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Effects of Ai-Chi on balance, functional mobility, strength and fatigue in patients with multiple sclerosis: A pilot study

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Abstract.
BACKGROUND: Multiple Sclerosis (MS) patients are often referred to aquatic physical therapy, but unfortunately, researches on the effects of aquatic therapy in MS patients are limited.
OBJECTIVE: The purpose of this study was to investigate the effects of Ai-Chi on balance, functional mobility, strength and fatigue in ambulatory patients with MS.
METHODS: Twenty-three ambulatory female patients were divided into two groups as experimental ($n = 15$) or control ($n = 8$) for an 8-week treatment program. The experimental group underwent Ai-Chi exercises in a swimming pool and the control group performed active arm and leg exercises combined with abdominal breathing exercises at home. Static standing balance was measured with duration of one-leg stance, functional mobility was evaluated with Timed-up and Go test and 6 minute walk test, upper and lower muscle strength was assessed with hand-held dynamometer and fatigue was evaluated with Fatigue Severity Scale.
RESULTS: Improvements were observed in static standing balance, functional mobility, upper and lower extremity muscle strength and fatigue in the Ai-Chi group ($p < 0.05$), but no significant differences in any outcome measures were observed in the control group ($p > 0.05$) after the intervention.
CONCLUSIONS: According to these findings Ai-Chi may improve balance, functional mobility, upper and lower extremity muscle strength and fatigue in patients with MS.

Keywords: Multiple sclerosis, aquatic therapy, Ai-Chi, balance

1. Introduction

Multiple Sclerosis (MS) is the most common demyelinating disease of the Central Nervous System and a frequent cause of non-traumatic disability. Europe has the highest estimated prevalence of MS in the world at 80 per 100,000 according to the World Health Organization [27]. The prognosis of disability is unpredictable in the early stages and therefore many different treatment strategies have been offered to cope with disability [5, 9, 14, 22].

Aquatic therapy has been used to treat different diseases from the antique era. The aquatic environment has unique properties, such as buoyancy, turbulence, hydrostatic pressure and resistance that can be used to

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gain a range of exercise benefits. Buoyancy reduces body weight and helps people who have difficulties to move on land. Turbulent water can provide an environment for static and dynamic balance training with minimal risk of injury. Resistance is important for strength training in water. Aquatic therapy is applied widely in various therapeutic fields [12, 13, 26, 28]. Also MS patients are often referred to the aquatic physical therapy, but unfortunately, researches on the effects of aquatic therapy are limited in this field [7, 11, 19, 23, 24] and none of these studies was a specific aquatic therapy approach such as Halliwick, Bad-Ragaz or Ai-Chi. Only one study was focused on the effects of Ai-Chi in MS patients and their primary aim was to evaluate the effects on the pain [6].

Ai-Chi focuses on balance, strength, relaxation, flexibility, and breathing [17]. There is not a study directly focused on effects of Ai-Chi training on balance, functional mobility, strength and fatigue in patients with MS. Therefore our aim was to investigate the effects of Ai-Chi on balance, functional mobility, strength and fatigue in ambulatory patients with MS.

2. Methods

2.1. Subjects

A telephone interview was conducted with twenty-eight MS patients among the population of Neurology Department of Gazi University Hospital, Turkey. Twenty-three female patients with MS were accepted to participate in the program. Inclusion criteria were: participants had a clinically definite MS according to Poser's criteria [20] and were able to walk independently. Exclusion criteria were being included in another ongoing physical therapy program, fear of water, uncontrolled hypertension, allergy to chlorine, pregnancy, incontinence, open wounds and acute MS attacks (three months prior to the study).

2.2. Procedure

The study was designed as single-blind and controlled. Various reasons made randomization impossible: lack of transportation, distance and cultural limitations were amongst the most important. Therefore allocation was conducted according to preference. Patients were allocated to the experimental or control groups. Experimental group underwent Ai-Chi in a swimming pool. Control group performed home exercise program. After the allocation was done no transition between groups was allowed.

The study protocol was approved by the institutional review board. All participants provided written informed consent. The study was conducted in accordance with regulatory standards of Good Clinical Practice and the Declaration of Helsinki.

2.3. Outcome measures

A neurologic examination was performed using the Expanded Disability Status Scale [15] (EDSS) by a neurologist. Descriptive measures such as age and duration of disease were recorded prior to the study. The outcome measures were balance, functional mobility, upper and lower extremity muscle strength and fatigue. The physical therapist that performed the tests was blind to the study. All measurements were performed before and after the intervention. Evaluations were performed in a standardized order.

Static standing balance: One-leg standing test was used to measure static standing balance. Subjects tried to stand on one-leg as long as possible. Test was performed with eyes open and bare feet. One try out was given before the test. The duration of the standing on one-leg was measured using a digital chronometer. No verbal stimulus was given during the test. The chronometer was stopped when the elevated foot touched the ground or subject lost the balance position. If a subject could stand for 180 second on one-leg, the test was accepted as completed [8]. The dominant side of the lower extremity was used for analysis. Lower extremity dominance was determined by asking 'which leg do you prefer for kicking a ball' [2].

Functional mobility: Timed up and go test (TUG) and 6 minute walk test (6MWT) were used to provide a measure of functional mobility and changing body position (d410-d429) and walking (d450) related to ICF.

In the TUG [21, 24] test, it requires the subjects to stand up from a chair, walk 3 m, turn around and be seated. The subject is timed from the moment he lifts the pelvis from the chair until he returns with the pelvis in the chair.

The six-minute walk test was administered in accordance to the guidelines outlined by the American Thoracic Society, a 30-m track was used in the present study [1].

Upper and lower muscle strength: The strength of shoulder flexors and abductors, elbow flexors, hip flexors and extensors, hip abductors and adductors, knee flexors and extensors and ankle dorsal flexors were measured using a hand-held dynamometer (Baseline®, White Plains, New York, USA). Position of the subjects and placement of the dynamometer were standardized according to Bohannon [3, 4].

Fatigue: Fatigue was evaluated using the Fatigue Severity Scale (FSS) [6], which evaluates the impacts of fatigue on daily functions, has 9 statements scored 1 to 7 (1 "strongly disagree" to 7 "strongly agree"). Total score ranges from 9 to 63 points. As scores decrease, fatigue severity also decreases in this scale.

2.4. Interventions

2.4.1. Ai-Chi

The experimental group participated in a 60 minute group session twice a week for 8-weeks. Ai-Chi was conducted by an experienced physiotherapist in neurologic rehabilitation and certificated in Ai-Chi. The first session was the introduction session and was not included in the 8 weeks program. The Ai-Chi program took place in a swimming pool which was 1.20 meters deep, the water temperature was 28°C.

Each session consisted of a warm-up period, Ai-Chi exercises, followed by a cool-down period. 15 minutes of warm-up period was consisted of free extremity movements or activities with different materials such as pool noodles, kickboards. The Ai-Chi program lasted 30 minutes and consisted of 16 different movements. Ai-Chi exercises, all performed in shoulder-depth water with knees slightly flexed, use a combination of deep breathing and slow, broad movements of the arms, legs and torso to work on balance, strength, relaxation, flexibility and breathing. The 16 movements or postures follows this sequence: contemplating, floating, uplifting, folding, shooting, gathering, freeing, transferring, accepting, accepting with grace, rounding, flowing, relaxing, and sustaining. 15 minutes of cool-down program in water (free walking and stretching) was performed after Ai-Chi program. The progression of the program was shown at Table 1. Attendance of the Ai-Chi was recorded.

2.5. Home Exercise Program

The control group was assigned to an eight week home exercises program (2 days/week) which included abdominal breathing and active range of motion exercises combined with abdominal breathing. These exercises were given for three sets with ten repetitions in an exercise day. Patients were asked to record the days that they could not do home exercises.

Table 1
Progression of the Ai-Chi program

Weeks	Tour*	Repetition**
1	1	3
2	2	3
3	1	5
4	2	5
5	1	10
6	2	10
7	1	20
8	2	20

*Tour describes a circle of all Ai-Chi movements from beginning to end. **Repetition describes how many times a movement of Ai-Chi was repeated.

2.6. Statistical analysis

All data were analyzed using the Statistical Package for the Social Sciences (SPSS1, Chicago, IL, USA, version 11.5). Since number of subject was not enough for parametric analysis, non-parametric tests were used for analysis. Mann Whitney *U*-test was used to compare age, disease duration and EDSS score. Comparisons of before and after intervention were done using Wilcoxon signed-rank test and were expressed as median (25th–75th IQR). Statistical significance was set at $p < 0.05$.

3. Results

Twenty-three patients were included in the study. Fifteen patients wanted to participate in experimental group, eight patients wanted to participate in control group. Four patients in the experimental group did not continue the program, because of various reasons, including difficulties with time, transport difficulties or family problems. One patient in the control group could not be evaluated after the intervention, because she had not done the exercise regularly. Therefore analyses were performed on data collected from eleven patients in the experimental group and seven patients in the control group (Fig. 1).

The demographic characteristics of the MS patients and control group were given in Table 2. Median EDSS score of patients was 1 (IQR = 0-2) in experimental group and 2 (IQR = 1-2) in control group. Age, disease duration and EDSS scores were similar in groups at baseline (Table 2).

No relapses occurred, and no alterations were done in medications for any participant during the study.

Compliance was good in both programs. The median attendance of the sessions was 14 sessions

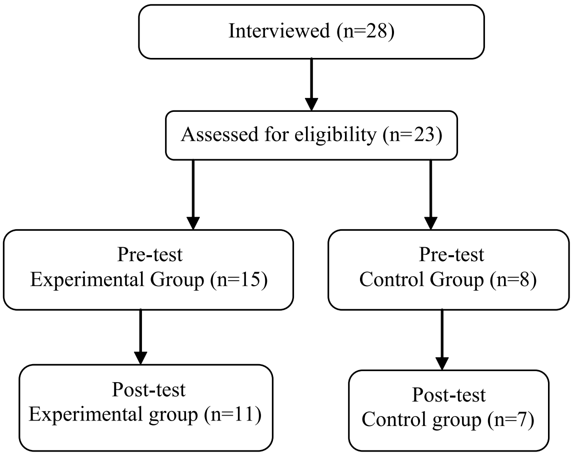

Fig. 1. Flow diagram of the study.

(IQR = 14-14) for experimental group and 16 sessions for control group.

Analysis of the outcome measurements indicated that experimental group performed significantly better at tests after the Ai-Chi as compared to baseline tests (Table 3). But no significant changes were detected in the control group (Table 3).

The duration of one-leg standing was significantly increased in experimental group ($p < 0.05$). Following Ai-Chi, TUG scores of patients were significantly decreased ($p < 0.05$). The distance covered during 6MWT was significantly increased after Ai-Chi ($p < 0.05$). On the other hand control group showed no significant differences in one-leg standing, TUG and 6MWT score ($p > 0.05$) after home exercises program.

The strength of shoulder flexors and abductors, hip flexors, extensors and abductors and knee flexors and extensors were significantly improved ($p < 0.05$), while no significant changes in the strength of elbow flexors, hip adductors and foot dorsal flexors were detected in experimental group ($p > 0.05$). In the control group no significant changes were found in the upper and lower muscle strength after home exercises program ($p > 0.05$).

FSS scores were significantly decreased in experimental group ($p < 0.05$). In the control group no significant changes were found in FSS scores after home exercise program ($p > 0.05$).

4. Discussion

According to our results in the recent study an eight-week Ai-Chi program was useful to improve balance, functional mobility, strength and fatigue in MS patients. The program was safe, and the sessions were well tolerated with no negative effects reported and all participants wished to continue in future programs.

We believe that as the technique of Ai-Chi includes one leg standing exercises like Tai-Chi on land [17] and the fear of falling diminished in the water environment, one leg standing balance improved more in the Ai-Chi group. Also the improvements in the lower extremity muscle strength may contribute to this result. In our

Table 2
Characteristics of the study sample

	Experimental group $n = 11$	Control group $n = 7$	p
Age, years			
Median (25th–75th IQR)	38 (33–48)	39 (27–47)	0.525
Dominant extremity (R/L)	11/0	7/0	
Disease duration, years			
Median (25th–75th IQR)	6 (2.75–10.5)	1.5 (0.4–4)	0.105
EDSS			
Median (25th–75th IQR)	1 (0–2)	2 (1–2)	0.307
EDSS n(%)			
0	3 (27.3)	0	
1	3 (27.3)	2 (28.6)	
1.5	1 (9.1)	1 (14.3)	
2	2 (18.2)	3 (42.9)	
4	2 (18.2)	1 (14.3)	
Medication n (%)			
Interferon β-1a	10 (90.9)	4 (57.2)	
Interferon β-1b	0	1 (14.3)	
Copaxon	0	2 (28.6)	
No medicadition	1 (9.1)	0	

Table 3
Comparisons of balance, functional mobility, upper and lower extremity strength and fatigue in experimental and control groups after the intervention

	Experimental group			Control group		
	Median (25th–75th IQR)	Median (25th–75th IQR)	*p*	Median (25th–75th IQR)	Median (25th–75th IQR)	*p*
One-leg standing balance (sec)	30.06 (11–73)	57.81 (14.73–180)	0.017	13.62 (2.66–52.87)	26.1 (1.8–87.39)	0.345
TUG (sec)	6.31 (5.17–6.97)	6.21 (5.17–6.53)	0.028	7.29 (6.16–8.53)	6.88 (6.61–8.14)	0.917
6MWT (m)	485 (456–511)	505 (464–593)	0.050	482.04 (422.20–521)	482.3 (420–510)	0.600
Upper extremity strength (lb)						
Shoulder flexion	31 (21–42)	41 (28–46)	0.041	50 (41.9–52)	50 (49–55)	0.715
Shoulder abduction	32 (21–43)	33 (31–41)	0.045	45 (40–50)	45 (40–50)	0.893
Elbow flexion	30 (26–50)	41 (29–52)	0.168	52 (46.31–60)	55 (50–55)	0.916
Lower extremity strength (lb)						
Hip flexion	32 (24–41.9)	42 (25–49)	0.008	50 (44.1–52)	50 (45–55)	0.058
Hip abduction	38 (21–62)	52 (48–73)	0.028	63.65 (58–70)	62 (60–80)	0.180
Hip adduction	35 (25–55)	44 (36–59)	0.130	60 (50–61.74)	60 (54–65)	0.176
Hip extension	31 (22–50)	33 (25–59.54)	0.018	50 (44–50)	50 (50–60)	0.345
Knee flexion	27 (21–33)	34 (30–44)	0.007	40 (30–41)	40 (35–40)	0.465
Knee extension	40 (39–60)	59 (45–68)	0.019	60 (50–61)	58 (40–60)	0.068
Dorsi flexion	45 (26–55)	49 (43–60)	0.140	50 (44.1–60)	52 (50–60)	0.066
FSS (0–63)	50 (38–53)	38 (33–50)	0.009	50 (39–55)	48 (26–52)	0.336

TUG: Timed up and go test, 6MWT: Six minute walk test, FSS: Fatigue Severity Scale, IQR = interquartile range, $p < 0.05$. sec: Second, m:Meter, lb: Pound.

study the subjects were able to get maximum points from all other sub-tests in Berg Balance Scale except the sub-test 'one leg standing'. Therefore we just focused on the single leg standing balance sub-test despite of the whole Berg Balance Scale. Salem et al. [24] found a 5-week program (twice in a week) consisting of aerobic exercises, strength training, flexibility exercises, balance training and walking activities improves Berg balance scores of MS patients. The improvements in our balance scores tended to be similar to those reported in the study of Salem. Likely, in another study that investigates the effects of Halliwick and Ai-Chi methods together in stroke patients Noh et al. [18] reported that an 8-week program increases Berg Balance Scale scores significantly. In a recent study of Teixeira et al. [25] balance also was improved significantly after a 6-week Ai-chi program in older adults, with effects sizes on the Performance Oriented Mobility Assessment of 1.3.

In our study, participants in the experimental group showed significant changes in the TUG test and 6MWT after the 8-week intervention. Similarly, in the study of Salem et al. [24] TUG scores were decreased and gait speed was increased and mobility was improved. In similarity in our programs with Salem, it can be concluded that Ai-Chi may improve functional mobility. But on the other hand, Gehlsen et al. [10] mentioned no change in walking speed after their aquatic program. The aquatic program of Gehlsen et al. was a ten-week (3 times a week) aquatic exercise program consisting of freestyle swimming and shallow water calisthenics and was not directly focused on gait and mobility. That could be the underlying reason of differences between our results on functional mobility.

Of the muscle strength measurements in our study, while significant changes were seen in strength of the upper and lower extremity in experimental group, no significant changes were found in the control group. Ai-Chi is a technique that is applied in shoulder-depth water with knees slightly flexed position, therefore the resistance of water is available for all the extremities and the torso while practicing the Ai-Chi. Coco et al. [7] and Gehlsen et al. [11] reported also increments on muscle strength in patients with MS after aquatic programs. Coco et al. reported their results after a 15-week program and Gehlsen et al. found similar results after a 10-week intervention, however in our study we gained similar results but in less time (8-week Ai-Chi). In the light of previous results and our findings we can say that Ai-Chi may improve the muscular strength in patients with MS. In the study of Noh et al. [18] knee muscle strength also increased after an 8-week program consisting both Halliwick and Ai-Chi techniques in stroke survivors.

A recent study of Castro et al. [6] that comparing the effects of Ai-Chi and relaxing exercises in MS patients, a significant decrease was demonstrated in fatigue in favor of Ai-Chi group. We can contribute our results to study of Castro that improvements can be gained in perceived fatigue in shorter programs. Similar to our results, Roehrs et al. [23] mentioned significant decrease in perceived fatigue in their 12-week aquatic aerobic study in 19 patients with MS. Despite of our results Salem et al. [24] reported no significant change in fatigue in their 5-week study. Salem mentioned about their results as, maybe their program was too short or the training intensity used in their study was not high enough to result in statistically significant changes in fatigue. As seen from results of our study, an 8 week program of Ai-Chi training was beneficial to cope with fatigue in MS patients. Coco et al. [7] also reported that fatigue decreased in their aquatic therapy program on a MS patient. But in contrast, Pariser et al. [19] reported that after an 8-week aqua aerobics program on 2 MS patients that results show difference. While, one patient has improvements on fatigue, the other one did not report any change. But both studies [7, 19] were case studies and their power to measure the perceived fatigue was limited.

Our study was conducted in a pool that was 28°C. Studies have shown no adverse effects when people with MS use pools with a temperature range of 25–36°C [6, 11, 24]. It can be said that the choice of water temperature could be related to purpose. In the study of Castro et al. [6] primary purpose was to investigate the effects of Ai-Chi on pain reduction and relaxing and therefore they performed their study in a pool that was 36°C. But in our study our aim was to investigate the effects of Ai-Chi on balance, functional mobility, strength and fatigue and some of our patients were thermo sensitive, therefore we preferred to perform our study in cooler temperatures as used in the studies of Gehlsen, Coco, and Salem [7, 11, 24].

5. Limitations

Unfortunately our population size was small, but still one of the largest population in the literature about aquatic therapy in MS. Our subjects were only females and their disability status was mild to moderate therefore; we can generalize our result just for females who are not effected severely. The effects of our program would be different in males or more severely affected MS patients. Also randomization was one of our limitations. Studies that will investigate the follow up effects are also needed. However, to our knowledge, this is the first reported controlled study of the effects of Ai-Chi on balance, functional mobility, strength and fatigue in patients with MS. Further studies with larger sample sizes, with randomized controlled design, in different levels of MS and in male population are needed.

6. Conclusions

This study demonstrated that an 8 week Ai-Chi program is feasible and resulted in improvements in balance, functional mobility, strength and fatigue of individuals with MS. This study provides additional data for the existing research examining the effects of Ai-Chi programs in individuals with multiple sclerosis and provides useful clinical information for those health professionals using Ai-Chi as an intervention in this patient population. Further researches should investigate additional aspects of Ai-chi programs such as the long-term effects and its effectiveness in different levels of MS.

Decleration of interest

The authors declare that they have no conflicts of interest.

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Conflict of interest

None.

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