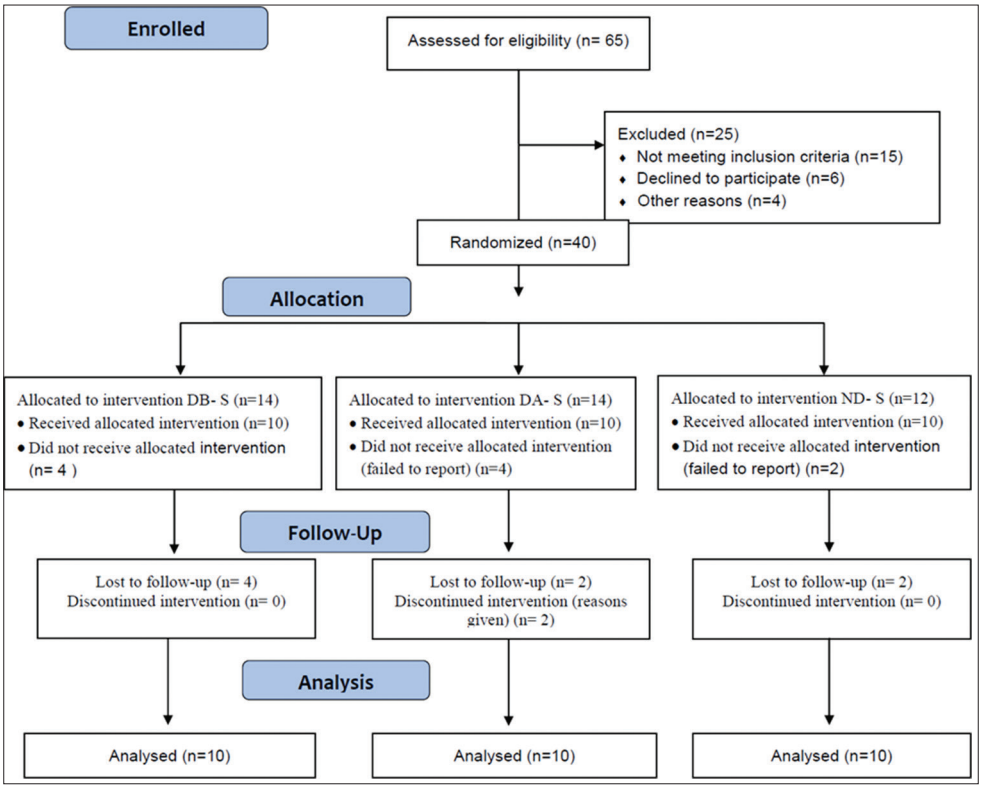

Figure 1: CONSORT 2010 flow chart for evaluating effectiveness of aerobic exercise on stroke survivors

Table 1: SSS for the treatment groups *n*=10

Treatment groups	SSS			
	Mean±SD		*t*-test	Significance
	Pre-test	Post-test		
DB-S	25.80±16.798	34.50±11.530	2.524	0.012**
DA-S	30.30±12.597	43.80±7.068	2.805	0.005**
ND-S	36.20±13.571	47.50±8.003	2.805	0.005**

***P*<0.01 in SSS, SSS: Scandinavian stroke scale, SD: Standard deviation, DB-S: Diabetes before stroke, DA-S: Diabetes after stroke, ND-S: Non-diabetic stroke

Table 2: BI for the treatment groups *n*=10

Treatment groups	BI			
	Mean±SD		*t*-test	Significance
	Pre-test	Post-test		
DB-S	43.40±21.691	47.40±18.762	2.032	0.042**
DA-S	44.50±18.775	63.00±16.377	6.467	0.005**
ND-S	59.00±32.215	79.60±20.095	2.371	0.018**

***P*<0.05 in BI, BI: Barthel's Index, SD: Standard deviation, DB-S: Diabetes before stroke, DA-S: Diabetes after stroke, ND-S: Non-diabetic stroke

Data Analysis

The subjects were analyzed pre- and post-test using SSS and BI. Likewise, periodic testing of random glucose level (RGL) was also carried out simultaneously from the beginning until the end of the treatment sessions. These data were analyzed using SPSS version 18. Pre- and post-intervention data were analyzed using two-tailed *t*-tests and delineated as a mean ±standard deviation, and the level of significance was set at $P < 0.01$ for SSS, $P < 0.05$ for BI, and $P < 0.05$ for RGL (Tables 1-3).

Table 3: RGL for the treatment groups *n*=10

Treatment groups	RGL			
	Mean±SD		*t*-test	Significance
	Pre-test	Post-test		
DB-S	258.40±103.914	124.60±43.390	2.807	0.005**
DA-S	201.20±80.793	87.60±16.460	5.293	0.005**
ND-S	111.19±24.098	94.22±9.782	1.608	0.005**

***P*<0.01 in RGL, SD: Standard deviation, RGL: Random glucose level, DB-S: Diabetes before stroke, DA-S: Diabetes after stroke, ND-S: Non-diabetic stroke

RESULTS

The subjects from the Outpatient Department ACS Medical College Hospital included men and women aged above 45 years. A total of 65 stroke patients were enrolled for the study, with the mean age of 53 of which 40 subjects (22 men and 18 women) were selected for treatment evaluation based on the above-mentioned inclusion and exclusion criteria. Further, the subjects were classified into three groups: ND with stroke [ND-S], DB-S, and DA-S. While comparing the intervention of the treatment groups using the SSS, BI, and RGL scores subjects without diabetes showed better prognosis through faster retrieval from their

neurological deficits and improved functional abilities of routine living. Comparatively the stroke patients with ND are having a good prognosis and faster recovery from their neurological deficits and activities of daily living. The stroke patients with diabetes diagnosed after stroke onset are having a better prognosis than the known DB-S patients. Value $P < 0.001$ means highly significant, value $P < 0.01$ means better significant, value $P < 0.05$ means fairly significant.

DISCUSSION

This study compares the effects of aerobic exercises and neurological rehabilitation on improving the motor and functional abilities between stroke patients who had a previous history of diabetes, stroke patients without diabetes, and stroke patients who developed diabetes after the stroke episode. The social reinforcement that develops between the subjects in group exercise sessions suggests further examination of its effect on stroke patients. Subjects often offer encouraging and helpful suggestions to each other during the course of group exercise sessions. During discussions, they communicate the feeling that is inside them, identify the same with the group, and attend the sessions almost without fail as they enjoy each other's presence. The overall attendance during the 3-month intervention program was above 87%. An important aspect of the adaptive physical activity is the social milieu and the chance to incorporate behavioral changes to improve mobility function in stroke patients. The better recovery rate and recovery status observed among the subjects during this study can be attributed to the dietary intervention implemented along with the aerobic exercise on them. Patients without stroke recovered better than the other two groups, the stroke patients with diabetes diagnosed after stroke onset are having a better prognosis than the known DB-S patients.

The practice of regular physical activities which aim at reducing the stress and body weight must be encouraged among these young females to avoid various health hazards in future likewise regular exercise reduces the stress in stroke patients.[11] Many studies have emphasized that exercising combined with physical training activities cause a shift from predominant reliance on FFA at rest to a blend of fat, glucose, and muscle glycogen, with a small contribution from amino acids.[12,13] This study examines the existing literature surrounding the use of exercise and physical therapy in the primary and secondary prevention of stroke. It explores the effect of gender, exercise intensities and the duration of observed benefit. It details the most recent evidence for physical activity in improving functional outcome in stroke patients. The review summarizes the current guidelines and recommendations for exercise therapy and highlights areas in which further research and investigation would be useful to determine optimal exercise prescription for effective prevention and rehabilitation in stroke.[14]

Limitation and Recommendations

This study had only assessed through SSS and BI scores which are preliminary scale for small sample size and could only follow-up 30 subjects successfully for the whole treatment session which was conducted over a period of 3 months. Larger clinical trials are required to evaluate the effectiveness of exercise for improving cardiovascular-metabolic health outcomes and in the tertiary prevention of stroke. Not all patients were cooperative during the treatment session; there was also the factor of time constraint to focus on individual subjects. Long term follow-up can be done with this study for more concrete evidence. Other stroke scales can be used to assessed and compare the effectiveness in various directions.

CONCLUSION

The study has successfully intervened the disabilities of stroke survivors with and without diabetes through the physical activity, specifically, the aerobic exercise and nutritional alterations. Aerobic exercise plays a major role in the rehabilitation of stroke survivors. Furthermore, the subjects without diabetes showed faster functional recovery than the other two groups. Since stroke affects people in different aspects, the therapy and training programs should be customized to the need and feasibility of the subjects to carry out the exercise. Dietary intervention helps in improving neurocognitive functions and plays a positive impact on the recovery process. Substantial randomized control trials are required to produce evidence based guidelines to ensure that stroke survivors are recommended safe and effective exercises and nutritional guidelines to lead a quality life again. There is also an influence of aerobic exercise in diabetic stroke patients and thus plays a very effective role in reducing and to maintain normal glucose levels. It's also very effective in improving the motor and functional ability levels and helps the patient to recover faster from neurological deficits and make them more independent in activities of daily living and to live a quality life.

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