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Research article

A STUDY TO ASSESS THE EFFECTIVENESS OF AEROBIC TRAINING ON EXERCISE TOLERANCE AND FUNCTIONAL INDEPENDENCE IN PATIENTS WITH MULTIPLE SCLEROSIS – A QUASI EXPERIMENTAL STUDY

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Abstract

Multiple Sclerosis (MS) is a chronic neurological condition characterized by an interruption of action potentials in the brain and spinal cord due to areas of inflammation, demyelination and axonal degeneration. Most people with Multiple Sclerosis (PWMS) complain of physical activity limitations due to fatigue and reduced Exercise Tolerance that leads to reduction in Functional Independence. Till date, there is a limited published evidence of the efficacy of aerobic training on Exercise Tolerance and Functional Independence in individuals with Multiple Sclerosis, although some studies that incorporate aerobic training into rehabilitation programs report positive outcomes with no harmful effects. This was an effort to study the effect of aerobic training on exercise tolerance and functional independence in patients with Multiple Sclerosis. 12 Subjects were selected for the study on the basis of convenient Sampling method. Subjects who were independently mobile with Kurtzke Expanded Disability Status Scale (EDSS) score between 2 and 6.5 and medically stable were included for the study. The parameters of Exercise Tolerance and Functional Independence were assessed with six min walk test distance (6MWTD) and FIMTM+FAM respectively as Pre test measurement. All the subjects were given Aerobic training(AT) with Elliptical trainer and the intensity of the exercise was individualized according to their tolerance with initial stage incline of 0 (no incline) and a resistance of 1 (lowest possible resistance) was fixed. Training was done in a well ventilated training setup and subject was provided with cool water to minimize the effect of heat on activity. Subjects were monitored during the exercise training via heart rate monitor fixed to the machine; heart rate was taken every 3 minutes. The subjects were advised to perform the exercise in their own pace throughout training session for 30 min with breaks as many as they require. Progression of exercise intensity was achieved by increasing the resistance level of the Elliptical machine and/or by increasing the subject's steps per minute (stepping speed was controlled by the subject and not the elliptical machine).To

ensure the progress of exercise protocol, the exercise intensity increased every 3 to 4 sessions. Totally 15 sessions were given in 6 weeks period. After 15 session of training Post test measurement for Exercise Tolerance and Functional Independence were taken. The Significance of the Pre test Post test difference were analyzed statistically using student paired "t" test . After 6 weeks (15 sessions) of Aerobic training with Elliptical trainer the subjects improved in Exercise Tolerance and level of Functional Independence as compared with the base line conditions. This was indicated by the changes in the Distance covered in 6 MWT and the FIMTM+ FAM score with P value <0.001. In all the subjects who were participated in this study showed greater improvement in the 6 Minute walk test distance and FIMTM+FAM scores. It implies that Aerobic training by Elliptical Trainer is effective for improving Exercise Tolerance and Functional Independence in PWMS.

Key words: *Aerobic training, exercise, tolerance, functional independence, multiple sclerosis*

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INTRODUCTION

Multiple Sclerosis is a chronic neurological condition characterized by an interruption of action potentials in the brain and spinal cord due to areas of inflammation, demyelination and axonal degeneration[7]. This disease process can lead to a many number of impairments such as visual disturbances, sensory loss, weakness, reduced co-ordination, increased tone, bladder and bowel difficulties, cognitive and speech impairments, increased fatigue, reduced exercise tolerance and Functional independence[10,13,41].

Multiple Sclerosis is the leading cause of disability in young adults. The average age at onset is 33[12]. Globally, the median estimated prevalence of Multiple sclerosis is 20 people per 1,00,000. Europe has the highest estimated prevalence of Multiple Sclerosis in the world at 80 per 1,00,000 [12]. A high prevalence has been estimated between 120.7 in the south east of the Republic of Ireland to 184.6 per 100, 000 in the north west of the Republic of Ireland [25]. It affects women more than men [12]. There is recent evidence of a world-wide increasing ratio estimated to be approximately 5:1 [12].

Multiple sclerosis in India is known to be different from West [1,4]. Optico-spinal phenotype (as generally reported in Asian population) is more common among Indian population. This means that the attacks are mostly confined to optic nerve and spinal cord. In India alone, there are 40,000 to 50,000 people who are affected with Multiple Sclerosis. Higher incidences of Multiple Sclerosis are observed in the Parsi community (descendants of Iranian zoroastrians) [45].

The cause of Multiple Sclerosis remains unknown. However, it is thought that immune, environmental and genetic factors interact, resulting in a pathophysiology [30] that is known to be increasingly complex. Two processes occur simultaneously in disease process of multiple sclerosis inflammation leading to demyelination and degeneration of the axon.

There are many consequences of Multiple Sclerosis including negative physiological changes, reduced physical components of Quality of Life (QoL) and a large cost of the disease. These have substantial implications both for the Patients with Multiple Sclerosis (PwMS) and for the family.

The negative physiological changes that can be seen in the Multiple Sclerosis patients are increased risk of cardiovascular disease, decreased VO_2 max ,decreased muscle strength, decreased bone mineral density and increased depression and fatigue[9]. The above changes are associated with inactivity.

Multiple Sclerosis can dramatically affect the Health Related Quality of Life (HRQoL) of people for many years without causing death. The literature consistently demonstrates that people with Multiple Sclerosis have lower physical components of QoL than healthy people and people with other chronic conditions[34,37,42] .The impact on physical components of QoL is more affected than psychological, social or mental components.

In 2007 the Multiple Sclerosis International Federation conducted a systematic review to evaluate the global economic impact of Multiple Sclerosis[42].They found that the total costs of Multiple Sclerosis vary substantially in all countries with an estimated mean (weighted by prevalence of Multiple Sclerosis) cost of $13,198 per person per annum for total direct medical costs, $11,383 for total direct non-medical costs and $16,755 (International Dollars) for total indirect cost.

Activities such as walking and balance can be affected. Additionally, participation in social activities and work can be limited and every person with Multiple Sclerosis has individual personal and environmental factors that contribute to their experience of their health condition. The expression of the disease is unique for each patient, in terms of the pattern of impairment and disability that occurs.

Most people with Multiple Sclerosis complain of physical activity limitations due to fatigue and reduced Exercise Tolerance that leads to reduction in Functional Independence. Fatigue is poorly understood and can be very disabling even in isolation. These symptoms can come and go with relapses and recovery. Relapses may stop and impairments may progress over time or they may progressively get worse from the onset depending on the type of Multiple Sclerosis.

MANAGEMENT OF MULTIPLE SCLEROSIS:

As there is currently no cure for Multiple Sclerosis, current management of Multiple Sclerosis is aimed at reducing Relapse rates, preventing disability directly due to Relapse, providing management of fixed neurological deficits, preventing disability acquired through progression and treating established progression [8]. Treatment of fatigue and Improving Exercise Tolerance

is also a part of management of Multiple Sclerosis to improve Functional Independence of the patients. Thus, it is important to find an intervention that optimally addresses change at many levels.

Exercise is one strategy that can ameliorate the condition at the levels of "Body structure and function", "Activity" and "Participation". Previously exercise was thought to be harmful for patients with Multiple Sclerosis, due to the temporary worsening of symptoms observed by a German Neurologist, Wilhelm Uhtoff late in the 19th century (Uhtoff's phenomenon)[40]. However, early studies in the 1980s and 90s suggested that exercise was well tolerated in patients with Multiple Sclerosis and did not exacerbate the disease [9].

With the advent of primary care and its emphasis on prevention and rehabilitation, exercise is an appropriate multi-dimensional intervention that should be considered as a primary intervention strategy for Patients with Multiple Sclerosis in minimizing the impact of the disease.

NEED OF THE STUDY

Today, exercise is being increasingly acknowledged as important in the management of the consequences of Multiple Sclerosis. Exercise can be used to address the negative physiological changes associated with Multiple Sclerosis and contributing to minimizing cardiovascular co-morbidities associated with a sedentary lifestyle[9]. It has been shown that patients with Multiple Sclerosis use more energy for Activities of Daily Living (ADL) than healthy individuals[27]. From above said viewpoints the patients with Multiple Sclerosis need to be fitter to cope with the increased demands of daily life.

The benefits of aerobic exercise for healthy individuals include reduced incidence of coronary artery disease, lowered blood pressure, reduction in total body fat, reduced insulin requirements and lowered cholesterol (American College of Sports Medicine(ACSM) 2005). Other postulated benefits are reduced anxiety and depression, enhanced wellbeing and improved performance during work, recreation and sport. Studies which examine the effects of aerobic exercise on patients with Multiple Sclerosis have shown a variety of positive effects including improved cardiovascular fitness[27], reduced fatigue and an increase in perceived quality of life. [32]

Till date, there is a limited published evidence of the efficacy of aerobic training on Exercise Tolerance and Functional Independence in individuals with Multiple Sclerosis, although some studies that incorporate aerobic training into rehabilitation programmes report positive outcomes with no harmful effects.

This is an effort to study the effect of aerobic training on exercise tolerance and functional independence in patients with Multiple Sclerosis.

DESIGN & METHODOLOGY

This study is a Quasi experimental design with a single group involving the Pre test - Post test analysis conducted in Indira Gandhi Govt. General Hospital & Post Graduate Instituite, Puducherry.

Patients diagnosed as Multiple Sclerosis with age group of 30-60 years and Independently mobile patients with Kurtzke Expanded Disability Status Scale (EDSS) score between 2 and 6.5 are included for the study. M.S patients with Medically unstable, with cognitive dysfunction and lack of mobility, with Progressive relapsing multiple sclerosis are excluded from the study. Sample size of Single Group with 12 subjects. Subjects were selected for the study on the basis of convenient Sampling method.

Table 1
Base Line Characteristics of Subjects

CHARACTERISTICS	VALUES
Total number of participants	12
Age(years) Mean ± SD	45.72 ± 5.18
Gender (F:M)	1:2
Duration of the condition	3.32 ± 1.89
EDSS Score Mean ± SD	4.5 ± 0.69
6MWT Distance(m) Mean ± SD	283±12.95
FIM™+FAM Score Mean ± SD	161.916± 5.567

6 Minute Walk Test and FIM™+FAM score are used as outcome measures for assessing Exercise Tolerance and Functional independence respectively.

Elliptical Trainer, Heart rate monitor, Stop watch, Measuring tape, worksheet for counting laps, chair that can be easily moved along the walking course are used for the study.

The parameters of Exercise Tolerance were assessed with six min walk test distance (6MWTD) and Functional Independence were assessed with FIM™+FAM as Pre test measurement. Exercise Tolerance was assessed by 6min walk test according to the criteria determined by American Thoracic Society.

All the subjects were given Aerobic training(AT) with Elliptical trainer and the intensity of the exercise was individualized according to their tolerance with initial stage incline of 0 (no incline) and a resistance of 1 (lowest possible resistance) was fixed. Exercise session's intensity was dictated by the subject's level of motivation, ability to perform, spasticity, and general fitness level. Thus, no minimum percentage of age-predicted heart rate was required. Each subject was monitored during the exercise training on the Elliptical machine via a heart rate monitor fixed to the machine; heart rate was taken every 3 minutes. The subjects were advised to perform the exercise in their own pace throughout training session for 30 min with breaks as many as they require.

Progression of exercise intensity was achieved by increasing the resistance level of the Elliptical machine and/or by increasing the subject's steps per minute (stepping speed was controlled by the subject and not the elliptical machine).

The heart rate during each exercise session was continually monitored in a log and tracked as a percentage of the age predicted heart rate maximum to ensure that subjects were progressing in exercise intensity as their fitness level improved. To ensure the progress of exercise protocol, we increased exercise intensity every 3 to 4 sessions.

Totally 15 sessions were given in 6 weeks period. Training was done in a well ventilated training setup and subject was provided with

cool water to minimize the effect of heat on activity.

After 15 session of training Post test measurement for Exercise Tolerance and Functional Independence were taken.

RESULTS

The effects of intervention on the changes from Pre to Post test values were analyzed using paired student "t" test.

TABLE – 6
ANALYSIS OF IMPROVEMENT IN 6MWT DISTANCE

	Mean ± SD	Mean Dif. ±SD	t - value	p - value	Significance
Pre test	283±12.95	53.83±4.75	30.19	<0.001	***
Post test	336±9.134				

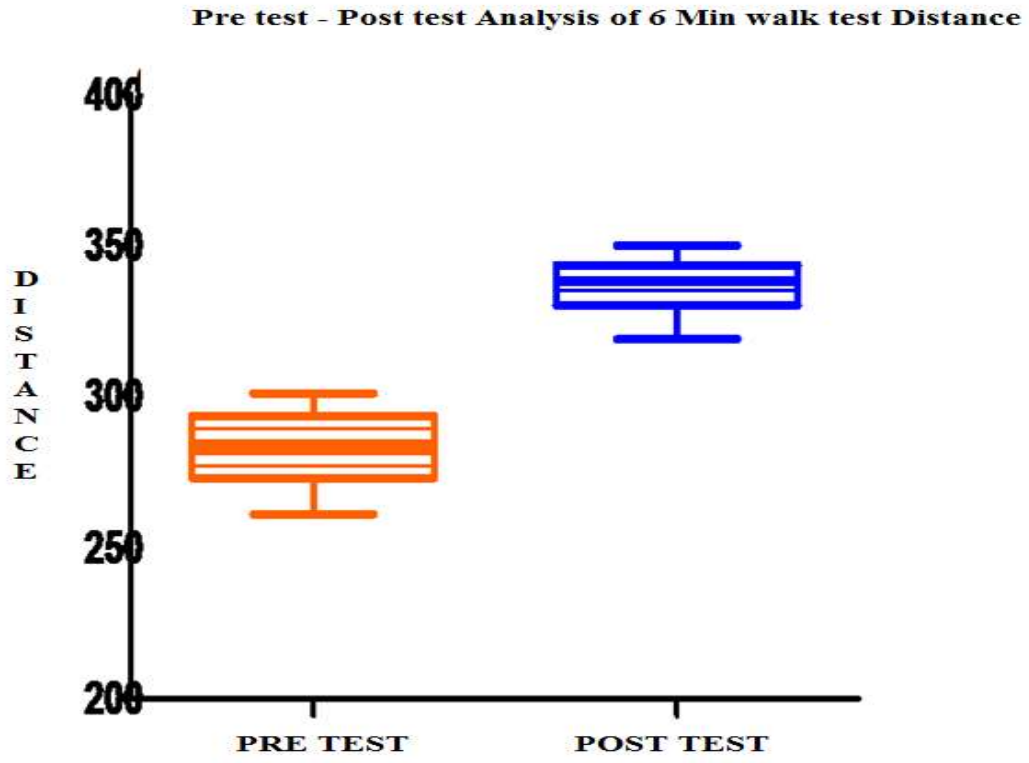
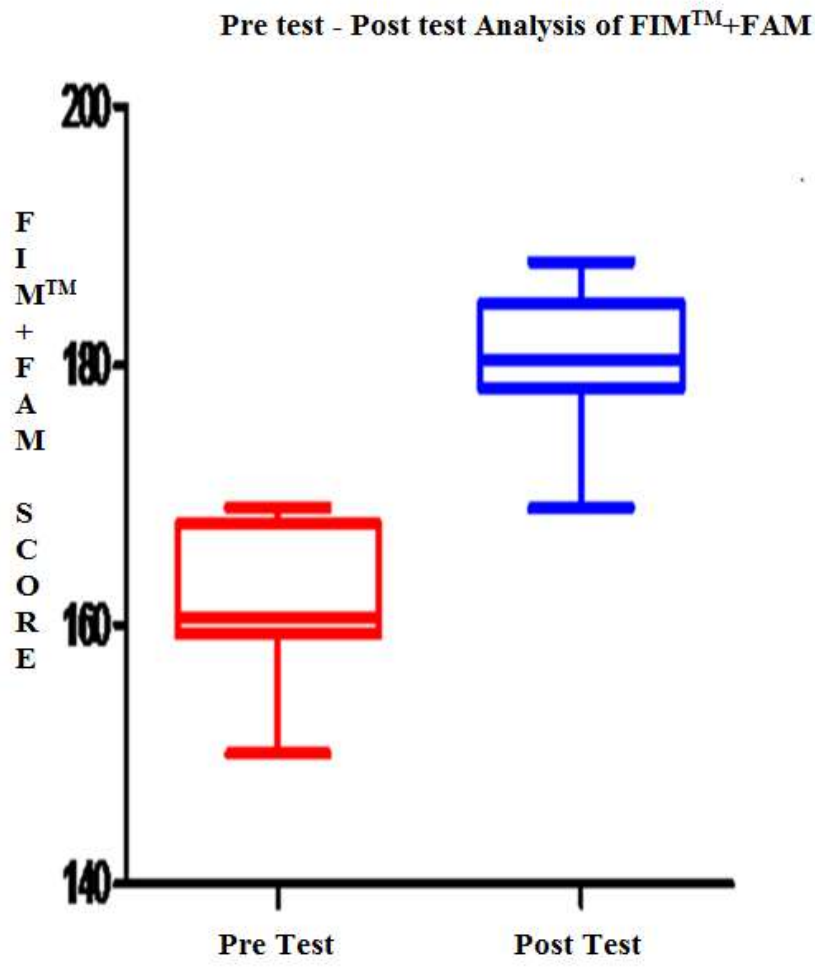


TABLE -7

ANALYSIS OF IMPROVEMENT IN FIM™+FAM SCORES

	Mean ± SD	Mean Dif. ±SD	t - value	p – value	Significance
Pre test	161.916 ±5.567	18.75±2.301	28.23	<0.001	***
Post test	180.7 ± 5.015				



DISCUSSION

Decreased Exercise Tolerance is one of the major causes for the decreased Functional Independence level of the patients with Multiple Sclerosis. Interruption of action potential in the brain and spinal cord due to areas of inflammation, demyelination and axonal degeneration causes various neurological disabilities and fatigue which negatively affects functional level of the patients. Decreased endurance, walking capacity and increased level of fatigue decreases the functional independence. The decreased functional level itself leads to deconditioning and make worsen the condition of the patient.

The impaired Exercise Tolerance in Multiple Sclerosis can be determined by the distance the patient Walked during 6 Minute Walk test [38,46] which may or may not correlate with the amount of neurological deficit measured by EDSS [6].As it also avoids overexertion of the patients the 6MWT might be the safe alternative for the evaluation of Exercise Tolerance.

In this study 12 subjects with Multiple Sclerosis who were having moderate disability (EDSS 2 – 6.5) completed the distance on average 283 mts in 6MWT at Pretest which was less than the distance walked by the subjects in a study conducted by *Sema.Savci et al 2005*. It was less than half of the distance when compared with the distance measured for normal ambulated individuals in that study. This shows the decreased Exercise Tolerance level in the subjects who participated in this study when compared to the normal ambulatory individuals.

The Functional Independence level was determined by FIM™+ FAM. Subjects in this study showed FIM™+ FAM Pretest scores, on an average of 161.916 and the maximum FIM™+ FAM total score is 210. It shows that the Functional Independence level also decreased in our subjects.

After 6 weeks (15 sessions) of Aerobic training with Elliptical trainer the subjects improved in Exercise Tolerance and level of Functional Independence as compared with the base line conditions. This was indicated by the changes in the Distance covered in 6 MWT and the FIM™+ FAM score. The average change in 6MWT distance is 53.83 meters which was found to be clinically significant improvement in functional exercise capacity according to a study by *Perera s et al 2000.*

Recently, *Kileff J et al*, (2005) in an uncontrolled study found that 24 biweekly sessions of 30 min of cycling on stationary bicycle improved walking distance. In that study, the mean improvement in 6 MWT walking distance was 32m. This distance was comparatively low when compared with this study which may be due to the subjects in that study had prolonged rest periods between the exercise sessions.

The improvement shown in Exercise Tolerance and Functional Independence level may be due to changes in the cardio respiratory or at the muscle tissue itself or due to central or peripheral changes in the nervous system.

As reported by previous studies [33] Aerobic exercise increases the cardio respiratory Aerobic parameters such as heart rate, blood pressure and greater oxygen consumption in multiple sclerosis also. Aerobic training program increases proportion of type I muscle fibers and thereby means oxidative capacity of muscles increases. As suggested by many

researchers damage to nervous system causes a state of "increased central motor drive" in which the CNS has to work much harder than it would in a healthy person to achieve a given level of functioning. As the Aerobic parameters of cardio respiratory system positively changes by Aerobic exercise it reflects effect on the Exercise Tolerance and the Functional Independence of the subjects who undergone Aerobic training program.

It also has been suggested that cycling activity (repeated upper and lower limb activity) influences the motion efficiency. It has been found that Participants in this Aerobic training program by Elliptical trainer improved in functional parameters of both lower limb (walking distance, and step climbing), and upper limb (writing). This greater improvement in both upper limb and lower limb functional activities with elliptical trainers may be due to the training which involves cycling movements of both U.L & L.L in standing. The patient performed repeated movements that included remarkable flexion and extension of all joints in U.L &L.L.

It has been observed in this study that the subjects showed better improvement in the functional activities which need more balance control compared with the pre Aerobic training level. We assumed that this difference was due to the prolonged reciprocal pedaling stimuli and in elliptical training, patient have to perform continuous trunk muscle activity for stabilizing the dynamic activity of upper and lower extremities .

In this study Increased emotional well being was observed within 2 to 3 exercise sessions in 8 out of 12 subjects in this study. This may be due to facilitation of socialization among the subjects took part in Aerobic training program, which itself, may have contributed to some of the beneficial effects on Exercise Tolerance. Moreover, it has been demonstrated that exercise may enhance psychological well being via a strong placebo effect [11].

In this it has been observed that Aerobic training improves the Exercise Tolerance measured by 6MWT Distance, and balance related activities, emotional well being and Functional Independence measured by FIM™+ FAM.

CONCLUSION

In all the subjects who had participated in this study, greater improvement were observed in the 6 Minute walk test distance and FIM™+FAM scores. It implies that Aerobic training by Elliptical Trainer is effective for improving Exercise Tolerance and Functional Independence in patients with Multiple Sclerosis .Hence Aerobic training with Elliptical trainer may be incorporated in the rehabilitation protocol of Multiple Sclerosis to improve their Exercise Tolerance and Functional Independence.

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