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The Effect of Core Stability Exercise Program on the Balance of Patients with Multiple Sclerosis

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ABSTRACT

Background: Multiple sclerosis (MS) is a chronic disease characterized by degradation of the central nervous system myelin which may impair the balance of patients. Core Stability Exercises have been the focus of attention for repairing the stability of some patients.
Objectives: To assess the effect of core stability exercise on the balance of patients with multiple sclerosis.
Materials and Methods: In this quasi-experimental (pretest-posttest study with no control group), 15 MS patients have been selected according to convenient sampling and Expanded Disability Status Score (EDSS) of less than 4.5. Participants performed core stability program according to the Jeffreys protocol (2002) at 9 O'clock in the morning over 8 weeks in summer 2015. Static (in second) and dynamic (in centimeter) balances were measured using modified stork and modified star (Y) tests respectively. Data were analyzed in SPSS-16 using Kolmogorov-Smirnov test to ensure normal distribution of data, and paired t-test to compare mean values before and after exercise program as they have normal distribution.
Results: Mean and standard deviation of static balance were 3.56±1.81 and 11.17±6.36 in pretest and posttest in the dominant foot, and 3.67±1.89 and 9.42±2.94 in the non-dominant foot, respectively. The sum of the 3 measurements in Y balance was 256.01±32.68 and 340.68±38.33 in pretest and posttest in the dominant foot, and 262.35±42.49 and 344.55±47.25, respectively, in the non-dominant foot ($p \leq 0.05$).
Conclusion: The core stability exercise program positively and significantly improved static and dynamic balance of patients with multiple sclerosis.

Keywords: Exercise; Balance; Multiple Sclerosis

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Introduction

Multiple sclerosis (MS) is one of the most common neurological diseases that mainly affects young adults and more commonly women. It is a chronic inflammatory disease characterized by demyelinating lesions in the brain, spinal cord, and optic nerves (1). There are 250000-350000 people with MS in America, increasing by about 200 new cases diagnosed every week (2). Based on the statistics from Iran Multiple Sclerosis Society, there are 30000 patients with MS in Iran till now (3).

The term of multiple sclerosis refers to two the features of the disease: the multiple areas affected in the brain and spinal cord known as plaques or sclerotic areas causing multiple neurological symptoms over time. Furthermore, the clinical course can vary from totally benign to progressive and debilitating (4). MS is a young people's disease, mostly diagnosed in people of 20 to 40 years old (4), although it may also be found in younger or older people. The mean age at diagnosis is 30 years, and women are affected two to three times more than men (5, 6).

Some common symptoms of MS include reduced balancing and walking ability, together with muscle weakness and fatigue. These symptoms affect not only people's general health, but also their ability to perform daily motor activities (7). Balancing ability is crucial to independence in daily activities. Impaired postural control leads to loss of stability, which can profoundly affect daily lives of people with central nervous system diseases. Loss of stability can lead to loss of functional independence, spreading disability and also greater risk of falls (8). In these people, loss of balance can be caused by impairment in the brain or cerebellum and also movement pathways. Other impairments and lack of sufficient movement can also affect these people secondarily due to loss of strength and fluctuating balancing ability (9).

Balance is an inseparable part of all daily activities and a key part of sports activities (10); it is a complex motor skill that defines postural dynamics of the body in avoiding falls (11). A variety of exercises are used to improve balance, including proprioception exercises and use of balancing board. In recent years, some investigators in physical medicine and rehabilitation have become interested in exercises which strengthen and stabilize the core area of the body to improve the patients' balance. This area includes waist-hips-thighs and muscles surrounding them, and its stability is highly important because the anatomic center of gravity is located in this area, where movements are initiated (12). Core stability is recognized as motor control and muscle capacity in the core area for maintaining stability in different postures and against external forces (13). In fact, stability of the core area is affected by three closely interactive and related systems including passive systems of bones and ligaments and active systems of muscles and also the nervous system, and any impairment in one system is compensated by the others (13). Previous studies have demonstrated the role of core stability in improving athletic performance and preventing damage. Clark *et al.* argue that core stability prevents wrong patterns of movement by maintaining postural alignment and correct body position, and thus improve athletic performance (14). Leetun *et al.* considers core instability as an important factor associated with lower extremities injuries (15). The results obtained by Cosio - Lima *et al.* showed that 5 weeks of core stability exercises on Swiss ball and on the floor have similar effects in improving balance (16). In a study of the effect of core exercises on balance, Eric *et al.* reported its significant effect on balance in healthy people after 4 weeks of trunk muscles strengthening program (17). The results obtained by White *et al.* showed that endurance exercise program can improve walking and power in lower extremities in MS patients (7). Kileff and Ashburn showed that aerobic exercises can enhance walking ability, improve balance, and reduce reported fatigue and disability by the individual in MS patients

(18). In a comprehensive study, Romberg *et al.* showed long term effect of exercise-therapy on functional impairments and health-related quality of life in MS patients (19). In contrast, DeBolt & McCubbin results did not confirm the effect of endurance (aerobic) exercises on balance and movement in MS patients (20). Kasser *et al.* studied the effect of 12 weeks balancing exercises on stability control in 4 patients with MS, using **Pro Balance Master** for both exercise and assessment of patients, and found 10% to 64% improvement in stability range test in participating MS patients after the intervention (21).

All previous studies agree that MS patients show improvement after a graded exercise program, and that as an important part of rehabilitation, exercise therapy can leave positive effects on these patients. Some previous studies have shown that core stability exercises improve balance in various people; yet very few studies have been conducted on the effect of core stability exercises on MS patients. Hence, the present study aimed to investigate the effect of these programs on the balance in MS patients.

Materials and Methods

Study design and participant

This study was a quasi-experimental pretest-posttest investigation (with no control group). The study population consisted of all 20-45 year-old patients with multiple sclerosis confirmed disease by a neurologist and disability score according to EDSS less than 4.5 who have presented to the Multiple Sclerosis Society of Guilan Province. They should have ability to regularly take part in exercise sessions (maximum allowable absence was 5 sessions in each exercise course) and minimum of two months should have passed since their last relapse (if they had). If a relapse occurred in the course of study the patient would excluded from the study. They should have no history of cardiovascular disease, epilepsy, metabolic diseases, psychological diseases, visual impairments and orthopedic diseases and the other comorbidities making participation in the exercise harmful. They should have no participation in regular exercise activities in the last two months. A questionnaire and medical records were used to find disease history and patients' problems. Finally 15 female patients were selected according to convenient sampling and considering exclusion and inclusion criteria.

Study Phases

Patients were invited to participate in a meeting where necessary explanations were provided. Then, based on inclusion and exclusion criteria eligible patients were selected and completed written consent forms for participation in 8 weeks of core stability exercise program (3 sessions per week) in groups in the gym from 9 am to 10 am in summer 2015.

Based on the Jeffreys protocol (2002), exercise sessions lasted 45 minutes to 50 minutes each. Prior to exercise program, participants underwent static and dynamic balance tests, which were repeated and results were recorded after completion of the 8 weeks exercise program.

Measurement Cases and Methods

Stork balance test:

This was performed for measurement of static balance with open eyes, on dominant and non-dominant feet. Training was provided before the test on how to assume the test position by placing hands on the waist and sole of the non-dominant foot on the inside of the supporting leg. The subject maintains this position on the ball of the foot for as long as possible. The test ends if the heel of the dominant foot touches the floor, hands come off the waist, or non-dominant foot loses contact with the knee of supporting leg. During the test, the subject stares at a sign 4 meters away in front of his face. Each participant attempted the test twice with 15 second rest (to eliminate the effect of learning and warming up), and the best time was recorded as their score. The standing time on one foot was measured and recorded in milliseconds from assuming the position and simultaneously raising the heel of the dominant foot from the floor until the position was lost using a stopwatch. The best time recorded in the two attempts was taken as participant's score. The test was repeated for the non-dominant foot as for the supporting one. Johnson & Nelson (1986) reported reliability of the test 0.87 (22).

Star balance test:

The dynamic balance was assessed using Y Balance Test (YBT), which is the modified version of Star Excursion Balance Test (SEBT). In this test, 3 directions (anterior, internal posterior and external posterior) are drawn at 135 degrees from each other. Since star balance test is significantly related to the length of the leg, for normalizing the data, the actual length was measured from the anterior superior iliac spine (ASIS) to inner ankle in the supine position (23). The necessary explanations about the test were provided by the examiner, and to learn how to perform the test, each participant practiced the test 6 times. A participant should stand in the center of the star on one leg, and try to reach as far as possible with the other leg in the direction the examiner choose, and return to their initial position. To eliminate the effect of learning, each participant practiced each direction 6 times with 15 Seconds rest. After 5 minutes rest, the participant began the test in a direction randomly chosen by the examiner, and the distance from the contact point of the foot to the center of the star was measured by the examiner in centimeters. Each participant repeated the test twice, and the best distance reached was divided by the length of the leg and multiplied by 100 to find the reach distance for the length of the leg. Using the reaching foot as support, movement of the other foot in the center of star or loss of balance meant elimination of the test, and participant was asked to repeat the test. Before the test, participant's supporting leg was determined. If the supporting leg was on the right side, the test was performed counterclockwise, otherwise clockwise (23).

Core stability exercise program:

The protocol was performed for the trial group in 3 thirty-minute sessions per week (every other day), over 8 weeks. The protocol included specific spinal stabilization exercises, lumbar-pelvic proprioception retraining, and abdominal maneuvers (holding the abdomen in) and multifidus muscle contraction, followed by maintaining stabilization maneuver using dynamic stability achieved in different positions (supine, prone, and squatting) and addition of dynamic elements (limb movement, use of Swiss ball) in later stages. These exercises were based on core stability exercises proposed by Jeffreys, and included three levels. Level 1 involved static contractions in a fixed position, which progressed with slow movement in an unstable setting. Level 2 included static contractions progressing from an unstable setting to a more stable one through dynamic movements. Finally, level 3 involved dynamic movements in an unstable setting, which progressed to endurance movements in an unstable setting. These exercises used weight of the patient, and Swiss and Madison balls (24). Box 1 shows stages of core stability exercises program.

Box 1: Exercise program for core stabilization

First and second week
Holding the abdomen in, in a supine position (3 sets and 20 reps in each set)
Holding the abdomen in, in a prone position (3 sets and 20 reps in each set)
Holding the abdomen in, in a squatting position (3 sets and 20 reps in each set)
Third week
Holding the abdomen in, with one leg in the abdomen in a supine position (3 sets and 20 reps in each set)
Holding the abdomen in, with one leg in the abdomen in a prone position (3 sets and 20 reps in each set)
Side lying bridge (for each side of the body, 6 reps, 10 second pause)
Fourth week
Holding the abdomen in, in supine position with limbs up and keep hands and feet close together (3 sets and 20 reps in each set)
Squatting with raising one leg out of back (3 sets foe each leg and 20 reps in each set)
Trunk rotation while holding weights in each hand (3 sets each part of the body and 20 reps in each set)
Fifth week
Sitting on a Swiss ball and holding the abdomen in (3 sets, 10 seconds)
Squatting while the Swiss ball is on the shoulder (3 sets and 15 reps for each set)
Bringing up the arm and legs simultaneously in the prone position (3 sets and 10 reps for each set)
Sixth week
Doing long in a 45 degrees inclined direction to the left or right (3 sets and 12 reps for each set)
Bridge (shoulders and hands on the ground and the bringing up on hip and foot (3 sets and 15 second pause for each set)
Seventh week
Lying supine on the Swiss ball and rotating the trunk to the sides (3 sets and 15 reps for each set)
Doing the above exercise with holding weights in the hands (3 sets and 15 reps for each set)
Side lying bridge with bringing up the leg (6 repetitions for each side of the body and 10 second pause)
Eighth week
Lying supine on the Swiss ball and holding the abdomen in and bringing one leg up (3 sets and 20 reps for each set)
Raising the opposite arm and leg while squatting (3 sets and 20 reps for each set)
Bridge so that the feet are placed on the Swiss ball and raise one foot (3 sets and 15 second pause for each set)

Analysis of data

Data were analyzed in SPSS-16 according to study objectives. Normal distribution of data was verified using Kolmogorov-Smirnov test. The balancing pretests and posttests were compared using dependent t-test. To reject or confirm all null hypotheses, $p \leq 0.05$ was considered significant.

Results

In this study 15 MS women participated with mean age of 33.80±6.53 years and mean EDSS of 4±0.46. The mean height of patients was 1.64±0.06 meters and the mean Weight of them was 65.53±15.09 Kg which produce mean BMI of 24.22±5.82 Kg/m2. Table 1 presents the results of dependent t-test, showing a significant difference in the balance of MS patients before and after core stability exercise program.

Table 1: Comparison the results of the pretest and posttest static balance of studied MS patient

Variable		Mean± SD*	*p*-value	*t*-value	Degree of freedom
Static balance in supporting leg	Pretest	3.56 ±1.81	0.0001	-5.04	14
	Posttest	11.17±6.36			
Static balance in non-supporting leg	Pretest	3.67±1.89	0.0001	-12.12	14
	Posttest	9.42±2.94			

*Standard deviation

Table 2 presents dependent t-test results of dynamic balance, showing a significant difference in the dynamic balance of MS patients before and after core stability exercise program.

Table 2: Comparison the results of the dynamic balance of MS patients according to dependent t-test results

Variable		Mean ± SD*	*p*-value	*t*-value	Degree of freedom
Dynamic balance in supporting leg (percentage of length of leg)	Pretest	256.01±32.68	0.0001	-12.12	14
	Posttest	340.68±38.33			
Dynamic balance in non-supporting leg (percentage of length of leg)	Pretest	262.35±42.49	0.0001	-11.55	14
	Posttest	344.55±47.25			

*Standard deviation

Discussion

The present study results indicate the effect of core stability exercises on the balance of MS patients. There was a significant difference between pretest and posttest static and dynamic balance, which agrees with a number of studies in this area.

The primary aim of the exercise-therapy in chronic diseases such as multiple sclerosis is to maintain and improve patient's independence (25). Exercise therapy is a safe method for patients with MS, and preferably should be used in patients with mild to moderate disability (26). Balancing rehabilitation is an effective tool for reducing falls and improving balance skills of patients with MS. Exercise in various sensory areas can improve dynamic balance of these patients (27). Exercise therapy can improve walking speed (26).

In a study titled "Barriers and problems in performing physical activities: A case study of a patient with MS in America", Zalewski showed improved physical and psychological performance in patients following 8 weeks of exercise (28). In a study titled "The effect of exercise on performing daily activities in women with multiple sclerosis" Atashzadeh, *et al.* showed that exercise positively affects basic and useful daily activities of life (29). In their study, Bolouchi *et al.* arrived at the conclusion that a course of Cawthorne-Cooksey balance exercises can improve balance in MS patients (30). In their studies, Cattaneo *et al.*, Cantalloube *et al.*, Giesser *et al.* argued that a course of exercise therapy significantly improves balance in patients with MS (27,31,32). Pouretezad *et al.* compared the effects of two types of exercise therapy on functional balance in MS patients and concluded that stabilization exercises along with balance exercises can be used as an effective therapy for improving functional balance in MS patients (33). Moradi *et al.* studied the effect of 8 weeks of endurance exercises on motor function in men with MS and showed that these exercises significantly affect results of "Up and Go" and "3-minute step" tests, but have no significant effect on the "10 meter walk" test results, which can be attributed to small sample size and time limitation (34). In their study titled "The effects of 12 weeks of Pilates exercises and aquatic training on dynamic balance of women with MS", Marandi *et al.* concluded that these exercises can significantly improve dynamic balance of women with MS, with no significant difference between them (35). Freeman *et al.* studied the effect of 8 weeks of stabilization exercises on balance and movement of patients with MS using stretched arm and walking tests. The results showed improvement in test scores in the sideway stretched arm and walking tests (36). In a meta-analysis, Snook *et al.* studied the effect of exercise therapy on walking in MS patients and confirmed the positive effect of exercise on walking ability in patients (37).

The effect of stabilization exercises on balance can be explained by the fact that contraction of core muscles before movement of the limb is a positional feed forward response by the central nervous system to avoid positional impairments, and achieve dynamic balance. Hence, exercise program probably improves anticipation of action, and thus reduces the misplacement and volatility of the center of gravity (38). According to previous studies, the weakness of the core area of the body causes instability in performing lower limb movements (39). Strengthening core muscles due to core stability exercises improves neuromuscular system, reduces displacement of center of gravity from supporting surface, and reduces its fluctuations, resulting in improved positional control, which will strengthen lower limbs muscles, causing better muscle stability. Therefore participants can better neutralize the generated torques during a reach action and thus achieve greater distance (23). Given the huge stress exerted on the abdominal and lumber muscles by core stability exercise program, improved endurance and coordination in these muscles resulted in better balance in participants, because these muscles have the greatest role in maintaining balance and orientation of postural muscles in this area (40). In their study, Marshall and Murphy argued that Swiss ball exercises involve greater number of pelvic-lumber muscles (41). In this study, the unsteady surface of the Swiss ball was used in exercises, which forced patients to maintain their balance more than before, which in turn led to improved balance. Johnson *et al.* suggested that core stability exercises can increase proprioceptive awareness of the body which leads to improved balance (42).

Conclusion

Core stability exercise program showed a positive and significant effect on static and dynamic balance in patients with multiple sclerosis. It appears that these exercises can be used as a non-invasive therapy along with medication in MS patients. Given study limitations, further studies are required to confirm these results.

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Conflict of Interest

The authors have no conflict of interest.

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