Synchronized pedalling with martial arts improves the women´s QoL with breast cancer

Abstract

Physical exercise improves the physical condition of women who have been operated from breast cancer. The objective of this study is to evaluate the effect of a new program that combines both aerobic and anaerobic exercise in women who have undergone breast cancer surgery. The sample consisted of 56 women who had previously gone through breast cancer surgery with axillary lymph node dissection and who had been treated with radiotherapy and/or chemotherapy. The programme lasted for 12 weeks. The patients were randomly assigned into two groups; a study group (28 patients) in which patients carried out a *synchronized pedalling with martial arts* routine of 2 sessions per week and a control group (22 patients) in which they went on with their previous treatment. A significant improvement was demonstrated in patients belonging to the study group, with an increase in muscle mass percentage, quadriceps and right hand strength, and ergometric values (maximum Oxygen consumption and max power -to-weight ratio) and a decrease in fat mass percentage. A controlled training system like *synchronized pedalling with martial arts* which combines aerobic and strength exercises is suitable for improving the physical condition of these patients.

Key words: Exercise program; Physical activity; Mastectomy; Axillary dissection; Chemotherapy; Lymphedema.

Introduction

Breast cancer is the most common cancer worldwide for females, presenting with a higher incidence than any other kind of cancer. In countries that have kept a record of breast cancer incidence, a progressive increase could be appreciated throughout the past decades with stabilization in the last decade, which is probably due to a more selective use of hormone replacement treatment [27].

Spain finds itself in an intermediate position, with an approximate incidence rate of 50 new cases per 100,000 persons-years [2]. Incidence is closely related to age, and the population groups who at a higher risk of developing breast cancer are those who find themselves in the fourth and fifth decades of life [19].

Its pathogenesis has been associated with genetic and environmental factors. Amongst the former, a number of genetic susceptibility genes have been identified (BRCA1, TP53). Some of the environmental factors which have been more strongly associated with this disease include hormone exposure, alcohol use and fat mass percentage [4].

Nowadays, breast cancer is the most common cause of cancer death, with around 375,000 deaths every year [8]. Even though the mortality rate is still very high, there has a decrease in the mortality rate in developed countries during the last 2 decades, especially in women who are over 50 years old. This is due to the new diagnostic techniques which lead to early diagnosis of the disease and to the new anticancer therapies [24]. This trend can be clearly seen in our country [13].

Breast cancer and its treatment (surgery, radiotherapy, chemotherapy) are responsible for a high morbidity which includes psychological and physiological disturbances. This leads to a deterioration in the patients' quality of life.Nowadays, there is evidence that proves that physical exercise is a protective factor against the development of breast cancer, in pre- and post-menopausal women, in white and black patients and in all segments of the body mass index. High intensity exercise has been linked to a greater efficacy [22,10]. Many clinical essays performed with breast cancer patients have proved that physical exercise, also reduces the morbidity which is associated to cancer and its treatment, with an improvement in cardiopulmonary performance, body composition, fatigue perception and depression scales [1].

The type and intensity of exercise which should be prescribed in order to reduce the morbidity of breast cancer is still in debate. Initially, only aerobic exercise was prescribed and a significant improvement in maximum oxygen consumption with a subjective improvement in quality of life perception was seen [25, 23]. However, it has now been demonstrated that strength and resistance exercises, with or without aerobic exercise, lead to a significant improvement in body composition, muscle strength and quality of life perception [5,26,18].

Upper limb malfunction is one of the most frequent complications that can be seen after surgery and/or radiotherapy in these patients. Several exercise programmes have proved an improvement in upper limbs anthropometrics, flexibility and strength [21].

In this clinical essay, the objective is to find out whether a physical exercise programme, which combines aerobic exercises with physical strength, can improve the malfunction of the affected upper limb as well as the aerobic performance of patients who have been diagnosed of breast cancer and who have been surgically intervened with posterior radiotherapy and/or chemotherapy.

Materials and Methods

Clinical Study design

We carried out a monocentric, randomized open-label controlled trial. In order to be included in our study, the patients had to meet all the inclusion criteria (table 1) and not meet any exclusion criteria (table 2). The trial protocol was approved by the *Portal de Ética de la Investigación Biomédica de Andalucía (PEIBA) and* has followed the ethical standards of the journal IJSM. [11]

Table 1: Inclusion criteria

Table 2: Exclusion criteria

Participants:

All the participants included were women who had been previously diagnosed with breast cancer, and who had undergone mastectomy or tumorectomy and lymphadenectomy. They had posteriously been treated with chemotherapy and/or radiotherapy with or without hormone treatment. Surgery had been performed at least 6 months before they were recruited for our trial. In all cases, chemotherapy and radiotherapy had already concluded when they were enlisted. 18 out of 26 of cases were still receiving hormone therapy. All cases were considered disease-free at the moment of randomization. The patients were member of the *Asociación Malagueña de Cáncer de Mama (ASAMMA)* and of the *Asociación Esperanza*, which are both included in the *Federación Española de Cáncer de Mama (FECMA)*. They were informed of the characteristics of the study before they joined it and they all voluntarily signed the informed consent document.

Intervention:

Patients were randomly split into two groups. The study group underwent a *synchronized pedalling with martial arts (SPMA)* supervised training programme during 12 weeks with two 60 minutes' sessions every week [15]. The control group continued with their previous treatment, which did not include supervised physical exercise.

SPMA is a training method for both the upper and lower body in an indoor cycling bike, with a strong foundation on martial arts. This method works with the synchronization of upper and lower limbs throughout pedalling. During the exercise, moderate pedalling together with lumbopelvic immobilization lead to the fulfilment of upper body workout with natural body movements which are based on fitness and martial arts exercises. Also, elements like balls, 0.5 and 1kg weights, bars and low, moderate and high resistance bands are used throughout the exercise.

SPMA is a cardiovascular aerobic training method in which the trunk remains in an upright position during the time spent performing exercises on the bike. The shoulders are kept back granting a better alignment with the spine, while constant pedalling takes place. The upper body is toned with martial arts and fitness exercises, enhanced with the use of exercise tools and diaphragmatic breathing. The core muscles and scapular girdle are also toned through lumbopelvic stabilization and diaphragmatic breathing (figures 1 and 2). That way of training is integrated in a program named *Sincrobox*^{R}.

Figure 1: direct attack shoulder-weight *Figure 2: shoulder defence*

Test performed

A number of demographic variables, including age and number of offspring were registered. The severity of breast cancer was established according to the treatment received. The use of chemotherapy as adjuvant therapy was considered an indicator of disease severity.

In order to study the effect of the intervention in both groups, physical and functional exams were performed by the Malaga Sports Medicine Unit at the beginning and at the end of the study. This examination included general anthropometric data, flexibility test, dynamometry of both arms and legs, and maximal ergometry.

Anthropometry: this concept refers to the mensuration of the size and proportions of the human body. Anthropometric equations give us a precise evaluation of body composition, of its morphology and its proportionality in relation to physical performance, nutrition and growth. The protocol proposed by the Spanish Group of Cineantropometry was followed [6].

Flexibility was evaluated using the *sit and reach test*. This test measures the flexibility of the lower back and hamstring muscles at the point of maximum trunk flexion with extended knees [17].

Dynamometry was used in order to measure the isometric strength of both arms and legs. 2 Isometric contraction test were performed in order to evaluate:

- Maximum hand grip strength using a hydraulic dynamometer (*ripATakeiPhysicalFitness* Test [20].
- Isometric extension strength on both legs using a model T.K.K 50 02 dynamometer from TakeiScientific instruments. 3 measurements were taken in each test, and the best result for each was recorded [3].

Ergometry was performed using an Ergoline 900 cycloergometer. A test of maximal power test was carried out, increasing the workload by 25 watts every 2 minutes until the patients could not continue. Max power - to-weight ratio(watts/kg), indirect maximum oxygen consumption (VO2 max), METS consumption and percentage of maximum heart rate were calculated [12].

Statistics

The patients' data were registered using Microsoft Excel v2010. Quantitative variables were expressed with their mean and standard deviation. Qualitative variables were expressed through their percentage.

Variables between the two groups were compared and a p value of 0.05 was used as the cut-off for significance.

An analysis of variance of partially repeated measurement of each analysed variable was carried out. The factors used were: group (1: experimental and 2: control) and measurement (1: pretest and 2: postest)

The descriptive statistics and the main effects of each analysed variable are presented in table 4.

Results

56 patients were selected. They were randomly allocated into two groups, the control group and the study group. Two cases were excluded from the study group. One of them was excluded because he was diagnosed with heart disease contraindicating physical exercise after the randomisation process. The other was excluded because she presented a relapse of her disease before the protocol was completed.

Two cases were discarded from the control group two. One of them because of her heart disease and the other because she was following a previous training method. 2 cases did not show up for their review and therefore did not complete the analysis period (figure 3). 56 patients were included for the pre-test analysis and 50 were included for the post-test analysis (those who completed the study).

Figure 3: Participants' selection

Both groups were similar in their demographics, anthropometric, functional evaluation and disease severity at the moment of randomization. The only exception was their weight, which was greater in the study group. This, however, had no influence on their BMI (table 3).

Table 3. Demographics, anthropometrics, functional evaluation and pre-test severity

After the study period was completed, the evolution of anthropometric, functionality (limbs strength and flexibility) and ergometric variables in both groups were compared (table 4). A significant decrease in fat mass percentage and a significant increase in muscle mass percentage, as well as in quadriceps and right hand strength was appreciated. There was also a significant improvement in ergometric values (watts/kg, maxVO2, and wattage). Some improvement could be seen on the left hand too but it did not reach statistical significance.

Table 4. Pre and post-test anthropometric, functional and ergometric variables.

Discussion

The main result of this trial is to prove the improving of anthropometric and functional variables from patients previously diagnosed of breast cancer by a training system known as SPMA

Breast cancer has a very high incidence among females, being responsible for great morbimortality in every society where a register is kept. Physical exercise has clearly demonstrated its efficacy in preventing the development this condition [10] and in reducing the morbidity associated with this disease and its treatment [23, 21].

It´s proposed the use of a new form of physical exercise, SPMA. This includes the combination of aerobic exercises of the upper and lower body with strength, inspired on martial arts, exercises in the upper limbs.

All the patients included in the study group showed excellent tolerance to this exercise, and no adverse effects were described.

Anthropometrics in both groups were very similar at the moment of their randomization. They only differed on their weight, which was significantly heavier in the study group. This difference did not affect the BMI, which showed no statistically significant difference. This suggests the difference in weight, even though statistically significant, was not clinically relevant. In any case, the heavier weight was present in the study group, and this could have only overshadowed the beneficial results that were sought with the use of SPMA

The patient losses that were present on both groups (2 in the study group and 4 in the control group) were considered assumable and inherent to this kind of study. The higher number of losses in the control group was considered to be a consequence of the smaller adherence of patients belonging to this group, since they did not have to perform supervised exercise two days a week.

This study is planned to be part of a trial that will include a greater number of participants in the future.

The findings of this study demonstrate the use of SPMA, leads to a beneficial effect in anthropometrics, with a significant reduction in global weight and fat percentage. The decrease in BMI did not achieve statistical significance in the study group even though there was a global and fat mass contraction. This could be explained by the significant increase in muscle mass that could be appreciated in the SPMA group when compared to the control group. A significant reduction in body fat percentage was achieved. This could also be a protection factor in future breast cancer development [4].

The results in dynamometric tests prove that supervised training with SPMA, increases isometric extension strength in both legs as well as grip strength in both hands. This correlates with the finding of similar previous studies [9].

Recent results have proved as well that this exercise technique improved shoulder mobility [7]. An improvement in strength and mobility of upper limbs could be a significant step in the treatment of the residual lymphedema that many of these patients present as a result from their cancer and its treatment [16].

Our results show a significant increase in maximum Oxygen consumption (VO2max), in max power -to-weight ratio (watts/kg) in the study group, proving that SPMA triggers an improvement in cardiovascular

response to physical exercise.

In short, our study is the first of this kind in demonstrating an increase in strength and mobility of upper and lower limbs as well as in muscular power capacity and maximum oxygen use in patients with a previous history of breast cancer and surgical treatment including lymphadenectomy, after a protocoled SPMA exercise. However, new studies with greater numbers of participants and direct measurement of oxygen use are needed in the future in order to confirm these results.

Conclusions

SPMA is a new exercise method that combines aerobic exercise and muscle strength. An excellent tolerance profile was appreciated among patients participating in our study.

Patients included in the study group showed an improvement in the anthropometric variables studied, as well as in muscle function of the analyzed muscle groups. An increase in indirect measurements of maximum oxygen use was appreciated. Therefore, there was a significant improvement in the functional status of the patients included.

New studies with larger number of patients are needed in the future in order to confirm the beneficial findings of SPMA *that* were revealed in our study

Conflict of interests

One of the authors, Clara Santiago-Sanchez has the intellectual property of a form of Sychronised pedalling with martial arts named Sincrobox[R.] This project has not received any type of external financing

References

1 Battaglini CL, Mills RC, Phillips BL, Lee JT, Story CE, Nascimento MG, Hackney AC. Twenty-five years of research on the effects of exercise training in breast cancer survivors: A systematic review of the literature. World Journal of Clinical Oncology 2014;5:177-190

2 Bray F, McCarron P, Parkin DM. The changing global patterns of female breast cáncer incidence and mortality. Breast Cancer Res 2004; 6: 229-239

3 Carrasco-Poyatos M, Martínez- González-Moro I, Vaquero- Abellán M. Cambios en la fuerza isométrica de mujeres postmenopáusicas tras el ejercicio acuático. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte 2013; vol. 13 (49) pp. 73-86. Http://cdeporte.rediris.es/revista/revista49/artcambios347.htm

4 Clemons M, Goss P. Estrogen and the risk of Breast Cancer. New Eng J of Med 2001; 344:276-285

5 Courneya KS, Segal RJ, Mackey JR, Gelmon K, Reid RD, Friedenreich CM, Ladha AB, Proulx C, Vallance JK, Lane K, Yasui Y, McKenzie DC. Effects of aerobic and resistance exercise in breast cancer patients receiving adjuvant chemotherapy: a multicenter, randoized trial. J Clin Oncol 2007; 25: 4396-4404

6 Esparza F. Manual de cineantropometría. Pamplona: Femede;1993

7 Espejo-Reina A, Becerra E, Candel R, Cerezo MV, Martin R, Meza H, Santiago C, Navarro-Sanz A. Sincrobox como método para mejorar la capacidad funcional del hombro de pacientes intervenidas de cáncer de mama. XII congreso Bienal SETRADE (Sociedad Española de Traumatología del Deporte). Mayo 2017. ISBN: 978-84-617-7677-1

8 Ferlay J, Bray F, Pisani P, Parkin DM: GLOBOCAN 2000 2000: Cancer Incidence, Mortality and prevalence Worlwide. IARC Cancer Base No 5. Lyon, France: IARC; 2001

9 Fernandez- Ortega A, De Paz-Fernandez JA. Efectos de un programa combinado de ejercicios de fuerza y aeróbicos de alta intensidad en pacientes supervivientes al cáncer de mama: estudio piloto. Apunts Med Esport. 2015;51 (189):3-12.

10 Friedenreich CM, Cust AE. Physical activity and breast cancer risk: impact of timing, type and dose of activity and population subgroup effects. Br J Sport Med 2008;42:636-647

11 Harriss DJ, Macsween A, Atkinson, G. Standards for Ethics in Sport and Exercise Science Research: 2018 Update. Int J Sports Med 2017; 38: 1126-1131

12 http://www.saludmed.com/LabFisio/PDF/LAB_F11-Sostrand_YMCA.pdf

13 http://www-depdb.iarc.fr/who/menu.htm

14 JCC Cancer Staging Manual, Sixth Edition (2002) published by Springer-Verlag New York, www.springer-ny.com

15 Manual de instrucciones Sincrobox Nivel I. Nº Expediente: MA 515-14 Nº Registro 201499901356483. Clara Eugenia Santiago Sánchez. www.sincrobox.es

16 Martínez-González E, Galán-Buznego M. Estudio de la influencia del ejercicio con levantamiento de pesos en pacientes con disección axilar. Rehabilitación (Madr). 2015;49(3):162-171

17 Mayorga-Vega D, Merino-Marban R, Viciana J. Criterion-Related Validity of Sit-and-Reach Tests for Estimating Hamstring and Lumbar Extensibility: a Meta-Analysis. Journal of sports science and medicine 2014 Jan 20;13(1):1-14. eCollection 2014

18 Musanti R. A study of exercise modality and physical self-esteem in breast cancer survivors. Med Sci Sports Exerc 2012;44;352-361
19 Parkin DM, Whelan SL, Ferlay J, Raymond L, Young J. Cancer Incidence in Five Continents, Vol VIII. Lyon: IARC Press; 1997
20 Ramirez-Balas A, Olcina-Camacho G, Robles-Gil MC, Maynar-Mariño M. Efectos de un programa de actividad física sobre la condición física en mujeres menopaúsicas. Apunts E.Fisica y Deportes 2012;109. 25-31
21 Sato F, Arinaga I, Sato N, Ishida T, Ohuchi N. The perioperative educational program for improving upper arm dysfunction in patients with breast cancer at 1-year follow-up: a prospective, controlled trial. J Exp Med 2016; 238:229-236.
22 Schmidt ME, Steinforf K, Mutschelknauss E, Slanger T, Kropp S, Obi N, Flesch-Janys D, Chang-Claude J. Physical activity and postmenopausal breast cáncer: effect modification by breast cáncer subtypes and effective periods in life. Cancer epidemiol Biomarkers & Prevention 2008; 17: 3402-3410
23 Schwartz AL. Fatigue mediates the effects of exercise on quality of life. Qual Life res 1999;8:529-538
24 Siegel R, DeSantis C, Virgo K, Stein K, Mariotto A, Smith T, Cooper D, Gansler T, Lerro C, Fedewa S, Lin C, Lech C, Cannady RS, Cho H, Scoppa S, Hachey M, Kirch R, Jemal A, Ward E. Cancer treatment and survivorship statistics, 2012. CA Cancer J Clin 2012; 62: 220-241
25 Winningham ML, Mac Vicar MG, Bondoc M, Anderson JL, Minton JP. Effect of aerobic exercise on body weight and composition in patients with breast cancer on adjuvant chemotherapy. Oncol Nurs Forum 1989;16: 683-689
26 Winters-Stone KM, Dobek J, Nail L, Bennett JA, Leo MC, Naik A, Schwartz A. Strength training stops bone loss and mulds muscle in postmenopausal breast cancer survivors: a randomized, controlled trial. Breast Cancer Res Treat 2011;127: 447-456
27 World Health Organization. International agency for research on cancer. 2013: 1-3. Available from: URL: http://www.iarc.fr/en/media-centre/pr/2013/pdfs/pr223_-.pdf

Table 1: Inclusion criteria

- Diagnosis of Stage I-IIIC unilateral breast cancer with axillary dissection of => 2 lymph nodes [14]
- Age 25-65 years.
- Adjuvant treatment with chemotherapy or radiotherapy must have been completed > 4 weeks before the beginning of the study. (current hormone therapy is not an exclusion criteria)
- Signature of Informed Consent (annex 2)

Table 2: Exclusion criteria

- Stage IV breast cancer at the time of diagnosis [14]
- BMI>40
- Concomitant disease which could compromise the patients' performance
- Prior structured training pattern at the time of randomization.

Table 3. Demographics, anthropometrics, functional evaluation and pre-test severity

Variables	**SPMA**	**Control**	**p**
Age	51.47 (+/-5.97)	47.9(+/-7.81)	.08
Number of children	2.06 (+/-1.03)	17 (77.3%)	.28
Patients with previous Chemotherapy	20 (71.4%)	17 (77.3%)	.64
Months since breast cancer diagnosis	85.36 (+/-56.69)	60.10 (+/-41.34)	.28
Height (cm)	161.19 (+/-4.99)	160.03 (+/-5.43)	.43
Weight (Kg)	72.5 (+/-14.45)	63.91 (+/- 10.34)	.04 *
BMI	27.94 (+/-6.21)	25.09 (+/-4.73)	.08
% Fat	31.11 (+/-5.39)	26.99 (+/-6.01)	.23
% Muscle	29.20 (+/-4.43)	29.07 (+/-4.57)	.09
% Bone	17.05 (+/-2.10)	18.11 (+/-2.23)	.45
Right hand dynamometry	22.45(+/-5.60)	22.78(+/-4.84)	.87
Left hand dynamometry	21.48(+/-5.16)	22.48(+/-4.79)	.49
Quadricepts dinamometry	55.75(+/-21.11)	49.93(+/-17.39)	.30
Flexibility	13.31(+/-6.62)	10.53(+/-6.03)	.09
watts/kg	1.16(+/-0.45)	1.38(+/-0.32)	.09
max $V0_2$ (ml/kg, mn)	17.22(+/-5.63)	19.61(+/-4.79)	.15

Max VO2: maximum Oxygen consumption. watts/kg: max power -to-weight ratio. SPMA: synchronized pedalling with martial arts

Table 4. Pre and post-test anthropometric, functional and ergometric variables.

Variables	SPMA PRE-Test	Control PRE- Test	SPMA POST- Test	Control POST- Test	F	η^2	p
Weight (Kg)	**72.50(+/-14.65)**	**63.91(+/-10.34)**	**71.76(+/-13.65)**	**63.61 (+/-9.88)**	**5.75**	**.11**	**.02 (*)**
BMI	279.4(+/-6.21)	25.09(+/-4.73)	27.47(+/-5.69)	24.97(+/- 4.90)	2.59	.05	0.12
% Fat	31,11(+/-5.39)	26.99(+/-6.01)	29.94(+/-5.59)	26.60 (+/-6.46)	4.27	.10	0.04 (*)
% Muscle	29.20(+/-4.43)	29.07(+/-4.57)	31.74 (+/-2.71)	29.06 (+/-4.99)	4.32	.09	0.04 (*)
% Bone	17.05(+/-2.10)	18.11(+/-2.23)	19.96(+/-1.97)	17.34 (+/-3,.6)	4.19	0,8	0.05 (*)
Right hand dynamometry	22.45(+/-5.60)	22.78(+/-4.84)	25 (+/- 385)	23.19 (+/-5.24)	4.18	.08	0.05 (*)
Left hand dynamometry	21.48(+/-5.16)	22.48(+/-4.79)	23,36 (+/-2.81)	22.69 (+/-3.48)	3.24	.07	0.08
Quadriceps dinamometry	55.75(+/21.11)	49.93(+/-17.39)	71.57(+/-16.07)	58.68 (+/-16.60)	21.12	.31	< 0.01 (*)
Flexibility	13.31(+/-6.62)	10.53(+/-6.03)	17.56(+/8.05)	12.93(+/- 7.21)	13.37	.25	0.001 (*)
watts/kg	1.16(+/-0.45)	1.38(+/-0.32)	1.45(+/-0.41)	1.45 (+/-0.34)	47.77	.50	< 0.001 (*)
máx power (watios)	83.86(+/-26.68)	88.33(+/-22.77)	98.96(+/-21.14)	89.43 (+/-19.31)	15.29	.25	< 0.001 (*)
Max. V02 ml/kg/ mn	17.22 (+/-5.63)	19.61(+/-4.79)	20.71(+/-5.31)	20.95 (+/-4.35)	47	.49	< 0.001 (*)

Max VO2: maximum Oxygen consumption. watts/kg: max power -to-weight ratio. SPMA: synchronized pedalling with martial arts

(*) p ≤ 0.05

Figure 3: Participants' selection