

Effect of a novel exercise therapy on the postoperative function and quality of life in a patient with breast cancer: A case study

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Abstract:

Purpose: Breast cancer (BC) treatments, including chemotherapy or radiotherapy, are frequently accompanied by numerous adverse effects. Although exercise programs provide considerable benefits, most patients with BC fail to meet minimum physical activity recommendations owing to substantial pain and fatigue. This study aimed to (1) develop an early exercise intervention to facilitate readaptation and restore mobility in the operated arm and (2) develop a combined aerobic and resistance training program incorporating the velocity loss approach to prescribe resistance training, thus minimizing fatigue and improving adherence. **Methods:** The 60-year-old female patient began the exercise intervention approximately six weeks after surgery. During the first part of the intervention, she also received five sessions of adjuvant radiotherapy. All variables were measured before the operation, before the first and the second parts of the intervention, and at the end of the intervention. **Results:** The exercise program was well tolerated. The fat-free mass percentage, fat mass percentage, six glenohumeral ranges of motion, aerobic capacity and strength of the upper limbs recovered and even improved from the preoperative initial values after the intervention. The health-related quality of life (HRQoL) increased, and fatigue decreased. **Conclusions:** The two principal novelties of this case study are the inclusion of an early exercise intervention for readaptation and recovery of the mobility of the operated arm and the use of the velocity loss approach to design the resistance training. Given the magnitude of the improvements observed, this initial case study should be used to design future clinical trials to confirm our findings.

Keywords: Breast cancer; fatigue, quality of life, rehabilitation, exercise training.

Introduction

Breast cancer (BC) is the most prevalent cancer in women, representing the 11.7% of all cancer diagnoses worldwide (Sung et al., 2020). Over 2.3 million new cases were diagnosed in 2020 (Sung et al., 2020; Arnold et al., 2022). This number is increasing due partly to increased life expectancy, and this number is predicted to reach over 3 million new cases by 2040 (Arnold et al., 2022). Regarding the number of deaths, although the mortality rate has declined in recent decades due to advances in early diagnoses, medical technology, and treatments (Giaquinto et al., 2022), around 685,000 patients with BC died in 2020 (Arnold et al., 2022), and the rising incidence of BC may attenuate future reductions (Giaquinto et al., 2022).

Various strategies have been developed for the treatment of BC, including surgery, chemotherapy, radiotherapy and immunotherapy, but those therapies are usually associated with numerous adverse effects during and after treatment (Pereira et al., 2023). Those side effects include impairments of physical functioning, reduced cardiorespiratory fitness, and reduced muscle strength, which may significantly impact patients' health-related quality of life (HRQoL) and overall well-being. Some of the treatment-related sequelae may even persist long after the end of treatment (Wang et al., 2020).

Therefore, new non-pharmacologic strategies to increase patients' HRQoL have been developed, including interventions such as diet supplementation (Luca et al., 2023) or physical exercise (Aune et al., 2022). Most exercise programs are considered beneficial during or after treatment for patients with breast and other cancers, alleviating their fatigue symptoms and improving their physical function and HRQoL (Liu et al., 2019). Indeed, high physical activity levels seem to be related to a better HRQoL and reduced mortality (Palesh et al., 2018). Physical activity has also been suggested to decrease the chance of recurrence (Holmes et al., 2005).

Regarding the patients diagnosed with any type of cancer, at least 150 min per week of physical exercise is usually recommended to improve their HRQoL (De Groef et al., 2018; Tumenbayeva et al., 2023). However, most patients with BC do not meet this minimum due to excessive pain and fatigue during and after cancer treatment, which tends to make them tend to rest and reduce their physical activity (De Groef et al., 2018). Although physical activity participation in this population is perceived as positive to help address the impacts of cancer and potentially reduce breast cancer recurrence, different factors contribute to inadequate physical activity, and it is necessary to support physical activity participation in this population (Inam et al., 2023).

Consistent with the American College of Sports Medicine guidelines, most recent systematic reviews support the idea that combining aerobic and resistance exercises is the most effective in improving HRQoL (Dong et al, 2024; Han et al., 2024). However, morbidity of the shoulder after BC is a typical occurrence, and reduced muscle activity associated with shoulder pain and disability has been found following treatment for BC, which is the reason why specific shoulder mobility exercises should also be included (Davies et al., 2020).

Regarding resistance training, it has often been suggested that performing repetitions to failure is the only method to maximize muscle mass and strength, but the findings of more recent studies do not support this belief, indicating that significant strength gains can be achieved without reaching muscle failure (Sampson & Groeller, 2016), which has led to a new method for resistance training based on the repetition velocity loss within a set. This new approach overcomes the necessity of measuring the level of effort in each session (González-Badillo et al., 2022). In this line, Pareja-Blanco et al. (2017) compared the effects of two resistance training programs based on the repetition velocity loss, on structural and functional adaptations, concluding that a velocity loss of 20% resulted in similar squat strength gains and greater improvements in countermovement jump than a velocity loss of 40%. However, this velocity loss of only 20% led to performing 40% fewer repetitions, which is relevant to patients with BC to avoid excessive fatigue and, thus, improve adherence to the resistance training program.

Because it is crucial to create individualized exercise programs to embrace the diversity of patients with BC, the case study approach is very useful for assessing the impact of a specific physical activity program in a real-life context. Therefore, this study had two aims: (1) To develop a first exercise intervention part for readaptation and recovery of the mobility of the right arm of a patient with BC after surgery, and (2) to develop an individualized combined aerobic and resistance training program to increase functionality and HRQoL, using the velocity loss approach to design the resistance training part to minimize the patient's fatigue.

Material & methods

Patient

The patient was a 60-year-old woman (height = 159 cm; weight = 45.6 kg) who presented no contraindications to training and a healthy lifestyle. She had never followed a daily aerobic or resistance training routine. She provided written informed consent to participate in this study, according to the Declaration of Helsinki. She was diagnosed with infiltrating carcinoma of the right breast, grade 2, Luminal B (RE+; RP+; HER2-), and less than 25% of cell proliferation de proliferation. There was no apparent lymph node involvement. The patient's cancer treatment involved surgery followed by adjuvant radiotherapy. The surgery was performed on September 21, 2024, and consisted of a conservative surgery (lumpectomy) with the extirpation of three sentinel nodes. Due to no complications, the patient had to stay in the hospital for only two days, but to avoid movements of the affected arm, she was recommended to rest for another 15 days. However, some days after the first cure, there was an accumulation of lymphatic fluid in the zone, and the scar was not correctly closed, so the incision was resutured, and she was told to stay in bed for another 15 days.

The client underwent external beam radiation therapy pointed to the BC tumor bed, starting on January 9, 2024. It involved 5 fractions administered daily using a 6-MV photon dose per beam, for a total exposure of 26 Gy (5.2 Gy per treatment). Once radiotherapy ended, she was prescribed tamoxifen for at least two years, and alendronic acid, calcium, and vitamin D for life to mitigate calcium deficiencies and to control osteoporosis. The patient experienced the followings side-effects after the treatment: skin changes, irritation of the affected zone, nausea, and fatigue.

Exercise Intervention

The exercise intervention consisted of two parts: the first part consisted of readaptation and recovery of the mobility of her right arm after the surgery, and the second part aimed to improve cardiorespiratory fitness, control body weight and body composition, and increase skeletal muscle mass, thus increasing functionality and HRQoL. Both parts were guided and supervised by a Physical Education and Sport graduate, who was advised and permanently in contact with the patient's oncologist.

The first part of the exercise intervention started on December 1, 2024, and lasted 10 weeks. It consisted of three sessions of general mobility exercises interspersed with three sessions of specific shoulder joint mobility exercises (flexion, extension, abduction, adduction, internal rotation, and external rotation) per week. The second part of the intervention started on February 16, 2025, and lasted eight weeks. It involved three sessions of moderate resistance training and three sessions of aerobic training per week on alternate days. Each resistance session started with a 10-min warm-up involving general flexibility, joint mobility, and muscle activation exercises, followed by a 40-min main exercise session targeting the major muscle groups of the upper body (chest press and rowing exercises) complemented with more specific exercises of the upper body (triceps extension, bicep curls, and shoulder presses) and exercises of the lower body (squats and glute bridges). The patient performed two sets of each exercise at 60% of one repetition maximum (1RM). As mentioned above, to avoid excessive fatigue, exercise velocity was controlled and volume was determined based on a velocity loss of 20%, which was sufficient to generate functional adaptations with fewer repetitions (Pareja-Blanco et al., 2017). A rest period of 90–120 s was established between exercises. The session ended with a 10-min cool-down consisting of stretching exercises of all muscle groups.

The aerobic sessions included a 5-min warm-up, a 40-min walk, and a 5-min cooldown. The ratings of perceived exertion (RPE) were measured with the modified Borg scale (Borg, 1982). The warm-up consisted of leg stretches followed by walking at an RPE of 1–4. The cooldown consisted of 5 min of slow walking. During the 40-min walk, training intensity was set to 65%–80% of maximum heart rate, maintaining the RPE between 3 and 5 points. Thus, if the RPE was > 5 at the end of a session, the training intensity was reduced in the following session. In contrast, if the RPE was < 3 at the end of a session, the training intensity was increased in the following session.

Outcome Measures

All the outcome measures were assessed about one week before the operation (time point T1), one week before starting the first part of the intervention (time point T2), one week before starting the second part of the intervention (time point T3), and one week after the second part of the intervention (time point T4).

Body composition was measured using an octopolar bioimpedance body composition analyzer (Smart Body Fat Scale Pro, FIAR, China). The patient was measured while standing erect and holding handgrips to make contact with the four metallic hand pads. Measurements were performed according to the manufacturer's guidelines and body weight, fat mass percentage, and fat free mass percentage were determined. Body height was measured to the nearest 0.1 cm with a stadiometer (SECA, Germany) and body mass index (BMI) was calculated ($BMI = \text{body weight/body height}^2$). Biceps, abdominal, and subscapular skinfolds were measured to the nearest 0.5 mm using a calliper (Accufitness TK, Spain). Waist, relaxed arm, and thigh circumferences were measured to the nearest 0.1 cm using an anthropometric tape (Accufitness TK, Spain). All anthropometric measurements were performed according to the International Society for Advancement in Kinanthropometry (ISAK) (Stewart et al., 2011) by the same accredited anthropometrist. The following glenohumeral joint ranges of motions (ROMs) were determined to the nearest 1° using a digital goniometer (GemRed, China): flexion, extension, abduction, adduction, internal rotation, and external rotation. Upper body strength was evaluated with bench press and handgrip strength. An incremental test to estimate 1RM was performed using a linear encoder to the nearest 0.1 kg (ADR Encoder, Spain), and the handgrip strength of both hands was measured using a handgrip dynamometer to the nearest 0.1 kg (Camry, China). Aerobic capacity was evaluated using the six-min walking test (6MWT). The Functional Assessment of Cancer Therapy - Breast (FACT-B) test was performed to evaluate the HRQoL of the patient. The FACT-B is a 37-item questionnaire used to evaluate five domains of HRQoL in breast cancer patients: physical well-being, social/family well-being, emotional well-being, functional well-being as well as a breast-cancer subscale (FACIT.org, 2013). The Revised Piper Fatigue Scale (R-PFS) was used to measure fatigue during various activities of daily living. The R-PFS is a 22-item self-report scale that measures overall fatigue on a scale of 1–10. It covers 4 subscales: behavioral/severity (6 items), affective meaning (5 items), sensory (5 items), and cognitive/mood (6 items) (Piper et al., 1998). Overall total fatigue was calculated as the average of the four-dimension scores. R-PSF has shown to be a reliable and valid instrument for breast cancer patients (Mock et al., 2001).

Results

The exercise program was generally well tolerated. The patient attended the 87% of the sessions in the first part of the intervention. She missed some sessions because of the side effects of the radiotherapy. In the second part of the intervention, she attended 100% of the resistance training sessions and 85% of the aerobic sessions. She missed some aerobic training sessions due to medical appointments and her return to work in the final weeks of the intervention.

Body Composition

The patient's physical characteristics at each time point are presented in Table 1. Her waist, relaxed arm, and thigh circumferences did not change meaningfully throughout the study period. However, her skinfold thicknesses gradually decreased after the surgery, reaching a minimum value after the second part of the intervention. Her fat mass percentage increased after the surgery but returned to its baseline value after the intervention. Her fat-free mass percentage decreased after the surgery but returned to its baseline value at the end of the intervention.

Table 1. The patient's physical characteristics in the four time-points measured.

Variables	T1	T2	T3	T4	Variables	T1	T2	T3	T4
BASIC VARIABLES					CIRCUMFERENCES				
Body mass (kg)	45.4	46	47	46	Waist (cm)	62	62	62	61
BMI (kg/m²)	17.9	18.2	18.1	18.2	Thigh (cm)	45	46	49	50
SKINFOLDS					Arm (cm)	25	25	27	28
Biceps (mm)	20	18	15	13	BIOIMPEDANCE				
Abdominal (mm)	15	13	10	10	FM (%)	14	17	17	14
Subscapular (mm)	18	16	10	11	FFM (%)	86	83	83	86

Note. T1: time-point 1; T2: time-point 2; T3: time-point 3; T4: time-point 4; BMI: body mass index; FM: fat mass; FFM: fat-free mass.

Gleno-humeral Joint ROMS

The six different glenohumeral joint ROMs of both upper limbs are presented in Table 2. Because the patient was right-handed, the ROMs of the right shoulder joint were, overall, higher than those of the left shoulder before surgery. However, after the surgery, the ROMs of the right shoulder joint decreased considerably but gradually increased during the first and the second parts of the intervention, finally reaching their baseline values. Due to the intervention, the ROMs of the left shoulder joint also increased, reaching similar values to those of the right shoulder joint at the end of the intervention.

Table 2. Gleno-humeral joint ranges of motion.

Variables	T1	T2	T3	T4	T1	T2	T3	T4
	RIGHT SHOULDER				LEFT SHOULDER			
Flexion (°)	152	136	148	153	141	140	153	155
Extension (°)	50	33	48	56	42	45	57	58
Abduction (°)	158	95	148	155	152	157	158	157
Adduction (°)	45	30	43	44	43	44	45	46
Internal rotation (°)	73	62	75	75	70	70	72	76
External rotation (°)	89	80	86	90	90	90	95	95

Note. T1: time-point 1; T2: time-point 2; T3: time-point 3; T4: time-point 4.

Aerobic Capacity and Strength

The results obtained for 6MWT, 1RM bench press, and handgrip strength of both hands are presented in Table 3. The 1RM bench press and 6MWT were not measured at the T2 time point, because the patient still had to rest. The handgrip strength of the right hand decreased drastically after surgery but approached the baseline value after the intervention. The 1RM bench press and 6MWT values decreased after surgery but recovered and even surpassed the baseline values after the intervention.

Table 3. Results for 6MWT and handgrip strength.

Variables	T1	T2	T3	T4	Variables	T1	T2	T3	T4
Right handgrip strength (kg)	35	19.8	26.7	31	Bench press 1 RM (kg)	22	-	18	24,8
Left handgrip strength (kg)	31.2	31	31.2	33.5	6MWT (m)	630	-	600	660

Note. 6MWT: six-minutes walking test; RM: repetition maximum; T1: time-point 1; T2: time-point 2; T3: time-point 3; T4: time-point 4.

HRQoL and Fatigue

The scores of the five domains and the total score of the BC specific HRQoL, measured with the FACT-B are presented in Table 4. Except for the emotional well-being domain, the HRQoL scores decreased after surgery but gradually recovered and even surpassed their baseline values. The total fatigue score and the scores of the four dimensions of the R-PFS are also presented in Table 4. Similar values were observed baseline and after surgery, but they decreased after the first part of the intervention and decreased further after the second part of the intervention.

Table 4. HRQoL (FACT-B) and fatigue (R-PSF) scores.

Variables	T1	T2	T3	T4	Variables	T1	T2	T3	T4
FACT-B					R-PFS				
Physical well-being	25	15	20	26	Behavioral/severity	6.2	5.9	4.0	3.2
Social/Family well-being	23	22	23	25	Affective meaning	5.4	5.2	3.3	2.6
Emotional well-being	4	12	19	23	Sensory	6.5	6.5	3.2	2.5
Functional well-being	14	17	20	32	Cognitive/mood	5.8	5.7	2.9	2.3
Additional concerns	22	20	28	31					
TOTAL FACT-B	90	86	110	137	TOTAL FATIGUE	6.0	5.8	3.4	2.7

Note. T1: time-point 1; T2: time-point 2; T3: time-point 3; T4: time-point 4; HRQoL: health-related quality of life; FACT-B: Functional Assessment of Cancer Therapy-Breast; R-PFS: revised Piper Fatigue Scale.

Discussion

Our study aimed to develop a postoperative exercise intervention for a patient with BC, which consisted of two parts: the first part, performed shortly after surgery, aimed to support readaptation and recovery of the mobility of the right arm after surgery, and the second part, performed after the first part, consisted of aerobic and strength exercises, to increase functionality and HRQoL. Two principal novelties of our study were the inclusion of some weeks dedicated to readaptation and recovery of the mobility of the right arm and the use of the velocity loss approach to design the resistance training part.

Approximately six months after the surgery, the patient completely recovered her baseline fat-free mass and fat mass percentages, recovered the mobility of her right arm, and increased the mobility of her left arm. She also exhibited increased upper limb strength and aerobic capacity, thereby improving in the five measured domains of HRQoL and decreasing fatigue. These results confirm that our novel therapy may offer profound improvements in functionality and HRQoL to patients with BC.

Body composition

Previous research has demonstrated the positive effects of a combined aerobic and strength training program on body composition in BC patients. De Luca et al. (2016) reported a decrease in fat-mass percentage after 24 weeks of a combined exercise program compared to a sedentary control group. Henao et al. (2024) performed a systematic review and concluded that a supervised combined aerobic and strength training program has positive effects on body composition in BC survivors. Our results confirm those findings because after surgery, the patient's fat mass percentage increased and fat-free mass percentage decreased, but both returned to initial values at the end of the exercise program.

Gleno-humeral joint ROMs

Ostos-Díaz et al. (2020) conducted an early rehabilitation program in women diagnosed with BC after sentinel lymph node biopsy, and, after 4–6 sessions of functional and scar recovery exercises, the global shoulder ROM had increased, and shoulder pain and disability had decreased. The authors also concluded that using an early rehabilitation program as a supportive intervention after sentinel lymph node biopsy was feasible and safe. Following their initiative, the first part of our exercise program aimed to support the patient in recovering the mobility of her right arm after the surgery. The surgery resulted in a great loss of mobility of all the glenohumeral joint ROMs of her right arm. However, they recovered to baseline values after the intervention, preparing the patient to better face the second part of our intervention. As mentioned above, surgery involved only the right breast, but this part of the intervention also showed important improvements in all glenohumeral joint ROMs of the left arm.

Aerobic Capacity and Strength

Many studies have analyzed the effects of combined aerobic and resistance or strength training in BC survivors in the last two decades, most of them obtaining positive results. Herrero et al. (2006) concluded that 8 weeks of combined cardiorespiratory and resistance training supervised by a fitness professional improved the overall physical fitness of BC survivors. De Luca et al. (2016) obtained that supervised concurrent aerobic and strength training produced significant improvements in maximal oxygen uptake and strength of the upper and lower limbs in BC patients. Even an 8-week telerehabilitation program including aerobic and resistance exercises produced greater improvements in handgrip, abdominal, back, and lower limb strength compared to a control group that received usual care. Our results are in line with those because upper body strength and aerobic capacity markedly decreased after surgery but returned to initial values at the end of the intervention.

HRQoL and Fatigue

As mentioned above, recent systematic reviews and meta-analyses have concluded that combining aerobic and resistance exercises is the best way of improving HRQoL in BC survivors (Dong et al., 2024; Han et al., 2024). Our total FACT-B score was over 50% higher than the initial value, confirming the good results obtained with a multimodal exercise program. Dong et al. (2024) also observed that none of the five different exercise modalities improved patient's fatigue significantly compared to usual care. However, our multimodal exercise program, with the resistance training part controlled with the velocity loss to reduce the patient's fatigue, did effectively lower it.

Recommended protocol

A systematic review of the current recommendations for physical activity in oncology patients concluded that all the guidelines included in the review recommended aerobic and resistance training as types of activities (Avancini et al., 2025). Regarding aerobic intensity and volume, most of them suggested a generic 150 min/week of moderate-intensity activity but current evidence lacks an established protocol regarding the intensity, duration, and progression of the resistance exercises for oncology patients (Avancini et al., 2025). Given that it is advisable to avoid excessive fatigue in patients with BC and that a high number of repetitions is not required to elicit physiological adaptations (Pareja-Blanco et al., 2017), a training intensity between 50% and 70%, using a velocity loss of 20% to control volume, may be a good alternative. In addition, due to the diversity of patients with BC, it would be interesting to use a pain scale to avoid excessively aggressive exercise programs.

Conclusions

Side effects associated with chemotherapy and radiotherapy may decrease the HRQoL of patients with BC. Participation in fitness programs can alleviate fatigue symptoms and improve physical functioning, cardiorespiratory fitness, and muscle strength, thus increasing patients' HRQoL. However, aggressive exercise programs can cause excessive fatigue and should be avoided. To our knowledge, this is the first case study to analyze the effects of specific mobility exercises in combination with aerobic and resistance training in BC patients with the novelty of using the velocity loss approach to design the resistance training in order to minimize the fatigue of the patient with BC and increase adherence. Given the magnitude of improvements observed, this initial case study should be used to design future clinical trials.

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