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Original

Effectiveness of individualized physical rehabilitation programs for upper extremity disorders in women with post-mastectomy syndrome

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ABSTRACT

Objective: The aim of this study was to determine the effectiveness of individualized physical rehabilitation programs targeted at improving functional state of upper extremity in women with post-mastectomy syndrome.
Method: Eighty five women with late symptoms of post-mastectomy syndrome were enrolled in the study. The participants were randomly enrolled for the first individualized program (Main Group, n=45) and for the second individualized program (Comparison Group, n=40). The first program included aqua aerobics (aqua jogging, aqua building, aqua stretching), conditional swimming, and recreational aerobics; the second program included conditional swimming and Pilates exercises.
Results: It was found that most of the investigated anthropometry and goniometry parameters in both groups steadily improved during the year of rehabilitation. After 6 months of rehabilitation the average values of active range of flexion and abduction were statistically higher in women Main Group compared with Comparison Group by 10 degrees ($p<0.001$) and 6.43 degrees ($p<0.01$), respectively. The severity of lymphedema in the Main Group was significantly lower at the area of forearm by 0.39 cm ($p<0.05$) compared with Comparison Group.
Conclusions: Findings have suggested that developed individualized physical rehabilitation programs could be considered as effective methods for improvement of the shoulder range of motion and decrease breast cancer-related lymphedema in patients with post-mastectomy syndrome.
Keywords: Lymphedema, Range of motion, Breast cancer, Exercise.

Efectividad de los programas de rehabilitación física individualizados para los trastornos de las extremidades superiores en mujeres con síndrome post-mastectomía

RESUMEN

Objetivo: El objetivo de este estudio fue determinar la efectividad de los programas de rehabilitación física individualizados dirigidos a mejorar el estado funcional de la extremidad superior en mujeres con síndrome post-mastectomía.
Método: Ochenta y cinco mujeres con síntomas tardíos de síndrome post-mastectomía participaron en el estudio. Los participantes se inscribieron aleatoriamente para el primer programa individualizado (Grupo Principal, n = 45) y para el segundo programa orientado a la personalidad (Grupo de Comparación, n = 40). El primer programa incluyó ejercicios acuáticos (carrera, pesas y estiramientos), natación condicional y ejercicio aeróbico recreativo; el segundo programa incluyó natación condicional y ejercicios de Pilates.
Resultados: Se encontró que la mayoría de los parámetros de antropometría y goniometría investigados en ambos grupos mejoraron constantemente durante el año de rehabilitación. Después de 6 meses de rehabilitación, los valores promedio del rango activo de flexión y abducción fueron estadísticamente más altos en mujeres del Grupo Principal en comparación con las del Grupo de Comparación en 10 grados ($p<0.001$) y 6.43 grados ($p<0.01$), respectivamente. La gravedad del linfedema del Grupo Principal fue significativamente menor en el área del antebrazo en 0.39 cm ($p <0.05$) en comparación con la del Grupo de Comparación.
Conclusiones: Los hallazgos sufieren que los programas de rehabilitación física individualizados podrían considerarse como métodos efectivos para mejorar el rango de movimiento del hombro y disminuir el linfedema relacionado con el cáncer de mama en pacientes con síndrome postmastectomía.
Palabras clave: Linfedema, Rango de movimiento, Cáncer de mama, Ejercicio.

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Efetividade de programas de reabilitação física individualizados para distúrbios de extremidade superior em mulheres com síndrome pós-mastectomia

RESUMO

Objetivo: O objetivo deste estudo foi determinar a eficácia de programas de reabilitação física individualizada destinados a melhorar o estado funcional da extremidade superior em mulheres com síndrome pós-mastectomia.
Métodos: Oitenta e cinco mulheres com sintomas tardios da síndrome pós-mastectomia foram incluídas no estudo. As participantes foram aleatoriamente inscritas para o primeiro programa individualizado (Grupo Principal, n = 45) e para o segundo programa individualizado (Grupo de Comparação, n = 40). O primeiro programa incluiu hidroginástica (corridas, pesos e alongamentos), natação condicional e aeróbica recreativa; o segundo programa incluiu natação condicional e exercícios de Pilates.
Resultados: Verificou-se que a maioria dos parâmetros de antropometria e goniometria investigados em ambos os grupos melhorou constantemente durante o ano de reabilitação. Após 6 meses de reabilitação, os valores médios da amplitude ativa de flexão e abdução foram estatisticamente maiores nas mulheres do Grupo Principal comparados ao Grupo de Comparação em 10 graus ($p < 0.001$) e 6,43 graus ($p < 0.01$), respectivamente. A gravidade do linfedema no Grupo Principal foi significativamente menor na área do antebraço em 0,39 cm ($p < 0.05$) comparada ao Grupo de Comparação.
Conclusão: Os achados sugeriram que programas individualizados de reabilitação física poderiam ser considerados como métodos eficazes para melhorar a amplitude de movimento do ombro e diminuir o linfedema relacionado ao câncer de mama em pacientes com síndrome pós-mastectomia.
Palavras-chave: Linfedema, Amplitude de movimento, Câncer de Mama, Exercício.

Introduction

Breast cancer-related lymphedema and decrease range of motion in the shoulder joint are still the major long-term complications after surgical treatment and radiotherapy.[1,2] Numerous studies of patients with breast cancer indicate that intensity of lymphedema, impaired shoulder range of motion, and severity of clinical damage of the cervico-brachial plexus increase over time after surgery.[2,4]

Rehabilitation measures are considered as the basis for the treatment of lymphedema, and physical exercises are an integral part of such rehabilitation. In the absence of proper treatment, lymphedema provokes the emergence of secondary complications, such as adipositis, lymphangitis, axillary vein thrombosis, and even lymphosarcoma.[4-6]

Recent studies have shown the acute necessity to create and implement specialized measures to improve the function of the upper extremity, because limitation of shoulder joint mobility and lymphedema significantly affect the quality of life and create barriers to returning to active labor.[6-8]

The majority of women are treated with a wide variety of methods that have steadily improved their outcomes. Many reports showed the effectiveness of acupuncture,[9] lymphatic drainage,[10] Pilates-based exercises,[11-13] Yoga exercises,[14,15] Nordic Walking[16] for treatment and postoperative prevention breast cancer-related lymphedema, improvement quality of life of woman.

Considering the high frequency of lymphedema and contracture after breast cancer treatment it is necessary to provide management of women with post-mastectomy syndrome during the implementation of rehabilitation program. It is also necessary to take into account the fact that physical rehabilitation program should be individualized for all woman with post-mastectomy syndrome according to their preferences, degree of lymphedema, and physical activity level.

However, theoretical analysis of the available scientific publications suggests that the issues related to physical rehabilitation of the patients with post-mastectomy syndrome have not been completely solved. Consequently, the aim of this study was to determine the effectiveness of individualized physical rehabilitation programs targeted at improving functional state of upper extremity in women with post-mastectomy syndrome.

Methods

Sample

The study was designed as a randomized, prospective, controlled trial in accordance with the CONSORT guidelines. Eighty-seven women with late symptoms of post-mastectomy syndrome were randomly enrolled for the first individualized program (Main Group, MG, *n*=47) and for the second individualized program (Comparison Group, CG, *n=40*). Written informed consent was obtained from all the participants before investigation. All the patients were informed about the aim of the investigation. Patients were randomized into one of two groups (MG and CG) using sequentially numbered, opaque sealed envelopes. Medical information concerning the stage of disease, surgery, and adjuvant therapy was obtained from medical records.

Women had undergone surgical treatment and adjuvant radiation therapy for breast cancer. The average age of the patients was 58.89±1.53 years. The time after surgery was 6 months.

The research was approved by Ethical Committee of Khortytsia National Academy. The study was conducted in accordance with ethical principles stated in the Declaration of Helsinki.

The inclusion criteria were as follows: 50-60 years of age, recent history of modified radical mastectomy and adjuvant radiation therapy, normal body mass index, consent to participate in the study, breast cancer-related lymphedema, limitation of shoulder joint motion, and decreased muscle strength of the hand on the side of the surgery. The exclusion criteria were as follows: bilateral lymphedema, metastasis, body mass index exceeding 25 kg/m^2, primary lymphedema, pulmonary edema, chronic nonspecific lung disease, congestive heart failure, or any contraindications limiting activity. All the women who were selected for the research met the eligibility criteria.

Experimental design

The participants were enrolled for the first individualized program (main group, MG, n=47) and for the second individualized program (comparison group, CG, n=40). The first program included aqua aerobics (aqua jogging, aqua building, aqua stretching), conditional swimming, and recreational aerobics; the second program included conditional swimming and Pilates exercises. Both groups received 140 sessions of rehabilitation intervention during the year.

The choice of the exercises was based on preliminary examination of the range of motion, lymphedema and individual goals of the patient as well as the acceptability of the aquatic environment for exercise training of patients with post-mastectomy syndrome. The exercises, forms, load intensity and methods of physical rehabilitation were selected individually for each patient in the study groups.

Differentiation of exercises for women with different degrees of lymphedema consisted in dosage of exercises, the choice of the most optimal starting position and the application of special equipment (water dumbbells, noodles, fitball, bar bells, rubber tube). Patients who had I-II degrees of lymphedema, performed

special exercises from different initial positions: standing, lying on the back, lying on the side, sitting on the fitball. Women with III-rd degree of lymphedema performed the majority of exercises from lying initial positions without special equipment. For successfully overcoming lymphedema it is extremly necessary to perform exercises with the upper limb position above the level of heart to provide a lymph outflow. In addition, such special exercises were performed not only as an independent part, but also after each series of strength exercises to relieve stress by lifting the upper limb as high as possible with the implementation of light shaky movements.

Differentiated approach to low-impact and middle-impact aerobic exercises was provided in accord with the participant's health status. Exercise intensity for women ranged from 40% to 60% of heart rate reserve.

The circumference (cm) of both upper extremities were measured at the same symmetrical areas at the level of the upper third of the shoulder, forearm and under the thumb of the hand. After that, for detecting lymphedema it was calculated the difference in circumferences between the upper extremity on the side of surgery and side where the operation was not performed.

Measurement of active range of motion (degrees) was performed using a goniometer. Active movements were tested in the shoulder joint: flexion, extension, abduction, internal and external rotation. All measurements were evaluated three times: at the beginning, six, and twelve months after the intervention.

Statistical analysis

Analysis of lymphedema and range of motion were performed using Statistica for Windows (version 8.00). Results that were normally distributed, were analyzed by the use of t-test for significant differences between groups. Within-group comparisons were performed by means of the paired samples t-test. P values <0.05 were considered statistically significant.

Results

The study was conducted between September 2014 and November 2016. We screened 99 women for eligibility; 9 (9%) were not eligible, and 4 (4%) were not interested in participating. The primary reasons for ineligibility were diagnosis with Stage 3 breast cancer (n=4), less than 6 months or more than 12 months post treatment completion (n=3), and body mass index greater than 25 kg/m^2 (n=2). A CONSORT flow diagram is presented in Figure 1.

The conducted experiment showed a positive influence of the developed individualized physical rehabilitation programs on the improvement of functional state of upper extremity in women with post-mastectomy syndrome (Table 1). Obtained results suggest that active movements in patients of MG were improved statistically during the first and second half of the year, particularly range of flexion, which increased by 24.09° (p<0.001) and by 3.38° (p<0.01), respectively; extension increased by 3.22° (p<0.001) and by 3.89° (p<0.001); abduction increased by 18.56° (p<0.001) and by 3.98° (p<0.001); internal rotation increased by 4.45° (p<0.001) and by 5.73° (p<0.001); external rotation increased by 4.48° (p<0.001) and by 3.87° (p<0.001) respectively.

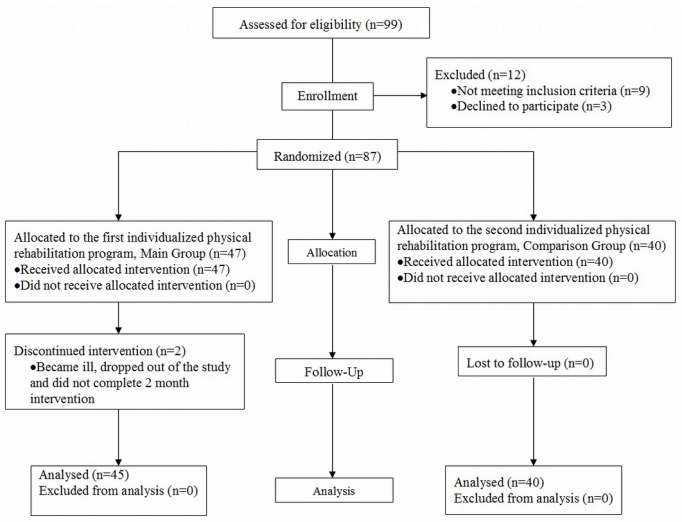

Figure 1. CONSORT flow diagram

As for women of CG (Table 1), during the first half of the year range of flexion increased by 14.92° (p<0.001), range of extension increased by 5.85° (p<0.001), range of abduction increased by 12.00° (p<0.001), range of internal rotation increased by 6.30° (p<0.001), range of external rotation increased by 3.55° (p<0.001); during the second half of the year, the above mentioned indicators increased by 3.78° (p<0.01), 3.30° (p<0.001), 6.02° (p<0.001), 3.25° (p<0.001) and 3.40° (p<0.001), respectively. Comparing the results of shoulder joint motions in half a year it was found that active range of flexion and abduction were statistically higher in women MG compared with CG by 10° (p<0.001) and 6.43° (p<0.01), respectively. It was found that implementation individualized program for the main group during the first six months (Table 2) helped to reduce lymphedema at the area of upper third of the shoulder by 0.98 cm (p<0.001), at the area of forearm lymphedema decreased by 0.96 cm (p<0.001), at the area of hand lymphedema decreased by 0.42 cm (p<0.05).

Comparison of the differences in the circumference of the upper limb between groups showed significantly better results in women MG compared with CG. The severity of lymphedema in the main group was significantly lower at the area of forearm by 0.39 cm (p<0.05).

Table 1. The evolution of active shoulder range of motion in patients of the Main Group and Comparison Group during the rehabilitation.

Indicator	Main Group (n=45)			Comparison Group (n=40)		
	Beginning	Six months	One year	Beginning	Six months	One year
Flexion	144.08±1.97	168.17±1.52***	171.55±1.12$^{••}$	143.25±2.10	158.17±1.58***	161.95±1.43$^{••}$
Extension	48.91±1.15	52.13±1.01***	56.02±0.72$^{•••}$	47.70±1.24	53.55±1.12***	56.85±0.95$^{•••}$
Abduction	144.77±1.82	163.33±1.26***	167.31±1.28$^{•••}$	144.90±1.37	156.90±1.41***	162.92±1.55$^{•••}$
Internal Rotation	55.28±1.13	59.73±1.06***	65.46±0.99$^{•••}$	53.20±1.51	59.50±1.26***	62.75±1.13$^{•••}$
External Rotation	71.80±1.36	76.28±1.18***	80.15±1.20$^{•••}$	71.10±1.11	74.65±1.02***	78.05±1.03$^{•••}$

Notes: Data are presented in dregrees (M±m); *** – p<0.001 compared with the initial data; •• – p<0.01, ••• – p<0.001 compared with the data for 6 months.

Table 2. The evolution of difference in the circumference of the upper limb in patients of the Main Group and Comparison Group during the rehabilitation.

Indicator	Main Group (n=45)			Comparison Group (n=40)		
	Beginning	Six months	One year	Beginning	Six months	One year
Upper third of the shoulder	2.42±0.19	1.44±0.13***	1.17±0.12***	2.05±0.19	1.67±0.15	1.37±0.15$^{••}$
Forearm	2.04±0.17	1.08±0.11***	1.02±0.11***	1.75±0.17	1.47±0.14	1.15±0.16$^{•}$
Hand	1.35±0.16	0.93±0.09*	0.88±0.09**	1.27±0.17	1.02±0.14	0.87±0.15

Notes: Data are presented in centimeters (M±m);* – p<0.05, ** – p<0.01, *** – p<0.001 compared with the initial data in patients of the main group; • – p<0.05, •• – p<0.01 compared with the initial data in patients of the comparison group.

Discussion

Results from this research indicate that developed individualized physical rehabilitation programs targeted at improving functional state of the upper extremity could produce a feasible therapeutic effect upon the patients with post-mastectomy syndrome.

A great deal of research[2-5] indicates that women, who undergoing breast surgery, axillary radiotherapy, chemotherapy are more likely to have higher risk of breast cancer-related lymphedema and impaired shoulder range of motion. The importance of the problem is underlined by the presence of numerous surgical methods[2] and conservative therapies[6,9,11,12] for overcoming upper extremity disorders in breast cancer survivors.

Despite the achieved progress in the treatment of breast cancer-related lymphedema, problem related to physical rehabilitation of the patients remains relevant.

The current study applied the low-impact and middle-impact water and land aerobic exercises according to the individual participants' health status in pool and gym. In accordance with the data obtained, conclusions could be drawn that patients of both groups improved significantly active shoulder range of flexion, extension, abduction, internal rotation, and external rotation.

A limitation of the study is that only our investigation was done on a limited number of patients and received results cannot be distributed to all breast cancer survivors.

Findings have suggested that developed individualized physical rehabilitation programs could be considered as effective methods for the range of motion improvement and decrease breast cancer-related lymphedema in patients with post-mastectomy syndrome.

Authotship. All the authors have intellectually contributed to the development of the study, assume responsibility for its content and also agree with the definitive version of the article. **Provenance and peer review.** Not commissioned; externally peer reviewed. **Ethical Responsabilities.** *Protection of individuals and animals:* The authors declare that the conducted procedures met the ethical standards of the responsible committee on human experimentation of the World Medical Association and the Declaration of Helsinki . *Confidentiality:* The authors are responsible for following the protocols established by their respective healthcare centers for accessing data from medical records for performing this type of publication in order to conduct research/dissemination for the community. *Privacy:* The authors declare no patient data appear in this article.

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