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ORIGINAL RESEARCH

Effect of core stability training on balance in elderly women

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Abstract

Objective: The study investigated the effect of core stability training on balance in elderly women.

Method: Sixty female volunteers 61–70 years of age were divided into training (n=30) and control groups (n=30). Core stability training was given to patients in the training group, and walking exercise was given to patients in the control group. The function of static and dynamic balance was detected before training and 30 weeks after training.

Results: The time of standing on one foot with eyes closed after training in the training group was significantly longer than the control group, and the stellate balance test with stretching the lower limbs straight ahead, behind, and laterally in the training group was significantly better than the control group. The performance of two lower limbs during the training in the straight ahead direction, behind, and to the outer side in the training group was significantly better than the control group. Significant differences also occurred when the left leg was supported on the outer rear, and the right leg was supported on the medial front and rear.

Conclusion: Core stability training is more beneficial than walking exercises in improving balance in elderly women.

Keywords: Core stability training, Elderly women, Balance

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Introduction

With an increase in age, multiple factors, such as decreased muscular strength, reduced range of motion of joints, and hypofunction of vestibular organs, can lead to a decrease in balance of elderly people, and a decrease in balance is an important cause of limiting activities and falls [1].

Numerous studies have shown that the muscles in the core area of the human torso (lumbar spine, pelvis, and hip joint) play an important role in maintaining body balance [2]. Core stability training plays a special role in developing muscle strength, physical agility, neuromuscular coordination, and balance. However, currently most research is oriented to training for professional athletes or the disabled, and less attention is paid to core stability training for the general population. The current study observed the effects of core stability training on balance in elderly women, and provided a scientific basis for the health care of the elderly.

Subjects and methods

Subjects

Sixty female volunteers, 61–70 years of age, who met the inclusion criteria were randomly divided into a core stability training group (hereinafter referred to as the training group

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[*n*=30]) and the control group (*n*=30). The inclusion criteria of the study subjects were as follows: urban non-manual laborer; physically healthy; no diseases, such as spinal disorders and muscle diseases; no orthopedic disorders and pain in the lower limbs; no chronic diseases, such as cardiovascular diseases; and no habit of participating in perennial physical exercise. The basic information of the subjects is shown in Table 1. The authors received consent from all participants.

Methods

Core stability training was given to patients in the training group and walking exercises were given to patients in the control group. The exercise time for patients in both groups was 30 min, 5 times per week, for a total of 30 weeks. Each training session was performed collectively and led by experienced personnel. Before the start of training and 30 weeks after training, static and dynamic balance functions were detected.

Walking exercise: Patients in the control group, led by experienced personnel, did walking exercises by running on a 400 m runway in the athletic field. The target heart rate was calculated as "170 – age," thus the immediate pulse after exercise was 100–110 times/min.

Core stability training: The subjects were instructed to lie face down, stretch their arms straight over the top of their head, stretch their legs straight, raise their arms and legs simultaneously off the ground when inhaling, and breathe slowly for relaxation after a little control. Next, the subjects were asked to lie on one's side with one single elbow touching the ground, overlap the two lower limbs, lift up the upper lower limb, keep the knee straight for 5–10 s, then put the limbs down, repeat the procedure several times, then shift to the other side. The subjects were instructed to lie on one's back, let the spine fully touch the ground, place the two hands flat on both sides of the hips, bend the knees, and make the feet close to the hip for support. Then, the hip is lifted with force, maintain the position for 2–3 s, lower the hip without touching the ground, and after a slight pause the procedure is repeated again, and finally the hip is lifted for 10 s. The subject lies on their back, two hands are straightened close to both body sides, both legs are bent slightly, the legs are lifted off the ground when inhaling, the hip leaves the ground, but the upper body and the head do not leave the ground, and the action should be slow and rhythmical. The subject lies on their back, the legs are bent slightly with the hands behind the head, the shoulders are opened, the body is lifted to the left front side when inhaling, the left thigh is lifted up, the subject exhales to relax and returns all body parts to the original sites, then shifts to the other side.

Static balance test: The subject was asked to stand on one foot with their eyes closed. During the test, the subjects closed their eyes and stood naturally. When hearing the command to "start", they raised their non-dominant foot and stood on one foot with the habitual supporting foot. Simultaneously, the personnel started timing the subject. The personnel stopped timing when the subject moved the supporting leg or the lifted foot touched the ground. The test was carried out twice, and the best of the two results was selected.

Dynamic balance test: The stellate stretch balance test was used. The zeros of 8 measuring tapes were aligned, fixed onto the ground at an interval of 45°, and separately name the 8 directions of the straight ahead, medial front, medial side, medial rear, right behind, outer rear, outer side, and outer front according to the test sequence [3]. Before the test, the lower limb length of the subjects was measured, and the specific test procedures were demonstrated to the subjects. Both hands are placed on the hips, the subjects look straight ahead, the center of the supporting foot is fixed at zero of the measuring tape, and the second toe is aligned straight ahead. Then, the knee of the supporting leg is bent, and the non-supporting leg is extended in the eight directions. The maximum achievable distance of

Table 1. Basic information of subjects

	Age (years)	Body height (cm)	Weight (kg)	Leg length (cm)
Training group (*n*=30)	65.57±5.02	160.85±5.03	61.94±5.22	84.90±5.11
Control group (*n*=30)	65.48±4.96	161.32±4.14	62.37±5.36	85.16±5.38

each direction is recorded. Before the formal test, the subject performs exercise three times in each direction. After a rest of 5 min, the test is begun with the right leg as the supporting leg, and tested twice in each direction. The best score is selected. With respect to the direction of the outer side, there are two situations (stretching from the front of the supporting leg and stretching from behind the supporting leg). The interval of each test is 10 s. After a rest of 5 min, the left leg is shifted as the supporting leg for testing. During the test, always maintain the body's center of gravity in the supporting foot, and make it fully contact with the ground. If the supporting leg moves, rotates, or loses balance, re-measurement is needed.

Statistical analysis

The original result of the stellate stretch balance test was divided by the length of the lower limbs of the subjects, then multiplied by 100 to standardize the raw data [4]. The SPSS16.0 statistical software was used to perform data processing. The independent sample t-test was utilized to compare the differences between the two groups and a $P<0.05$ indicated that the differences had statistical significance.

Results

Before training, for the time of standing on one foot with eyes closed, there was no difference between the training group and the control group, but after training, the time of the training group was significantly longer than that of the control group (Table 2).

When the stellate stretch balance test was utilized to test the two lower limbs in all directions, there was no significant difference whether before or after the training. Before training, there was no significant difference between the training and control group with respect to training in all directions. After training of the two lower limbs in the straight ahead direction, right behind, and outer side, including the two situations of stretching from the front and stretching from the rear, the time of the training group was significantly longer than the control group. Significant differences also occurred when the left leg was supported on the outer rear and the right leg was supported on the medial front and medial rear (Table 3).

Discussion

Core stability refers to the control of the stabile position of the pelvis and torso muscles during movement, creating a foothold for the movement of upper and lower limbs, and coordinating the force exerted by the upper and lower limbs, so that the power generation, transmission, and control can be optimized [5]. The core stability training was much different from the traditional lumboabdominal strength training; the former involves the muscles of the entire trunk and pelvic, emphasizes the holisticity of the waist, pelvis, and hip, and focuses on the training of the small muscle deeply located groups. In particular, multiple factors, such as stability, interference resistance, and coordination, are included [6, 7].

Usually, core stability training emphasizes carrying out under unstable conditions, and the body must constantly adjust posture to control body weight and the balance and stability of posture, which can increase the stimulation of the central nervous system so as to increase the level of central activation. It can mobilize more movement units to participate in the completion of the movement, which is conducive to training of the core muscle strength, thereby improving the body's ability of balance and stability [8]. This study created training environments on an unstable support surface, emphasizes the stability and balance of posture, and stimulates the abdominal muscles, lumbar and back muscles, side flexors, gluteal muscles, rotator muscle of the hip, post-femoral muscle group, and adductor muscles of the hip.

Standing on one foot with eyes closed is a scientific method suitable for balance ability test for the elderly, mainly depending on the functional status of proprioceptive sense, vestibular sense, and the central nervous system. In this test, the time of

Table 2. Test result of standing on one foot with eyes closed (s)

	Training group (*n*=30)	Control group (*n*=30)	t	*P*-value
Before training	8.90±4.56	9.00±4.53	0.085	0.932
After training	11.93±4.06	9.63±4.05	2.198	0.032

Table 3. Result of stellate stretch balance test (%)

Direction	Time	Left supporting leg				Right supporting leg			
		Training group	Control group	t	*P*-value	Training group	Control group	t	*P*-value
Straight ahead	Before training	69.37±7.54	69.23±7.63	0.068	0.946	69.00±7.34	69.17±6.93	0.090	0.928
	After training	73.83±6.96	70.07±6.91	2.104	0.040	74.47±6.66	70.60±6.62	2.256	0.028
Medial front	Before training	71.87±7.35	71.70±7.14	0.089	0.929	71.00±6.47	72.07±8.01	0.567	0.573
	After training	74.43±6.76	72.57±6.14	1.120	0.267	76.43±4.78	72.83±7.30	2.261	0.028
Medial side	Before training	75.40±7.74	75.13±7.00	0.140	0.889	76.00±7.06	76.13±7.39	0.071	0.943
	After training	78.83±6.47	76.10±6.78	1.598	0.116	78.87±6.35	77.13±7.25	0.985	0.329
Medial rear	Before training	81.20±8.34	80.50±8.13	0.329	0.743	81.07±7.89	81.30±7.07	0.121	0.904
	After training	84.73±6.66	81.47±8.04	1.714	0.092	85.73±6.76	82.10±6.16	2.177	0.034
Right behind	Before training	76.20±6.26	76.70±6.31	0.308	0.759	78.27±7.48	78.47±6.67	0.109	0.913
	After training	80.97±5.35	77.50±6.71	2.211	0.031	82.77±7.13	78.87±6.84	2.161	0.035
Outer rear	Before training	67.83±5.22	67.23±5.11	0.450	0.654	68.57±5.78	68.83±5.61	0.181	0.857
	After training	71.23±5.10	68.53±4.85	2.102	0.040	71.23±4.27	69.00±5.66	1.726	0.090
Outer (front)	Before training	52.00±4.59	51.37±4.41	0.545	0.588	51.37±4.63	51.43±4.39	0.057	0.955
	After training	56.27±2.70	53.90±4.56	2.446	0.018	54.40±4.18	51.80±3.74	2.539	0.014
Outer (rear)	Before training	60.27±5.13	59.20±4.91	0.823	0.414	59.50±5.93	59.07±5.66	0.289	0.773
	After training	63.63±3.89	60.80±4.39	2.646	0.010	62.77±5.35	59.53±5.51	2.306	0.025
Outer front	Before training	65.07±6.31	65.27±6.24	0.123	0.902	64.23±5.39	64.57±5.63	0.234	0.816
	After training	67.87±6.58	66.60±5.93	0.783	0.437	66.17±5.35	64.40±5.37	1.277	0.207

standing on one foot with eyes closed of the training group after 30-week core stability training increased significantly compare to the control group. When compared with the walking exercise, the core stability training in an unstable state can better stimulate the body's proprioceptive sense and the ability of neuromuscular control, strengthen the spinal and pelvic muscles, and enhance the conduction of power in the kinematic chain. At the same time, the swivel movement also helps to improve the function of the vestibular organ so that the core stability training can better improve the static balance in elderly women than walking exercise.

The stellate stretch balance test is often used to detect and evaluate the dynamic balance ability of the subjects, is characterized with a simple operation, is suitable for people of all ages, and is an effective and reliable function detection method [9, 10]. In this study, both before training and after training, there was no significant difference in terms of the stretch amplitude in all directions between the left supporting leg and the right supporting leg, indicating that there was no significant difference in the dynamic balance between the left and right lower limbs. This might be associated with the fact that healthy ordinary people alternately swing feet when walking and the movement levels of the two lower limbs are basically consistent, which is consistent with the results of previous studies [11, 12].

Many studies have shown that core stability training plays a role in promoting the dynamic balance ability of athletes. The study conducted by Samson [13] has shown that the core stability training plays a role in promoting the dynamic balance ability of athletes. After investigating the effects of a 5-week core stability training on the dynamic balance ability of tennis players, the results showed that the patients in the stellate training group after training behaved significantly better than before training or the patients in the control group in eight directions of stretching during the balance test. It was considered that the core stability training could enhance the dynamic balance ability. In the current study, the results of the stellate stretch balance test showed that after a 30-week core stability training, the stretch amplitude of the patients in training group increased significantly. The performance of two

lower limbs during the training in the directions of straight ahead, right behind, and outer side in the training group was significantly better than the control group. The significant differences also occurred when the left leg was supported on the outer rear and the right leg was supported on the medial front and medial rear. The training effects of leg-lifting exercise and lateral flexion and rolling abdomen for muscular training on muscles at the front of core regions were marked, increasing the stretch magnitude in the direction of straight ahead. Lying face down with both ends lifted and lying on one's back and lifting the hip increased the stretch magnitude after training on muscles at the rear of core regions. The relatively wide rotation range of the trunk was needed when the extension was toward the outer side, the rotation range of the trunk during the walking exercise was narrow, and the act of lateral flexion and rolling the abdomen could enhance the strength and stability of rotator muscles and balance. Generally speaking, the core stability training is more beneficial than walking exercise for elderly women in improving dynamic balance ability.

This test used non-random samples, and the sample size was small. There are more core stability training methods, the sample size needs to be enlarged for further study and confirmation, and the training programs need improvement.

Conflict of interest

The authors declare no conflict of interest.

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