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The impact of exercise therapy on upper extremity strength in a breast cancer survivor diagnosed with breast cancer-related lymphedema: A single-case study

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THE IMPACT OF EXERCISE THERAPY ON UPPER EXTREMITY STRENGTH IN A BREAST CANCER SURVIVOR DIAGNOSED WITH BREAST CANCER-RELATED LYMPHEDEMA: A SINGLE-CASE STUDY

by

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Submitted in Partial Fulfillment of the Requirements for the
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MAJOR PROFESSOR: Dr. Philip Anton

Breast cancer-related lymphedema (BCRL) is one of the complications resulting from treatment, particularly surgical removal of lymph nodes. It is defined as arm edema in breast cancer patients caused by interruption of flow in the axillary lymphatic system from surgery or radiation therapy, which results in the accumulation of fluid in the subcutaneous tissue of the arm, with a decrease in tissue distensibility around the joints and an increased weight of the extremity.

There are a number of therapies for the management of BCRL. Most common among them is decongestive lymphatic therapy, which includes exercise therapy. Exercise and movement plans are designed to strengthen and stimulate the muscles involved in lymph drainage.

This paper discusses the case of a woman diagnosed with breast cancer in whom lymphedema occurred after a mastectomy. The patient had 28, 12-week sessions of exercise therapy over nearly 11 years. The exercise therapy consisted of resistance and balance exercise targeting all major muscle groups including the shoulders, biceps and triceps, as well as aerobic and flexibility training.

Throughout participation in the structure exercise program, it was noted that exercise therapy did not have any adverse reaction on the symptoms of BCRL. Exercise therapy appeared to be safe and successful at improving strength in the upper extremity, without exacerbating the

symptoms of lymphedema. In fact, there were signs that exercise therapy reduced the occurrence of lymphedema.

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DEDICATION

This research paper is especially dedicated to the memory of my grandparents, Bertha L. Ward, John D. Matich, and Arliss C. Matich who set strong examples of hard work and perseverance and inspired me to choose a career in health promotion. I would also like to dedicate this paper to my grandfather Edgar L. Ward, Sr. who continuously reminds me that I am strong, intelligent and a leader. Lastly, I would like to dedicate this paper to my parents who have encouraged me to follow my dreams and supported me physically and emotionally all along the way. I would like to extend special thanks to my siblings for making me smile, being good listeners and providing great advice.

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INTRODUCTION

Breast cancer-related lymphedema (BCRL) is an incurable condition in which fluid and protein accumulate in the extravascular interstitial spaces. This malady most often occurs after treatment for breast cancer, particularly when lymph nodes are surgically removed. BCRL is associated with edema in the breast, axilla, arm, and/or hand; tissue fibrosis; pitting; hemosiderin staining; and heaviness/discomfort in the affected limb(s). Depending on the method of measurement, threshold of diagnosis, length of follow-up, and study population, the incidence of BCRL ranges from 9.1% to 39% (Zhang, 2020). Rates tend to be higher in patients receiving chemotherapy, radiation, axillary lymph node dissection (ALND), those with more advanced disease stage, and those with higher BMI (Nguyen, T. T., 2017). Survivors of breast cancer suffer from a perpetual risk of BCRL occurrence, with an average onset time of 14.4 months after treatment (DiSipio, T).

BCRL results in a number of physical and psychological sequelae. BCRL severely affects the quality of life of patients due to lifestyle and occupational alterations, changes in functional status, as well as changes in psychosocial and economic aspects. If the physiological effects of lymphedema (e.g., swelling, pain, etc.) can be managed, quality of life can typically be maintained and possibly improved.

The primary role of the lymphatic system during exercise is to assist in the regulation of tissue volume and pressure by carrying fluid and plasma proteins that have leaked into the interstitial space from surrounding tissues back to the cardiovascular system. Exercise was once believed to be a factor in the development of BCRL, as it was thought that the damage to the axillary lymphatics from breast-cancer treatment resulted in a primary obstruction to lymph flow.

However, the exact etiology and pathophysiology of BCRL appears to be multi-factorial and not as simple as a "stop-cock" effect. Furthermore, recent studies have shown that participating in vigorous, upper-body exercise is not related to an increase in arm volume, which would indicate the development of BCRL. It is still not known, though, how long-term exercise affects lymphatic system function in breast-cancer survivors with and without BCRL (Lane, 2005).

In this report, we present the case of a breast cancer patient following diagnosis and mastectomy, whose symptoms of lymphedema were managed in part by exercise therapy. The results indicate that exercise does not have a systematic negative effect on BCRL and, on the contrary, can potentially improve subjective and objective parameters in BCRL patients, with dynamic, moderate, and high-frequency exercise appearing to provide the most positive effects.

Case report

We examined a 52-year-old female patient in menarche who was diagnosed with Stage 0 ductal carcinoma in the left breast. The patient received surgery to remove the left breast in 2010. The right breast was also removed at that time as a preventive measure. She did not undergo chemotherapy or radiotherapy treatment. She had no complaints of edema or swelling in her left or right arm before the breast cancer surgery; however, post-mastectomy, the patient developed mild BCRL in the left and right arm and hand. The patient reported that having BCRL "very much" interfered with her ability to lift or carry heavy objects (e.g., a filled bucket or shopping bags), participate in hobbies or leisure activities, and to do usual household activities. Having BCRL interfered with her ability to perform tasks with the affected limb(s) "quite a bit". Since her diagnosis, the patient received physical or massage therapy and wears compression garments on her right and left arms and hands to relieve symptoms of BCRL. Compression garments are worn to reduce the interstitial pressure of the extremity with the

pressure they apply and reduce capillary filtration and lymph production. Regular use of compression garments is very important during the treatment and recovery process. In addition to BCRL, the patient also experienced arthritis pain in the knees, occasional lower back pain, anxiety or nervousness, and trouble falling and staying asleep. To the best of her knowledge, the patient has been cancer free since 2010.

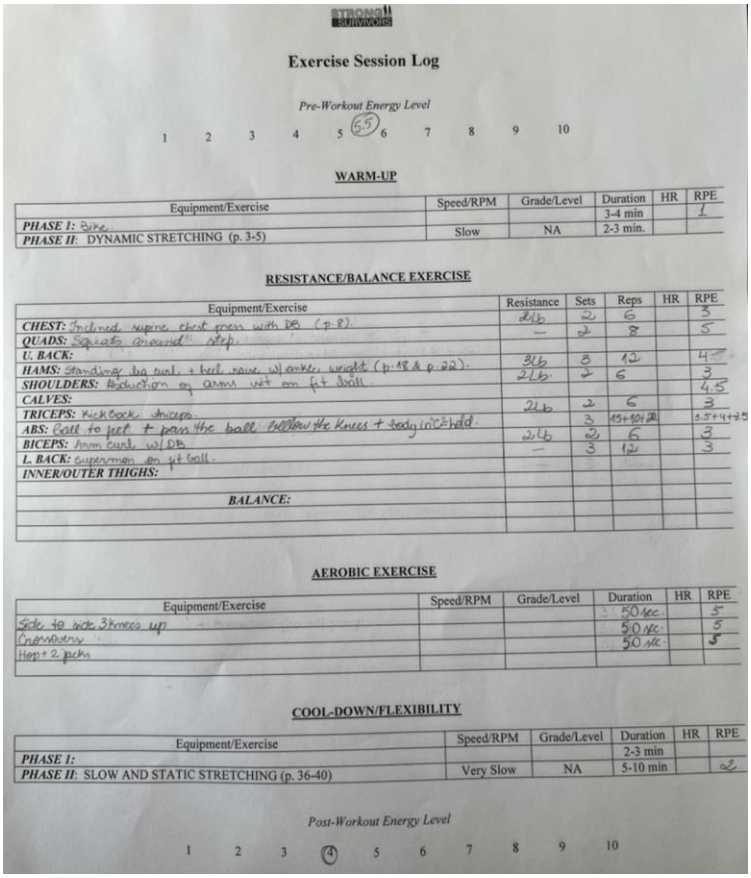
The patient initially enrolled in the Strong Survivors program at Southern Illinois University Carbondale (SIUC) in January 2011. Strong Survivors is a free, 12-week program, provided in conjunction with SIUC's Exercise Science Program to help cancer survivors and caregivers throughout the cancer continuum of treatment/recovery develop a safe/effective exercise routine and make informed, proactive choices about nutrition. Exercise included low to moderate intensity resistance, balance, flexibility, and aerobic training.

Upon initial evaluation, the patient completed an informed consent approved by the SIUC Human Subjects Committee. In order to evaluate her medical/fitness history, the patient completed a pre-assessment diet and activity log, medical history questionnaire, a cancer treatment questionnaire, a nutritional & demographics questionnaire, and an exercise history and potential contradictions questionnaire. Psychosocial health was evaluated using the CHAMPS Activity Questionnaire for Adults, the Berlin Social Support Scale, the Exercise Regulations Questionnaire (BREQ-2), the Profile of Mood States Short Form Fatigue Subscale (F_POMS-sf), and the Ferrans and Powers Quality of Life Scale (Cancer Version).

Functional activity testing was performed intermittently over an 11-year span and included the following tests: Bruce treadmill protocol, lift and carry, one foot stand, sit to stand, and stair climb and descent. The Bruce protocol test is commonly used to help identify a person's level of aerobic endurance. It does this by evaluating the subject's heart rate response to

treadmill exercise of increasing intensity. The lift and carry test is used to assess upper extremity strength and was measured in terms of the time it took to complete 10 repetitions (we focused on this test particularly in the analysis of her progress due to the involvement of the upper extremities). The single leg balance test is used to assess static postural balance control. The sit to stand test is used to assess an individual's leg strength and endurance by having them stand up from a sitting position repeatedly 10 times. The stair climb and decent test is used to assess functional strength, balance and agility through ascending and descending a set number of steps. The QuickDASH outcome measure was used to assess physical function and symptoms in people with disabilities of the upper limb.

The patient enrolled in a total of 28, 12-week Strong Survivors sessions over the course of nearly 11 years. The patient attended an average of two sessions each week during each 12-week session. During each 12-week Strong Survivor session, patient-specific exercise programs were developed which took into account the patient’s goals, physical or health-related restrictions or limitations, current level of activity, and how much time the patient was willing and/or able to commit to an exercise program. The personal exercise therapy program developed for the patient consisted of aerobic fitness, strength training, core exercises, balance training, and flexibility and stretching. Specific shoulder, triceps and biceps exercises performed include overhead dumbbell raise, kickbacks, overhead extension, arm curls, and hammer curls. An illustration of an actual exercise session log for the patient appears in Figure 1.



STRONG II SURVIVORS

Exercise Session Log

Pre-Workout Energy Level

1 2 3 4 5 (5.5) 6 7 8 9 10

WARM-UP

Equipment/Exercise	Speed/RPM	Grade/Level	Duration	HR	RPE
PHASE I: Bike.			3-4 min		1
PHASE II: DYNAMIC STRETCHING (p. 3-5)	Slow	NA	2-3 min.		

RESISTANCE/BALANCE EXERCISE

Equipment/Exercise	Resistance	Sets	Reps	HR	RPE
CHEST: Inclined, supine, chest press with DB (p. 8).	2lb	2	6		3
QUADS: Squats forward step.	—	2	8		5
U. BACK:					
HAMS: Standing leg curl, + heel raise, w/ankle weight (p. 18 & p. 22).	3lb	3	12		4
SHOULDERS: Abduction of arms wit on fit ball	2lb	2	6		3
CALVES:					4.5
TRICEPS: Kickback, tricep	2lb	2	6		3
ABS: Roll to feet + pass the ball Rollow the knees + body in c hold.		3	15+10+12		5.5+4+5
BICEPS: Arm curl, w/DB	2lb	2	6		3
L. BACK: Superman on fit ball.	—	3	12		3
INNER/OUTER THIGHS:					
BALANCE:					

AEROBIC EXERCISE

Equipment/Exercise	Speed/RPM	Grade/Level	Duration	HR	RPE
Side to side 3 knees up			50 sec		5
Cha cha step			50 sec		5
Hop + 2 jacks			50 sec		5

COOL-DOWN/FLEXIBILITY

Equipment/Exercise	Speed/RPM	Grade/Level	Duration	HR	RPE
PHASE I:			2-3 min		
PHASE II: SLOW AND STATIC STRETCHING (p. 36-40)	Very Slow	NA	5-10 min		2

Post-Workout Energy Level

1 2 3 (4) 5 6 7 8 9 10

Figure 1 – Exercise Session Log

According to the patient's initial exercise history and potential contradictions questionnaire, the patient reported reduced upper body strength and ongoing pain on her left side post-mastectomy surgery. The patient also indicated that her current level of aerobic fitness was 'average', and her current level of resistance activity was 'low'. The patient reported she had performed "a lot" of upper body exercise prior to the mastectomy procedure; however, post-mastectomy, she has done "very little". She assessed her frequency and intensity of upper body resistance activities for the arms in the last 3-4 months at one day each week with moderate intensity. According to the results of functional activity testing, the patient completed the lift and carry test in 92 seconds (Table 1). At the conclusion of the first 12-week exercise therapy session, the patient was reassessed and completed the lift and carry test in 57 seconds.

Table 1 – Lift and Carry Results

Date of Assessment	Time to Complete 10 Repetitions (Minutes/Seconds)
February 2011	1:32
May 2011	0:57
January 2012	1:02
April 2012	0:58
November 2012	0:49
September 2015	0:55
April 2016	0:51
March 2022	0:55

A second exercise history and potential contradictions questionnaire was completed 12 months after the initial questionnaire, after having completed three 12-week exercise therapy session. At that time, the patient indicated that her current level of aerobic fitness was 'high', and her current level of resistance activity was 'average'. She assessed her frequency and intensity of upper body resistance activities for the arms in the last 3-4 months at two days each week with moderate intensity. According to the results of functional activity testing, the patient completed the lift and carry test in 62 seconds. At the conclusion of the first 12-week exercise therapy session, the patient was reassessed and completed the lift and carry test in 58 seconds (Table 1).

The patient completed a third and final exercise history and potential contradictions questionnaire 11 years after the initial questionnaire, after having completed 27, 12-week exercise therapy sessions. At that time, the patient indicated that her current level of aerobic fitness was 'high', and her current level of resistance activity was 'average'. She assessed her frequency and intensity of upper body resistance activities for the arms in the last 3-4 months at one day each week with moderate intensity. According to the results of the final functional activity, the patient completed the lift and carry test in 55 seconds (Table 1).

The QuickDASH questionnaire was administered after the patient completed 28 12-week exercise therapy sessions. The patient was asked to complete two questionnaires – one in which the patient was asked to recall their experiences pre-exercise therapy, and another for which the patient was asked to recall their experiences in the past week. The patient demonstrated improved ability to open a tight or new jar, do heavy household chores, carry a shopping bag or briefcase, wash her back, and use a knife to cut food between the period before enrollment in Strong Survivors and after 28, 12-week exercise therapy sessions over 11 years (Table 2). Additionally, there was evidence of diminished pain in the arm and hand (Table 2).

Table 2 – QuickDASH Questionnaire Results

Activity	**Pre-Exercise Therapy**	**Post-Exercise Therapy**
Open a tight or new jar.	Severe difficulty	Moderate difficulty
Do heavy household chores (e.g., wash walls, floors).	Unable	Moderate difficulty
Carry a shopping bag or briefcase.	Severe difficulty	Moderate difficulty
Wash your back.	Mild difficulty	No difficulty
Use a knife to cut food.	Moderate difficulty	No difficulty
Recreational activities in which you take some forceor impact through your arm, shoulder or hand	Unable	Moderate difficulty
To what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbors or groups?	Moderately	Not at all
Were you limited in yourwork or other regular daily activities as a resultof your arm, shoulder or hand problem?	Moderately limited	Not limited at all
Arm, shoulder or hand pain.	Moderate	None
Tingling (pins and needles) in your arm,shoulder or hand.	Moderate	None
How much difficulty have you had sleeping because of the pain in your arm,shoulder or hand?	No difficulty	No difficulty

In addition to receiving exercise therapy through the Strong Survivors program, the patient reported having participated in other non-supervised aerobic and resistance activities. On one occasion, the patient injured herself while performing aerobic exercise.

CHAPTER 2

DISCUSSION

Research outcomes support a shift in thinking about the implementation of aerobic and resistance exercise therapy for the management of BCRL. The more traditional theory suggests that the use of aerobic and resistance exercise therapy for breast cancer survivors diagnosed with BCRL should be limited due to concerns with safety and worsening symptoms. However, there is very positive evidence to suggest that exercise therapy is a good treatment option for lymphedema management in circumstances where patients are not prohibited from exercise. The results of this single case study support the argument that resistance exercises under supervision of a professional can reduce physical limitation and pain. The implementation of an aerobic and resistance exercise program can also increase arm strength and endurance when conducted post-surgical intervention to treat BCRL.

The patient demonstrated improved performance on the lift and carry test between the initial and final assessments, having reduced the time it took to complete 10 repetitions by 37 seconds (Table 1). After one 12-week exercise therapy session, the patient was able to reduce the time it took to complete 10 repetitions in the lift and carry test and maintained that level of performance after 11 years. This suggests that the patient exhibited increased strength in the upper extremities over time, despite the natural progression of the aging process. The patient's performance on the lift and carry test was consistent after 28, 12-week Strong Survivors exercise therapy sessions, spanning over 11 years, which suggests that there are positive long-term effects of exercise therapy when exercise is consistent.

The results of the QuickDASH Questionnaire suggest that the patient demonstrated improved strength in the upper extremities; however, it is not clear whether exercise alone, or

exercise in combination with compression stockings and garments resulted in improved strength/flexibility to perform the various activities included in the survey. Also observed was diminished pain in the arm and hand which also could have played an indirect role in the patient's ability to perform the activities more easily.

The patient injured herself during unsupervised aerobic activity, therefore it is important for a trained professional to design an exercise therapy plan that is in line with the person's ability, condition, co-morbidities, and medications.

No negative implication of supervised exercise therapy were observed. The patient demonstrated improved strength in the upper extremities, and diminished pain which were her stated fitness goals when she first joined the Strong Survivors program. While we did not measure the impact of the other interventions on strength, we believe there is clear evidence that exercise therapy contributed to the improved strength in the upper extremities; therefore, exercise should be included as part of an overall treatment program for BCRL.

CHAPTER 3

LIMITATIONS

This case report presents promising results. Our patient did not have any adverse reaction to the exercise therapy and the exercise therapy appeared to be safe and successful. However, it is necessary to conduct randomized controlled trials with objective measurements to confirm obtained data on a larger group of patients, inclusion/exclusion protocol, randomization, follow-up and statistical analysis. In the future, we will try to conduct the study as a trial among patients divided into a few groups. For example, to present exercise therapy as a monotherapy (compared to manual lymphatic drainage, compression therapy and others). Particularly because the type, order, timeframe, and frequency in which other interventions were carried out was not measured over time, it is difficult to draw firm conclusions about the effect of exercise therapy specifically on muscular strength in the upper extremities among patients diagnosed with BCRL.

Functional activity testing was the only quantitative tool used to assess the effects of exercise therapy on upper extremity strength. There are a number of other tests that can be used to assess upper extremity strength. In the future, we will incorporate other measures to assess upper extremity strength. This will help to validate results.

The QuickDASH questionnaire was administered at the conclusion of the 12-week intervention to measure the patient's ability to complete tasks, absorb forces, and severity of symptoms, pre- and post-therapy. In the future we would like to present survey questions to study participants prior to the intervention to facilitate better recall. Further, we would like to expand our research and analyze more aspects like fluid reduction, pain relief, mental health, and quality of life after exercise therapy, too.

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