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ORIGINAL ARTICLE

Resistance Training and Vibration Improve Muscle Strength and Functional Capacity in Female Patients with Multiple Sclerosis

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Abstract

Purpose: **The purpose of this study was to evaluate the effect of an eight-week progressive resistance training and vibration program on strength and ambulatory function in multiple sclerosis (MS) patients.**

***Methods*:** **Twenty-Four female MS patients with the following demographics: age 27-45 years, and expanded disability status scale (EDSS) 2-4, participated in this study. The subjects were randomly allocated to one of two groups. The exercise group (n=12) trained according to a progressive program, mainly consisting of resistance training and vibration, three times a week for eight weeks and compared with subjects in the control group (n=12) that received no intervention. Subjects completed one set of 5-12 reps at %50-70 maximal voluntary contraction (MVC). After 5-10 minutes rest, six postures on plate vibration were done. Isotonic MVC of knee extensors, abduction of the scapula and downward rotation of the scapular girdle muscle groups were predicted by using the Brzycki formula. Right leg balance (RLB), left leg balance (LLB), and walking speed (10-Meter Walk Test) were assessed before and after the training program. Descriptive statistics and Co-variance were used for analyzing data.**

***Results*:** **After eight weeks of training the exercise group showed significant increase in MVC of Knee extensors (32.3%), Abduction of the scapula (24.7%) and Downward Rotation Scapular (39.1%) muscle groups, RLB (33.5%), LLB (9.5%), and decrease in 10-Meter Walk Test (10MWT) (9.3%), (*P*<0.05).**

***Conclusions*:** **The results of this study indicated this type of training can cause improvements in muscle strength and functional capacity in patients with multiple sclerosis.**

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INTRODUCTION

Multiple sclerosis (MS) is an inflammatory disease of the Central Nerve System (CNS), which causes demyelination and axon loss. MS can cause non-traumatic disability in young adults. About 1-2.5 million people around the world are estimated to be affected, depending on the publication [1,2]. The prevalence of MS is more common in women than men (female to male ratio approximately 2-3:1). MS usually presents between the age of 18 to 35 years, rarely much earlier during childhood, or in old age. The disease course is relapsing-remitting in the majority of cases, with progression into a secondary progressive form after a varying period of time or primary progressive right from the beginning. Several symptoms and signs may occur, such as visual impairment, spasticity, weakness, ataxia, and balance impairment, pain, sensory impairment [3,4]. Fatigue, often severe, affects about 85% of MS patients which causes decreased mobility, leads to impaired functional capacity and subsequently reduced physical activity and sporting [5-12]. So this life style which reduces mobility can lead to secondary sequels such as obesity, osteoporosis, and/or cardiovascular damage [10-11]. Impairment of saltatory conduction, slowing of conduction speed and/or

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conduction block are the pathophysiologic hallmarks of MS.

The exposure to heat during the physical exercise can lead to worsening symptoms [11]. Exercise programs must be designed to activate working muscles but avoid overload that results in conduction block [11,13].

Whole body vibration (WBV) is increasingly promoted safely and could be an efficient training method to improve muscle strength [14,15]. It has been demonstrated that WBV is an effective method for improving postural control in elderly subjects [16-19]. In addition, studies have shown the effect of WBV on postural control, balance, mobility, strength and endurance in MS [15].

To prevent exacerbation due to training, moderate intensity of exercise program is suggested [20], so because of the low intensity of training in MS patients compared to healthy people, WBV program after resistance training (combination of resistance training and WBV) may be used to increase the effect of protocol without increasing the intensity of training, increasing the body temperature and causing fatigue that could induce exacerbation [20].

We hypothesized that an 8-week resistance training and WBV program can increase muscle strength that affects body posture and balance.

METHODS AND SUBJECTS

Subjects:

This study was carried out during November to December 2010 in Najafabad Branch, Islamic Azad University. Twenty-four patients between 20-50 years with definite MS according to McDonald's criteria, with relapsing- remitting (RR) form of the disease and expanded disability status scale (EDSS) 2–4 were enrolled in the study. Each subject signed an informed term of consent. Patients were randomly divided into an exercise group (n=12) and control group (n=12). Before and after the training program a neurologist assessed EDSS. The exclusion criteria were presenting any type of orthopedic, any cardiovascular or pulmonary disease, pregnancy, cancer, bone fracture of less than 6 months, use of prostheses, any serious nervous system disorder, any health problems to prevent effort on the physical test and taking part in regular physical activities before this study.

Physiological Assays:

Body mass was measured by using a portable scale (Mechanical Bathroom Scale, Seca model: 760. Germany), their body height was measured with a portable wall-mounted stadiometer (telescopic height rod Seca model: 220, Germany, accuracy 0.1 cm), and body mass index [BMI (Kg/m^2)] was calculated [21]. Maximal Voluntary Contraction (MVC) of isotonic strength of the Knee extensors (Quadriceps), the Abduction of the scapula girdle (Pectoralis major) and Downward Rotation of the scapular girdle (Latissimus dorsi) muscle groups was predicted by using Brzycki formula [22,23]. These maneuvers were performances on the multipurpose exercise machine (Rain Co. 9026. Iran).

To assess Balance and monitor mobility, the standing balance test was used [23]. The subjects stood on one leg for as long as possible. The subject was permitted to practice their balancing before starting the test for one minute. The timing stopped, when the elevated foot touched the ground or the subjects lost their balance position. The best of three attempts was recorded. The test was repeated on the other leg.

The 10-Meter Walk Test (10MWT) was used to examine the gait speed. The subjects walked 10 meters as above as fast as possible, which it was marked at least 14 meters in length with tape on the floor, approximately two meters before starting line and two meters past the tape line to minimize the effect of acceleration and deceleration. They repeated it for three times and recorded the average times. To obtain the speed (m/min), walking distance (10 meters) was divided by elapsed time, then multiplied by 60 [24].

The multipurpose exercise machine and vibration procedures [Crazy Fit Massage, Fitness Vibration Machine, Power Plate (TQ908) e., China] were used in the study protocol. The protocol of training was always done at the same time of the day. During eight weeks subjects participated in resistance training and WBV program, three times a week with at least 48-hour rest

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between exercise sessions. Subjects completed the protocol under the supervision of an exercise physiologist and a physician. At the end of the study all of the variables that were measured as pretest were measured again as posttest.

Procedure:

All subjects performed 10 min warm-up at the beginning of each training session consisting of five minutes static stretching movements like Chest Stretch, Biceps Stretch, Upper Back Stretch, Shoulder Stretch, Side Bends, Hamstring Stretch, and five minutes, pedaling on a cycle Ergometer (Cross sport U325. China), 30 watts, 50–70 RPM (revolutions per minute). The protocol of training consisted of three sets of 5-12 reps at %50-70 MVC in the position of Knee Extension, Pec Deck Fly, and Back Lat Pull-Downs with one min rest between each repetition; and 2-3 min rest between each position. After 5-10 min rest, six postures on the plate vibration were done in three series of 30 Sec with 30 Sec rest between each two series, and 1-2 min rest between each posture. Those postures consisted of: squat (both knee angles of ~140°), deep squat (both knee angles of 90°), deep lunge (right and another time left foot forward on the plate, at the knee angle of 90°), sitting forward bend, gentle push up, calf massage. Subjects maintained static positions on the platform which were explained above and the frequency and amplitude were set at 2-20 Hz and 2 mm respectively. At the beginning, the vibration frequency was set 2-5 Hz and gradually increased to 20 Hz at the end of the protocol, regarding the parameters of the vibration signals used in studies [25-28]. During the study, we had no exacerbation and had no drop out.

Statistical analysis:

Descriptive analyses were adopted for demographic characteristics as means ± SD. Parametric independent t-test was used for the normality distributed variables: age, weight, height, and EDSS. Before statistical analysis Levene's Test was used to show homogeneity of variances between two groups before the start of the protocol ($P>0.05$). Kolmogorov-Smirnov Test was used for determination of the normality of the distributions, $P>0.05$ was considered statistically significant. Differences among groups were assessed by using analysis of covariate (ANCOVA).

RESULTS

The characteristics of the 24 subjects that completed all pre and post tests are given in table 1. No significant differences were observed at baseline between the experimental and the control groups in terms of age, weight, height, and EDSS by use of independent-samples T-Test ($P<0.05$).

Values expressed of measured variables before and after the protocol as mean and standard deviation have been shown in table 2.

ANCOVA test, significantly, partial eta squared (η) which demonstrated percentage changes of variables due to protocol of training and observed power that indicated adequate of number of subjects have been shown in table 3.

In all cases the level of statistical significance was set at $P<0.05$.

After eight weeks of training the exercise group showed significant increase in MVC of knee extensors (32.3%), abduction of the scapula girdle (24.7%) and downward rotation of the scapular girdle (39.1%) muscle groups, whereas in control group showed decrease in MVC of knee extensors (11%), abduction and downward rotation of the scapula girdle (4.1%),

Table 1: Characteristics of the patients in the exercise and control groups

Variables	Exercise group (n=12) mean (SD)	Control group (n=12) mean (SD)	*t*	*Sig (2-tailed)*
Age (yr)	35.08 (6.89)	33.75 (5.32)	0.53	0.60
Weight (Kg)	61.91 (10.30)	58.20 (5.54)	1.09	0.28
Height (cm)	157.08 (6.97)	158.83 (4.80)	-0.71	0.48
EDSS	2.87 (0.82)	2.79 (0.65)	0.27	0.87

SD: Standard Deviation; EDSS: expanded disability status scale; $P<0.05$; df=22

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Table 2: Before and after values of MVC and functional indexes in the studied subjects (values expressed as mean ±SD)

Variables	Exercise group (n=12)		Control group (n=12)	
	Before	After	Before	After
Knee extensors (Kg)	17.05 (4.25)	22.56 (4.28)	18.86 (3.92)	16.61 (3.33)
Abduction of the scapula girdle (Kg)	12.87 (2.66)	16.06 (2.03)	12.56 (2.48)	12.04 (1.82)
Downward rotation of the scapular girdle (Kg)	19.23 (5.36)	26.76 (4.39)	19.71 (4.20)	17.49 (3.89)
RLB (Sec)	10.02 (4.46)	13.38 (5.13)	13.28 (2.89)	9.69 (3.43)
LLB (Sec)	7.76 (2.12)	8.50 (3.27)	8.95 (4.23)	5.13 (2.99)
10MWT (m/min)	60.73 (11.46)	66.41 (10.83)	51.47 (11.19)	47.41 (10.30)

MVC: Maximal Voluntary Contraction; SD: Standard Deviation; RLB: Right Leg Balance; LLB: Left Leg Balance; 10MWT: 10-Meter Walk Test

(11.2%) muscle groups, also exercise group showed significant increase in RLB (33.5%), LLB (9.5%), and significant decrease in 10MWT (9.3%), whereas the control group showed a decrease in RLB (27.0%), LLB (42.6%), and increase in 10MWT (7.8%), (P <0.05).

DISCUSSION

This is one of the few studies to investigate the effects of combination resistance training and WBV on muscle strength in MS patients. The results of the study clearly demonstrated that 8 weeks of resistance training and WBV training lead to a significant improvement of MVC in knee extensors, abduction of scapula, and downward rotation of the scapular girdle muscle groups in MS patients with EDSS=2-5. Dalgas confirmed our results that after 12 weeks of resistance training, the isometric strength of knee extensors and knee flexors increased [29]. Kraemer showed that resistance training in the healthy population induces greater neuromuscular adaptations in weaker versus stronger muscles [30]. Because the motor lesions in MS patients may have caused asymmetric muscle strength [16, 31], we used symmetrical movement in planning the protocol of our study so that strong muscles helped weak muscles. Claerbout mentioned increase of muscle strength after 3 weeks WBV [32]. WBV is based on the mechanical multidimensional oscillations of muscle-nervous system [33]. As observed by Chung et al, many MS patients also develop asymmetric leg strength [34], by considering this point we carefully increased the frequency of WBV on any position of limb with weaker sensitivity.

Some studies have indicated a loss of muscle mass in MS patients [35-37] that is due to decreased muscle strength [36,38], and may affect balance defect [32]. The mechanisms of strength deficit are probably of both muscular [36,38,39] and neural origin [40,41], but we only study MVC in some muscle groups that could affect static balance, and balance during walking that could affect walking speed. In our study comparing control and exercise group, it has shown significant difference in left foot standing balance, and right foot standing balance. Schuhfried showed using WBV a low frequency had positive effects on postural control in patients with EDSS 2.5-5 after two weeks [43]. In addition, Mason mentioned positive effect of WBV on

Table 3: Analysis of Covariance in measured variables in exercise and control groups

Variables	*F*	*P* value	*η*	Observed Power
Knee extensors (Kg)	36.54	<0.001	0.63	1.00
Abduction of the scapula girdle (Kg)	45.08	<0.001	0.68	1.00
Downward rotation of the scapular girdle (Kg)	44.75	<0.001	0.68	1.00
RLB (Sec)	6.64	0.02	0.24	0.69
LLB (Sec)	12.38	<0.001	0.37	0.91
10MWT (m/min)	47.21	<0.001	0.69	1.00

RLB: Right Leg Balance; LLB: Left Leg Balance; 10MWT: 10-Meter Walk Test

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balance and physical activity [42]. Previously studies mentioned beneficial effects of WBV on motor function in Parkinson patients [25-28]. Roelandts has shown that balance improved after 10 weeks resistance training and vibration in MS patients [44].

Compared with the control group, exercise group showed significant difference in terms of the Timed 10-Meter Walk Test, for measuring functional index like walking speed after the protocol. Salmon showed WBV training improved physical performance of people with knee osteoarthritis with the 10 meter walk test [45]. Mason mentioned WBV increased walking speed in MS patients [42], whereas Roelandts mentioned that neither resistance training nor whole body vibration had no significant effect on functional mobility [44].

This difference may be related to a variety of subjects' EDSS, or may be related to protocol of training. We used resistance training plus WBV, whereas other researchers just used WBV as the method of training.

A limitation of this study was the use of formula to predict MVC.

CONCLUSION

Because of the benefit of resistance training for MS patients, and prohibition of participation in intense physical activity, we can use WBV to increase the severity of training without rapid increase of body temperature and fatigue. It was mentioned that WBV is very suitable for persons who want to stimulate and strengthen their muscles without overloading joints like professional athletes or those who are difficult to train due to aging, disease, disorders, obesity, or injury. Therefore this method could be suitable for MS patients.

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Conflict of interests: None

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