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Effects of Selected Combined Training on Balance and Functional Capacity in Women with Multiple Sclerosis

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Abstract: The purpose of this study was to determine the effect of eight weeks combined training on balance and functional capacity in women with multiple sclerosis. Twenty volunteers women were randomized into two groups, experimental group (N =10) and control group (N=10). The experimental group participated in selected combined training program 3 times a week for 60 minutes and the control group did not participate in training protocol and performed routine program. Participants completed pretest (included testing on balance and functional capacity measures: balance, 3-minute step test, Timed Up and Go test and Timed 10-Meter Walk), before begin of the intervention and after 8 weeks, completed posttest. The data were analyzed with SPSS18 software and t-test for paired samples significant with level at ($P \leq 0/05$). The result of this study showed that combined training on balance measures in experimental group were significantly increased ($P<0/05$), But improvement in timed 10-meter walk and Timed Up and Go measures in experimental group did not significantly change. But improvement in measures in control group MS patients did not significantly increased ($P>0/05$). However, the result suggests that combined training program can improve balance and functional capacity in women with multiple sclerosis.

Key words: Combined training · Multiple sclerosis · Balance and functional capacity

INTRODUCTION

The Multiple Sclerosis (MS) is the most prevalent disease of the central nerve system. MS is a chronic disease which effects on different aspects of individual life [1]. The prevalent symptoms of MS include reduction of ability in the walking and balance, increase of skeletal muscle weakness and tiredness that leads to reduction of movement and the reduction of movement in these individuals leads to atrophy of muscular fibers, which the consequence is the muscular fibers reduction of slow twitch fibers [2].

MS can have a negative impact on both physical and psychological wellbeing and individuals with this disease often report lower quality of life scores than when compared to healthy individuals [3]. Despite the high incidence of balance impairment in people with MS and its potential negative impact on functional ability, relatively little attention has been directed toward improving balance in this population. However, participation in regular physical activity has been suggested to positively influence feelings of fatigue [4, 5] and depression, as well as modify quality of life in persons with MS. In many MS patients show reduced physical activity levels and suffer from inactivity- induced muscle atrophy and loss of muscle strength, reducing daily life physical functioning as indicated by Motl *et al*. [6]. To date, resistance training may also improve contractile characteristics, cellular respiration, quality of life and walking speed and distance, which have been reported to be deficient in MS [7-9].

As a consequence, MS patients are neither able to fully activate muscles in the lower limbs nor to drive active motor units at high firing frequencies (rate coding) [10]. Accordingly, the muscle strength of MS patients is

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30-70% lower compared to healthy control subjects, stating that muscle weakness is a common symptom of MS [11]. Strength training has been shown to increase the neuromuscular activity in skeletal muscles through the use of surface electromyography [12].

Chronic mild to moderate stroke patients often have a non-paretic and paretic body side caused by upper motor lesions resulting in asymmetric muscle strength [13]. Because in a healthy population resistance training induces greater neuromuscular adaptations in weaker versus stronger muscles, [14] progressive unilateral resistance training has already been applied in stroke patients to optimize training stimulus. As observed by Chung *et al*., many MS patients also develop asymmetric leg strength [15]. However, given the underlying disease mechanisms such as increased central conduction time [16] and reduced motor unit recruitment and firing rates, it is unclear if unilateral strength training in MS has similar effects [17].

Current research is demonstrating overwhelming benefits when people with Multiple Sclerosis exercise. Aerobic exercises and strengthening program improve maximal aerobic capacity [18] and muscular force production, power, work and endurance [19, 20].

Further benefits of exercise for people with MS include improved fatigue, cognitive ability and energy [21]. Published exercise program have shown the benefits of specific strengthening regimens [20, 23], aquatic [19] and aerobic program [18, 24].

The duration of this program vary from four to fifteen weeks, with most participants attending three times a week. In a single case study of a person with MS Van Sint Annaland & Lord (1999) showed that a combined program of aerobic, strengthening and balance exercises was beneficial but again the participant attended the program three times a week over a five-month period [25]. Carter *et al*., showed that 12 weeks of twice weekly combined training were well tolerated, that muscle strength was improved and that the level of effort.

Of walking was reduced [26]. Romberg *et al*. and Surakka et al found that home-based combined training was well tolerated by MS patients. Surprisingly, none or only small (10%) improvements were seen in muscle strength and Walking time [17, 27].

To the authors' knowledge the reported resistance training studies in MS all use 'classical' bilateral training methods [2]. Unilateral resistance training applying relative workloads to investigate strength gains in weaker versus stronger legs has not been applied in this population yet.

The present study compared functional capacity and balance in persons with MS who did regularly participate in physical activity. It was hypothesized that persons with MS who participated in regular physical activity would report favorable functional capacity, balance and muscle strength when compared to those with MS who were classified as Non-exercisers.

The purpose of this study was to assess the effects of an 8-week selected combined training on balance and functional capacity in subjects with Expanded Disability Status Scale. We hypothesized that combined training is advanced type of exercise which is not specified its effects on balance and functional capacity, few researches used the combined training their executive protocol was executed and was not under the observation and gathered information was the result of participants feeling in the research, which the results of research should be studied carefully. So researcher wants to answer following question: Does the combined training increase balance and functional capacity of the patients with MS.

MATERIALS AND METHODS

The participations included 20 female volunteers with mean age of 34.55±4.78 yrs, mean Expanded Disability Status Scale 2.95±1.54, mean weight 71.95±7.45 Kg and mean body mass index 24.78±2.01 Kg/m^2 (mean ± standard deviation [SD]). Inclusion criteria for this study were healthy adults with MS and the ability to walk (with or without assistive devices) at least 20m without rest, examinees age were among 30-40 years old, the samples were residents of Sari and their consumed medicine were Interferon Beta 1-a (Avonex or Cinnovex). Subjects were recruited through the entire local chapter of the Mazandaran Multiple Sclerosis Society's support group meeting and under the supervision of Dr Habibi Saravi. All subjects participated in daily physical activity for six months prior to the study (3 times per week). Before beginning of the training, the patients were examined under the neurologist and Expanded Disability Status Scale (EDSS) score was determined for all subjects. Then, Subjects gave informed written consent prior to participation.

The volunteers were randomized into two groups, experimental group (N =10) and control group (N=10). The experimental group, besides consuming the prescribed drugs, participated in eight weeks selected combined training program while control group only consumed prescribed drugs. Before testing, One Repetition Maximum (the maximum load a subject was able to sustain

Table 1: Exercise program

Aerobic Exercises	Independent cycling against progressively increasing resistance (50 to 60% Vo2max) and duration (for 5 to 10 minutes).
Balance Exercises	Balancing exercises, depending on the individual participant's ability, included: sit to stand, squats, side to side walking, semi tandem and tandem standing and, stair climbing, single leg balancing, walking changing direction, walking uneven surfaces, fast stepping, walking and dual tasking, walking up and down an incline, walking unaided and with assistive devices.
Strengthening Exercises	Exercises included (depending on the individual): squats, calf raises, hip abduction (standing/supine), knee extension (side lying/sitting), knee flexion (side lying/prone), bridging, bench press. The intention was to perform 3 sets of exercises, with 10 repetitions of each exercise per set (3x 10) and exercised at least 3 days per week for 60 to 90 minutes per session. The resistance used in the strengthening exercises was progressed by increasing the number of repetitions performed.

throughout the range of motion) was determined and each participant completed a familiarization period (2 sessions), which included testing on balance and functional capacity. After the familiarization period, participants completed pretest before beginning of the intervention and after 8 weeks, completed posttest. The scores of pretest and posttest were registered by the researcher. All testing sessions were performed at approximately 9:00 O'clock. The following formula was used to determine the 1RM.

1RM = W. (1 + 0.025. R)
1RM = One Repetition Maximum;
W = Weight Lifted;
R = Repetitions Completed [28]

Procedures: The training programs for Subjects in experimental group included strengthening exercises, aerobic fitness (stationary cycling) and balance exercises and were done three times a week for Eight weeks under the supervision of one physiotherapist. Each session finished with a stretching program for the lower limb. The details of these programs are shown in Table 1 [29].

A training protocol can be described in terms of sets, repetitions and load. Between set and exercises a rest period of approximately 2-3 minutes was allowed. The program was to increase the absolute level of peak torque of the muscles throughout repeated maximum strength. The principle of the program was to have low-load, relatively long pauses of rest between exercises and at least 1 day of rest between the training sessions. If the subjects managed to perform the exercises against resistance, the load throughout the training was 40% to 50% of 1RM.

The resistance training protocol was adopted from American College of Sports Medicine's resistance-training guidelines and recognized criteria for load assignment in older individuals [30].

Primary Outcome Measures: Balance was measured using the Stork balance Test and the functional capacity was assessed with a 3-minute step test, Timed Up and Go test and Timed 10-Meter Walk (T10W).

For the Stork Stand the subjects completed the test on the dominant and non-dominant foot. The subjects kept their hands on their hips with the uninvolved foot against the medial side of the knee of the stance leg. Each subject maintained this position while standing on the ball of the foot for the maximum possible time. The trial ended when the supporting foot swivel or move (hop) in any direction, the non-supporting foot loses contact with the knee, or the heel of the supporting foot touch the floor [31].

After balance testing, subjects were tested for functional capacity using a 3-minute step test, in which subject were asked to step up onto 6-inplatform with both feet as many times as possible within the 3-minute period and the total number of steps were recorded [5]. Timed up and go test measured, the time taken by a person to stand up from a standard arm chair, walk a distance for 3m, turn, walk bake to the chair and sit down again [32]. Then, for assessed timed 10-m walk test, individual walks without assistance 10 meters with normal comfortable speed and the time of walk, was recorded [32].

Statistical Method: Data were expressed as mean and standard deviation. Data analysis was performed using pretest to posttest changes that assessed by t- test for paired samples. $P \leq 0.05$ was considered statistically significant. SPSS version 18.0 was used for all statistical analyses.

RESULTS

There were no differences between the groups in any of the pretest measures (Table 3). All patients in the experimental group were able to complete 24 sessions during the 8-week period.

Table 2: Result of A Paired t-test for differences between Pre-test and post-test in control and experimental groups

Variables		Pre test (Mean±SE)	Post test (Mean±SE)	t	Sig
Timed 10-m walk (s)	Control	7.10±0.170	7.07±0.170	1.98	0.0800
	Experimental	7.17±0.190	7.12±0.180	2.14	0.0600
Timed up and go (s)	Control	6.46±0.200	6.44±0.200	1.62	0.1400
	Experimental	6.65±0.320	6.64±0.320	0.43	0.6800
3-minute step test (number)	Control	83.50±3.000	83.10±3.480	0.41	0.6900
	Experimental	92.00±4.530	113.60±3.690	-10.24	0.0001
Balance (s)	Control	88.31±15.40	92.39±9.650	-0.45	0.6700
	Experimental	93.75±15.10	182.80±21.49	-10.21	0.0001

Sig. level was P ≤ 0/05

Table3. Result of t-test for difference of pre-tests between Control and experimental groups

Variables	Mean Difference	S.D. Difference	t	Sig
Timed 10-m walk (s)	-0.70	0.26	-0.27	0.79
Timed up and go (s)	-0.19	0.37	-0.50	0.62
3-minute step test (number)	-8.50	5.43	-1.56	0.14
Balance (s)	-5.44	21.57	-0.25	0.80

Sig. level was P ≤ 0/05

The Table 2 showed the relationship between the pretest and posttest scores in balance test, 3-minute step test, Timed up and go test and 10-meter walk test. Correlation of the experimental group between pretest and posttest was statistically significant (P ≤ 0.05) and for the control group did not significant changes between pretest and posttest in balance test (P>0.05). Correlation of the experimental group between pretest and posttest was statistically significant (P ≤ 0.05) and for the control group did not significant changes between pretest and posttest in 3-minute step test (P>0.05). Correlation of experimental group between pretest and posttest was not statistically significant and for the control group did not observe significant changes between pretest and posttest in Timed up and go test (P>0.05).

Correlation of experimental group between pretest and posttest was not statistically significant and for the control group did not observe significant changes between pretest and posttest in timed 10-meter walk test (P>0.05).

Pretest and posttest results for the measures of balance and functional capacity were presented in Table 2. No differences between training modes (resistance-exercise and routine exercise) were found for any of the measures of balance and functional capacity in pretests. However, analysis of the data found that functional capacity measures of experimental group improved with eight weeks of resistance exercise protocol, but balance measures of experimental group significantly increased.

DISCUSSIONS

It is obvious that MS patient have deficits in various areas of physiological profile. In theory, optimal rehabilitation aiming at a normalization of the physiological profile would therefore require the application resistance training. Presently, the concept of combined training is however so sparsely investigated in MS patients that solid evidence-based recommendations cannot be provided [7].

In this study, significant increases for experimental group in balance and 3-minute step test were found, But improvement in timed 10-meter walk test and timed up and go test in experimental group with MS did not significantly decreased (P>0/05) and no significant differences for control group in balance, 3-minute step test, timed 10-meters walk test and timed up and go test observed. These changes are more indicative of normative tests of subjects without known impairments and thus support our hypothesis. Furthermore, our subjects showed improvements in functional capacity and balance. Limited research has been conducted on combined training in persons with MS. In that they observed improvements in functional capacity as a result of combined training program. In neither study, carter et al. found that 12 weeks of twice weekly combined training were well tolerated, that muscle strength was improved and that the level of effect of walking was reduced [26]. In addition, Romberg et al. and Surakka et al. found that combined training was well tolerated by MS patients.

The small or non-existent change in muscle strength and VO^2-max, some functional improvements were found. Walking time during a short (7.62m) and a long (500 m) test showed improvements of 12% and 6% respectively [17, 27]. Shwid et al demonstrated that a 20% improvement in the 25 Foot walk, a test similar to the 10-m walk test, is a significant change in Multiple Sclerosis [34, 35].

The mechanisms through which endurance-and resistance-exercise lead to improvements in mobility have not yet been determined. A previous three-week balance training program reported improvements in both the Berg Balance Scale and Dynamic Gait Index Score and suggests that balance training improved both balance and mobility in people with multiple sclerosis [36]. In addition, a relationship between postural sway and brisk walk time in people with multiple sclerosis has been reported [15]. It is possible that the improvements in mobility observed in the present study are secondary to improvements in balance. However other factors, such as improved gait kinematics (gait pattern) and cardio respiratory fitness, cannot be ruled out.

Muscle strength has been defined as an important predictor of ambulatory function [37]. Given the reported muscle strength gains, improved functional mobility and gait kinematics could be assumed after resistance training, as indicated by Gutierrez in persons with MS [5].

Our results conflicts data from White and co-workers [4] who were unable to detect improved walking speed following 8 weeks of regular resistance training in persons with MS. This could be related to the size of the strength improvement which was lower in the present study, as compared with previous studies reported [2, 8, 38]. This could also be explained by the fact that throughout the study course, participants did not specifically train functional mobility, suggesting the need for more specific training and testing [39].

Our subjects improved their stepping rate by following the eight-week combined training program, which supports our hypothesis that muscle strength gains would be associated with improved stepping. Our results show that strength training in MS is associated with improved stepping. In contrast, 25-ft walking speed and walk time remained unchanged following the training program, which is consistent with a previous investigation [40]. Our subjects had a mean walk time of 7.17 seconds, which is reflective of moderately disability levels in individuals with MS [41]. Given the short test distance, we may have not been able to detect subtle changes in walking ability. It has been suggested that large increases in 25-ft walk time may reflect detrimental changes in gait [41]. A longer walking test may be more sensitive to changes in walking speed associated with exercise interventions in individuals with MS.

The less conservative gait of our subjects suggests improved lower extremity coordination and perhaps efficiency. This assertion is supported by the observed increase in 3-minute stepping.

The results of this preliminary study suggest that combined training program cause increase balance in women with multiple sclerosis. These results are supported by a few previous case studies that have reported improvements in balance in people with multiple sclerosis [42, 43]. The type of endurance-exercise training performed may be of importance in determining balance outcomes. A study conducted in older adults with balance deficits investigated different types of endurance-exercise training and found that balance improved when the activities performed ‘stressed’ the subject’s balance [44]. That is, those activities during which the individual was required to maintain their centre of mass over their base of support in response to either an internal or external perturbation. These authors reported that cycling did not improve balance, whereas walking and aerobic-exercise classes did [44]. It is possible that the activities that stressed balance (treadmill, cross-trainer and step-ups) contributed to the improvement in balance observed. However this is an area that requires further investigation.

The results of this study are in contrast to the findings of a previous study. De Bolt et al reported no improvements in balance after a home-based resistance-training program in people with multiple sclerosis [33]. The supervised exercise setting used in the present study, when compared to the home-based training described in the study by De Bolt et al may explain the discrepancies in balance adaptations observed following resistance-exercise training. Similarly, a recent meta-analysis on walking mobility in people with multiple sclerosis found that walking mobility improved with exercise training when conducted in a supervised environment, but not when the training was home-based [33].

Our subjects also scored below normative values for similar age groups in all categories. Balance predominantly requires adequate strength and range of motion at the ankle. The lower scores may indicate that the subjects had limitations in one or both of these areas. Prior research has shown a relationship between balance ability, ankle strength and range of motion [45, 46]. Although ankle range of motion was not measured in this study, the results indicate that subjects had increased in balance.

Weakness is common in MS [47] muscle strength at the ankle could have also played some part in the lower than-normal balance scores. Several of the activities (i.e., strength exercises, aerobic fitness (stationary cycling) and balance exercises) in the exercise program were designed to address these impairments specifically and could have led to the improvements in muscle strength, functional capacity and balance.

In this study, balance and functional capacity improved after training for experimental group. Although not statistically significant were observed in control group after routine daily training for all tests. Also, results suggested that the routine daily training did not effect on functional capacity and balance in women with MS. However, with a small sample size, additional studies are needed to confirm these observations. In addition, the combined training protocol used in this study may not have highlighted the full benefit or dangers of strength in persons with MS. Despite these limitations, there were significant improvements in all parameters in experimental group that performed combined training protocol for 8- week. More studies that include balance and functional capacity measures, with larger sample size, EDSS with high score and increased duration and intensity of training, are recommended.

In conclusion, this paper reported on the effects of a combined training program on functional capacity and balance in women with MS. The results of the present study suggest that an 8-week selected combined training program can increase balance and improvement functional capacity in women with MS.

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