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Rehabilitation Effect of Systematic Exercise on Breast Cancer Patients after Adjuvant Chemotherapy

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OBJECTIVE To investigate the rehabilitation effect of systematic exercise on breast cancer patients after adjuvant chemotherapy.
METHODS One hundred and ten subjects were randomly divided into 2 groups. The patients in the control group received original exercise. The others in the intervention group received systematic exercise including aerobics and 24 postures of Taichi for 4 months besides the original exercise.
RESULTS After the systematic exercise, the limb muscle strength, maximal oxygen uptake and lung capacity of the patients in intervention group were increased compared with those before the systematic exercise ($P < 0.05$). The lung capacity of patients in the intervention group was significantly increased than the control group after the exercise ($P < 0.05$). The body mass index (BMI), the ratio of waist and hip (WHR) of the patients in intervention group were decreased compared with those before the systematic exercise ($P < 0.05$). The bone mineral density of control group was decreased comparing with pre-exercise ($P < 0.05$), but there was no significant difference in the intervention group between pre-exercise and pro-exercise ($P > 0.05$). There was no significant difference in the quality of life between the 2 groups after the systematic exercise ($P > 0.05$).
CONCLUSION Systematic exercise can not only promote the restoration of limb function in patients with breast cancer after treatments, but also improve pulmonary function of the patients and lower the BMI and WHR of the patients. Systematic exercise can improve the outcomes of overall rehabilitation.

KEY WORDS: breast cancer, aerobics, Taichi, nursing.

Introduction

Breast cancer is one of the common malignant tumors of women. The present treatment model for breast cancer is the surgery combined with radiotherapy, chemotherapy and with or without endocrine therapy. The majority of the patients have received the procedure of breast-conserving with or without lymph node dissection. When the procedure is performed, it may decrease the mobility and strength of the operated shoulder and arm[1].These symptoms may lead to permanent dysfunction of the arm[2]. During 4 months of chemotherapy after surgery, the patients are guided by a nurse to do the original rehabilitation exercise. Accumulated evidence has shown that the

early rehabilitation exercise can improve the function recovery of the surgery-affected limb[3,4]. When the patients get home from hospital and return to family life, their physical condition gets better compared with that when they were in the hospital receiving chemotherapy. But the amount of original rehabilitation exercise can not well meet the patients' physical need for recovery. Meanwhile, some factors including side effects of the drugs, fatigue, lack of the nurse's guide in rehabilitation exercise at home, lack of related knowledge about rehabilitation exercise, and lack of confidence in exercise, often stop the patients from keeping the rehabilitation exercise. Therefore, some patients have appeared some problems, such as limb movement disorder, osteoporosis, weight gain, physical condition running down, and so on. For example, comparison patients' flexion, abduction, internal rotation and external rotation movements before and after the surgery, 12% of women did not regain full shoulder function 12 months after the operation of breast cancer[5]. A number of uncontrolled trials have suggested that significant increase in weight occurs in 50%-96% of all early stage breast cancer patients during treatment. Weight gain usually ranges from 1.0 to 6.0 kg during the first year after diagnosis in western countries [6,7]. Some studied have shown that the exercise supervised by rehabilitation experts could promote the long-term effect for recovery including the function of surgery-affected limb, heart and pulmonary function, bone mineral density, body shape, and quality of life, etc[8-11]. It has been proved that aerobic exercise is one of the effective ways to improve the physical condition of the patients[12]. Taichi, the Chinese traditional sport, has been popularized in helping the patients recover because it is easy doing and can improve respiration and reduce stress[13].

In order to decrease the long-term problems disturbing breast cancer patients after adjuvant chemotherapy, we want to establish an exercise program according to the physical status of the patients in family life. In our study, aerobic exercise and 24 postures of Taichi as a systematic exercise were applied in the patients 1 year after the breast surgery with the guidance of the nurse from April 2009 to April 2010, and the effects of the systematic exercise on limb muscle strength, pulmonary function, bone mineral density, body mass index (BMI), the ratio of waist and hip (WHR), and other indicators of quality of life were comprehensively evaluated. The results of our study are presented in this paper.

Patients and Methods

Patients

Patients who diagnosed as breast cancer in our hospital and received modified radical mastectomy followed by adjuvant chemotherapy for 4 months were selected in the study. The criteria for enrollment included:

i) nearby one year after received modified radical mastectomy; *ii)* aged ranging from 35 to 65 years; *iii)* received CAF (cyclophosphamide, doxorubicin, fluorouracil) or CMF (cyclophosphamide, methotrexate, fluorouracil) regimen of chemotherapy and endocrine therapy after the surgery; *iv)* presented no cardiopulmonary disease or other diseases of nerve, muscle or joint that involve movement; *v)* agreed to participate in the study. Exclusion criteria were: *i)* cardiac function above grade II; *ii)* had bone or joint disease that kept the patients from doing exercise. Patients with exercise participation rate less than 80% would be excluded at the end of the study.

Methods

Grouping

One hundred and ten patients met the above criteria and were randomly divided into intervention group and control group, with 55 patients in each group. Patients in intervention group received systematic exercise program based on their original exercise, and conventional rehabilitation exercise equipment and limb activities were given to patients in the control group

Exercise program

Systematic exercise program included exercise items, exercise intensity and exercise frequency.

Exercise items

In addition to the conventional limb rehabilitation exercise with equipment established in our hospital, the subjects also do aerobics and 24 postures Taichi. Before starting the exercise each time, the conventional limb rehabilitation exercise was performed for the first 10 min, which included movements of upper limb and major joins. The details of the upper limb movements were as follows: clenching fist, turning wrist, bending elbow, turning shoulder, raising arms, touching ears, climbing wall with involved arm, etc. After this set of exercise, the aerobic exercise was followed. Aerobics included head movement, head rotation, interlaced shoulder raising, double shoulders raising, arm pulling forward, arms raising and lateral bending, body rotation left and right, arms raising and forward bending, hip lateral moving, hip forward moving, stepping around, arm squaring. The entire exercise included 12 items of movements, and, the whole set of the movements was repeated 2 to 3 times. The effective time for the aerobic exercise was 20 to 25 min. For following 10 min for relaxation activities, such as marking time, swing arms, etc. After the relaxation activities, 24 postures of Taichi was practiced consecutively for 2 times, with each time lasting for 20-25 min.

Exercise intensity

The intensity of each type of exercise was based on the target heart rate of the patients. The formula of the target heart rate = (220-age-resting heart rate) × 45%-60% +

resting heart rate[14].

Exercise frequency
The resting heart rate was measured before exercise, and the heart rate during the exercises was measured using a Polar monitor. The heart rate during the exercises was supposed within the range of target heart rate. The total exercises lasted for 40-50 min. Subjects in the intervention group were guided by a nurse specialized in breast cancer rehabilitation to do the exercises 3 times per week lasting for 4 months.

Evaluation methods and indicators
Limb muscle strength, maximal oxygen uptake, pulmonary capacity, bone density, BMI, WHR and Quality of life scale (FACT-B) for breast cancer patients were measured in both groups right before and 4 months after the systematic exercises. The measurements included:

Limb muscle strength
Limb muscle strength was measured using self-made pulling-and pushing pressure sensor when turning wrist and bending elbow.

Maximum oxygen uptake
Subjects wearing the Polar monitor did bicycle riding with a frequency of 50 rev/min and the 25 W initial load at uniform speed for 3 min, and then adjusted to 50 W or 75 W for at least 3 min until heart rate reached steady state which was around 120-150 BPM. The maximal oxygen uptake was calculated using Astrand-Rhyming monograms based on the last load and heart rate,.

Pulmonary capacity
Electronic spirometer with accuracy of 1 mL was used to detect patients' pulmonary capacity. The patients were required to take a deep breath till the end of inspiration, and then blowed strongly through the open of the electronic spirometer. The test was done twice and the maximum was used.

Bone mineral density
Bone mineral density in the 2nd to 4th lumbar spines and neck of femur were detected using the American Lunar Prodigy dual-energy X-ray absorptiometry.

Quality of life of breast cancer patients
The Chinese version of FACT-B was used to measure the quality of life in breast cancer patients, which was developed by the U.S. research and education center and translated by Wan CH. The measurement for the quality of life of cancer patients consisted of by common modules (including physical conditions, social/family status, emotional status, functional status) and specific module for patients with breast cancer (that is additional concern), has good reliability and validity[15].

Statistical analysis
SPSS13.0 software was used to calculate the mean and standard deviation. Differences between the 2 groups were compared using Student's *t*-test.

Results

The general information of subjects and their participation rate for the exercises
In all enrolled 110 subjects, 97 (88%) completed the exercises, and 13 participants were excluded because the frequency of participation was less than 80%. Intervention group consisted of 51 subjects and control group consisted of 46 subjects. The average age was 52.99 ± 6.15 years in the intervention group, in which 29 subjects received CAF regimen and 22 received CMF regimen. The average age was 52.20 ± 6.31 years in the control group, in which 26 subjects received CAF and 26 subjects received CMF. There were no significant differences in general information and the participation rates were found between the 2 groups ($P > 0.05$).

Comparison of physiological index of the patients before and after exercises
After the systematic exercise, the strength of the wrist flexor muscles and elbow flexor of the patients was stronger than that before the exercise in the intervention group ($P < 0.05$); maximum oxygen uptake and pulmonary capacity of the patients were significantly higher than those before exercise in the intervention group ($P < 0.05$); also the vital capacity in the intervention group was significantly higher than that in the control group after exercise ($P < 0.05$); bone density of the patients was lower than those before exercise in the control group ($P < 0.05$), and the difference in bone density in the intervention group before and after exercise was not significant ($P > 0.05$); BMI and WHR of the patients in the intervention group were decreased after exercise ($P < 0.05$), however, the differences in BMI and WHR in the control group before and after exercise were not significant ($P > 0.05$, Table 1).

Comparison of quality of life before and after exercise in the 2 groups
The differences in the general module and additional attention module of FACT-B between the 2 groups and within each group before and after exercise were not significant ($P > 0.05$, Table 2).

Discussion

Systematic exercise helps to promote functional recovery of limbs in patients with breast cancer
After breast surgery, because the operated limb was immobilized for long time, it may develop adhesions or contracture, leading to decreased shoulder range of

Table 1. Two groups were compared before and after exercise physiological indices ($\bar{x} \pm s$).

Time	Group	Cases	Limb muscle strength		Pulmonary function		Bone mineral density		Shape	
			Wrist turning (kg)	Elbow bending (kg)	Maximum oxygen uptake (L/min)	Pulmonary capacity (mL)	Spinal L2-L4 (g/cm²)	Femur (g/cm²)	BMI (kg/cm²)	WHR
Pre-exercise	Intervention	51	4.51 ± 2.19	4.93 ± 2.67	1.71 ± 0.31	2352.80 ± 609.38	1.08 ± 0.15	0.94 ± 0.10	26.01 ± 3.17	0.96 ± 0.05
	Control	46	5.42 ± 2.53	5.90 ± 3.05	1.78 ± 0.29	2372.70 ± 350.84	1.11 ± 0.17	0.96 ± 0.13	26.85 ± 2.79	0.96 ± 0.07
Post-exercise	Intervention	51	5.27 ± 2.35*	6.77 ± 3.00*	1.84 ± 0.37*	2500.30 ± 554.23*#	1.07 ± 0.15	0.94 ± 0.09	25.38 ± 3.21*	0.95 ± 0.06*
	Control	46	5.94 ± 2.67	7.67 ± 3.41*	1.80 ± 0.29	2340.50 ± 334.20	1.10 ± 0.18	0.95 ± 0.12*	26.69 ± 2.86	0.96 ± 0.08

* In the same group before and after exercise were significantly different between themselves, $P < 0.05$; # after exercise between the two groups was significantly different, $P < 0.05$.

Table 2. Comparison of the 2 groups in quality of life scores ($\bar{x} \pm s$).

Time	Group	Cases	Physical conditions	Social/ Family status	Emotional status	functional status	Additional concern
Pre-exercise	Intervention	51	22.86 ± 3.31	19.38 ± 7.10	19.71 ± 4.03	17.29 ± 6.51	21.05 ± 5.18
	Control	46	21.32 ± 4.10	17.74 ± 6.04	18.37 ± 5.12	19.32 ± 6.83	19.89 ± 6.65
Post-exercise	Intervention	51	23.86 ± 2.89	21.39 ± 3.99	20.90 ± 2.93	20.24 ± 5.30	23.01 ± 6.28
	Control	46	23.39 ± 3.87	19.89 ± 6.49	18.78 ± 5.33	20.00 ± 5.55	21.08 ± 7.81

motion. The limb may become disuse atrophy and decreased muscle strength and a series of complications. Thus these may affect the activities of their daily lives. It is essential for the patients to do limb exercise so as to promote rehabilitation early[16,17]. Effective muscle strength exercise can increase the number of capillary endothelial cells, and as a result, more nutrients can be absorbed in muscle tissue, thereby increasing the muscle strength. In addition, muscle strength exercise can improve muscle contraction and coordination, leading to an increased muscle strength[18].

In this study, patients in the intervention group practiced systematic exercise which included the aerobics and tai chi 1 to 2 years after breast cancer treatments, besides the original upper limb exercise. In this study, the aerobic training is considered to increase upper limb extremity movement, and tai chi exercise emphasis on the coordination of arm movements. The results showed that the ipsilateral elbow flexor strength after exercise was greater than that before exercise in the 2 groups, therefore, exercise with equipment and systematic exercise can improve the limb strength to some extent. The results is in accordance with the findings in the study led by Xu et al.[19] The wrist flexor strength of the patients in the intervention group was also stronger after exercise than that before exercise, indicating that the systematic exercise for the recovery of wrist flexor strength is better than the original exercise which included exercise with equipment and limb movements.

Systematic exercise can improve pulmonary function in patients with breast cancer after the treatments

Because chemotherapy drugs (such as cyclophosphamide, methotrexate) can cause different levels of lung parenchyma damage, and in breast cancer patients after receiving postoperative chemotherapy, the respiratory muscle relaxation, the elasticity and expansion of the lung may be decreased accordingly, thereby reducing ventilation function of the lung. Many studies have shown that appropriate aerobic exercise can reduce the adverse effects induced by chemotherapy on the cardiopulmonary function[20].

The results showed that the pulmonary function of the patients in the intervention group was significantly improved after the exercise, and the maximal oxygen uptake and lung capacity of the patients in the intervention group after exercise were higher than those of the patients in the control group, which suggest that systematic exercise can improve pulmonary function in patients with breast cancer after the treatments. The outcomes of the study are consistent with the findings in the research overseas[21].

The effects of systematic exercise on bone mineral density

Chemotherapy and endocrine treatment for breast cancer can cause ovarian failure, leading to decreased level of

estrogen. Reduced estrogen can reduce bone remodeling, leading to bone thinning and osteoporosis and even fracture. Relative studies have postulated that regular exercise can reduce bone loss and fracture rates caused by surgery, radiotherapy or chemotherapy in cancer treatment[22].

The mechanism of delayed bone loss by exercises may be related to the followings: Exercise could alter certain hormones or hormone-like substances related to bone metabolism toward a positive effect. Exercise can influence regulator factors of local bone metabolism, which affect the reconstruction of bone, so to increase or maintain bone. Exercise can promote blood circulation and increase blood flow of cortical bone, therefore, the calcium absorption is increased. The results in this study showed that the difference in bone mineral density of the patients in the intervention group before and after exercise was not significant. Bone mineral density of the patients in the control group was decreased after the exercise compared with that before exercise, but there was no significant difference in the intervention group between pre-exercise and pro-exercise, which suggests that exercises may delay bone mineral running off.

Some studies have shown that, as the time for bone reconstruction lasts for at least 4-6 months, and the exercise which lasts for 8-12 months can lightly increase bone mineral density. It takes more than 1 year for exercise intervention to increase physical bone mass[23]. In this study, the period of practicing the exercises in both groups was only 4 months, a relatively short period, therefore, the intervention exercises couldn't increase bone mineral density. However, the systematic exercise did slow down the decrease of bone mineral density. It is proposed that prolonged period of exercise is need. Relative studies are needed to further understand the impact of exercise on bone mineral density.

Systematic exercise can effectively reduce the patients' weight index and waist-to-hip ratio

Obesity is a common complication induced by breast cancer treatments, which is one obviously causative factors of breast cancer. It has been reported from many domestic researches that BMI (> 23.00) and WHR (> 0.82) are the risk factors for the women developing breast cancer[24-26]. After a 14.6-year tracing investigation, Whiteman[27] has found that breast cancer patients developing obesity (BMI ≥ 30.00) have a higher rate of the recurrence and death rate than those patients who have proper weights (BMI ≤ 22.99). As breast cancer patients are usually supplied with plentiful nutrition during the therapy, intake more than they need, furthermore, chemotherapy the patients received usually causes patients tired. Once the patient has developed the habit of lying or sitting, with less energy consumption, the superfluous energy changes to fat and gradually causes obesity. What is more, the female hormone can irritate the secretion of leptin which uses up the superfluous fat in the body[28]; however, the effect of female hormone for the post-operative breast cancer patients is obviously weak. And the female hormone secretion is inhibited because the patients usually receive endocrine therapy. The BMI and WHR of the breast cancer patients are easy to rise.

Taking exercise is a effective way to control body weight, the systematic exercise we are studying is a scientific exercise involving the whole body besides the involved limb functional exercise and consequently reduce the BMI and WHR for the breast cancer patients to some extend. And it is benefit for maintaining the body shape as well as reducing the risk of recurrence of cancer. It has been reported in the literature overseas that exercise intervention for a short time (8 to 12 weeks) has no obviously effect to improve the BMI of the breast cancer patients[29,30], and prolonging the exercise intervention suitably (12 month) can improve the body shape and ingredient of the breast cancer patients obviously[31].

In our study, both BMI and WHR of the patients in the intervention group are lower after 4 months' systematic exercise than those before the exercise, therefore, we can see one effect of the systematic exercise is to improve the body shape in a short time exercise for the breast cancer patients.

The effects of the exercises on patients' quality of life

Because of the change of body shape after operation, the side effects of the chemotherapy, as well as the financial burden, breast cancer patients may have negative feelings, such as tension, anxiety, depression, fear, and so on. What is more, for the reason that the function of the involved arm is limited, the quality of life of the patients can be influenced to some extend. It has been found[32] that taking exercise can transfer the attention, which can reduce the negative feeling of the patients; during the exercise, the component of endogenous opioid peptide in human body maintains a high level, which causes the feeling of happiness, therefore, exercise can reduce the extend of anxiety, depression and other kinds of negative feeling.

Thus, taking exercise can promote the health of the breast cancer patients in both physical and psychological aspects, resulting in an improved quality of life. It has been reported in some literature overseas that the rehabilitation exercise lasting for 2-6 month can improve the quality of life[11]. Our study showed that patients' quality of life in the 2 groups was improved, however, the difference in patients' quality of life was not statistically significant before and after the exercises, which is not consistent with the findings reported in the literature. Some studies have shown that breast cancer patients' quality of life can be influenced by many factors[33], so there may be no obvious improvements in quality of life by simply exercise.

In this study, we have set up a systematic exercise training program for one-year postoperative breast cancer patients. We have proved that this program is

better than original rehabilitation exercise in enhancing the muscle force of surgery-affected limb, increasing pulmonary capacity, reducing bone mineral loss, and in decreasing BMI and WHR. Therefore, we suggest popularizing this program in the breast cancer patients after adjuvant chemotherapy to restore their physical condition. On the basis of this study, we have learned that further research is needed to find how to well instruct the breast cancer patients with adjuvant chemotherapy to do scientific general movements to decrease their postoperative complications and improve their quality of life.

Conflict of interest statement

No potential conflicts of interest were disclosed.

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