Exercise for Women With or at Risk for Breast Cancer–Related Lymphedema

Breast cancer accounts for approximately one third of all cancers diagnosed in American women. In 2005, it was estimated that 211,240 women would be diagnosed with invasive breast cancer in the United States and 58,490 would be diagnosed with in situ breast cancer.[1] Although advancements in technology have led to early detection and a higher survival rate,[2] approximately 40,410 US women were expected to die from this disease in 2005.[1] Many women experience secondary complications of the disease and its treatments, including decreased quality of life (QOL), weight gain, sleep disturbances, poor body image, fatigue,[3] increased risk for osteoporosis, cardiovascular disease, premature menopause, and lymphedema.[4]

Breast cancer is commonly treated by surgery, chemotherapy, or radiation. Axillary dissection or radiation can result in lymphedema due to obstruction, trauma, and inflammation of the lymphatic system.[5] *Lymphedema* has been defined as an abnormal accumulation of protein-rich fluid,[4,6] edema, and chronic inflammation[5,7] and can elicit pain, tightness, and heaviness in the upper extremity (UE), as well as lead to recurrent skin infections.[8]

Lymphedema is classified into 3 stages based on severity. Stage I lymphedema is spontaneously reversible[9] and typically involves pitting edema, an increase in UE girth, and heaviness.[8] Stage II is marked by a spongy consistency of the tissue without signs of pitting edema. Tissue fibrosis causes limbs to harden and increase in size. Stage III, lymphostatic elephantiasis, is the most advanced stage but is rarely seen following breast cancer treatment.[9]

[Bicego D, Brown K, Ruddick M, et al. Exercise for women with or at risk for breast cancer–related lymphedema. *Phys Ther.* 2006;86:1398–1405.]

Deanna Bicego, Kathy Brown, Moraine Ruddick, Dara Storey, Corinne Wong, Susan R Harris

Management of lymphedema in women with breast cancer has been a subject of debate for many years. Treatment options include elevation, massage, compression garments, pneumatic compression pumps, and complex physical therapy.[8] Traditionally, women who had been treated for breast cancer and those with pre-existing lymphedema were advised to avoid strenuous or repetitive activities that required effort with the affected UE because these activities were assumed to initiate or exacerbate lymphedema.[10] The purpose of this update is to review and critique recent studies investigating the effects of aerobic exercise and UE resistance training for women with or at risk for breast cancer–related lymphedema. The questions we will address are: (1) Does aerobic or resistance exercise lead to lymphedema in women who are at risk for the condition? and (2) Does aerobic or resistance exercise reduce or exacerbate pre-existing lymphedema? We begin by reviewing the prevalence, etiology and pathophysiology, and diagnosis of lymphedema and then review recent exercise studies.

Lymphedema

Prevalence

Because no standardized definition of lymphedema exists, breast cancer–related lymphedema may be underreported.[5] Erickson and colleges[2] and McKenzie and Kalda[11] reported that approximately 25% of patients develop lymphedema after breast cancer surgery, with an increase to 38% for those who also undergo radiation therapy. Other risk factors include extensive axillary disease, previous cancer in axillary lymph nodes, and obesity.[8]

According to Petryk and colleagues,[12] a 2-cm difference between the surgical-side UE and contralateral UE is the most common definition of lymphedema, although the visibility of this difference may go unnoticed in women who are obese yet be more obvious in thinner women. Although a difference greater than 2.0 cm at any point has been defined by some authors[13,14] as "clinically significant," other authors[15,16] have classified this degree of lymphedema as mild.

Management of lymphedema in women with breast cancer has been a subject of debate for many years.

Etiology and Pathophysiology

Surgical resection of the axillary lymph nodes is used to stage and control breast cancer.[5] This procedure alone, or in conjunction with radiation therapy, places patients at high risk for developing lymphedema.[17] Lymph node dissection disrupts lymphatic flow and results in a build-up in pressure in the vessel walls, causing them to distend and leading to deficient lymphatic valves that allow backflow of fluid and blockage in fluid transport. This blockage obstructs the main lymphatic route for fluid to exit the UE, resulting in lymphedema.[5] Breast cancer–related lymphedema can affect the trunk and any remaining breast tissue, as well as the UE.[5,18] A new, less invasive surgical procedure involves dissection of one or more sentinel nodes, the first lymph nodes that drain the breast region. A biopsy is performed to determine the extent of metastasis. If these nodes do not contain malignant cells, additional dissection may be avoided.[5] Sentinel node biopsy, however, has yet to become standard practice.

Lymph nodes are especially susceptible to radiation, leading to vessel wall fibrosis. This condition impedes the lymph nodes' ability to filter the fluid that normally flows through.[5] Because lymph drainage is impaired, the lymph provides a breeding ground for bacteria, making these individuals susceptible to infection.[18,19] Additional problems associated with lymphedema include decreased range of motion (ROM), slower healing of injuries or infections, tightness and heaviness, paresthesia, and pain, all of which can lead to functional impairment.[2,7,18]

Diagnosis

Clinicians use a variety of strategies to diagnose UE lymphedema. The most widely used strategy is circumferential UE measurements using specific anatomical landmarks.[8] Arm circumference measurements are used to estimate volume differences between the affected and

D Bicego, BSc, K Brown, BSc, M Ruddick, BSc, D Storey, BSc, and C Wong, BSc, are MPT students in the School of Rehabilitation Sciences, University of British Columbia, Vancouver, British Columbia, Canada.

SR Harris, PT, PhD, FAPTA, is Professor, School of Rehabilitation Sciences, University of British Columbia, Vancouver, British Columbia, Canada V6T 2B5. Address all correspondence to Dr Harris at: shar@interchange.ubc.ca.

All authors provided concept/idea/project design. Ms Bicego, Ms Brown, Ms Ruddick, Ms Storey, and Ms Wong provided writing and data collection and analysis. Dr Harris provided project management and consultation (including review of manuscript before submission).

This article was received October 14, 2005, and was accepted May 22, 2006.

DOI: 10.2522/ptj.20050328

unaffected UEs. A more accurate measure of volume difference is the water displacement technique.[10]

A newer method, multifrequency bioelectrical impedance (MF-BIA), measures the rate of resistance of extracellular and intracellular fluid to different frequencies of electrical current.[2] This method is used infrequently in research and clinical settings even though it has a false positive rate of zero,[2,3] likely due to the time required to set it up, position the electrodes, and so on.

Lymphoscintigraphy, another measure of peripheral lymphatic function, also is rarely used[2] because it involves injection of a radiotracer. Computed tomography, magnetic resonance imaging (MRI), ultrasound, and observation also can be used to help confirm the diagnosis of lymphedema[20] but are used less commonly than anthropometric measures.[21] Contraindications, as well as potential benefits, of upper-body exercise for women with or at risk for breast cancer–related lymphedema have recently received attention in the research literature, including examination of the effects of both aerobic and UE resistance exercise.

Effects of Exercise for Women With or at Risk for Breast Cancer–Related Lymphedema

Physiologic Rationale for Exercise in Prevention or Management of Lymphedema

As recently as 2000 and 2001, review articles by leading oncology experts have advised that "violent exercise and strenuous exertion" (arm and hand precautions) should be avoided in an effort to prevent lymphedema[12(p298)] and that the affected limb should be used in moderation with repetitive motion to be avoided.[2] These warnings were based on the belief that vigorous exercise would increase lymph production, leading to an increase in UE volume.[22] As these authors noted, however, there was no scientific evidence or data at that time to support these preventive strategies.[2,12]

Exercise encourages skeletal muscle contractions to provide the primary pumping mechanism for lymphatic and venous drainage[23] and therefore should stimulate the contraction of lymph vessels because these vessels are innervated by the sympathetic nervous system.[11] As McKenzie and Kalda[11] have suggested, upper-body exercise may "re-set" the sympathetic drive to lymph vessels and thus assist in the long-term management of lymphedema.

The use of compression bandaging in combination with exercise may improve venous and lymphatic return[6] and minimize fluid from leaking into the interstitial space.[5] Compression also may provide a protective component of lymphedema during exercise and, consequently, has been recommended[8] and used[4] as a precautionary measure during exercise.

Research on Exercise and Breast Cancer–Related Lymphedema

In February 2006, we searched the databases CINAHL, EMBASE, MEDLINE, PEDro, and PubMed (back to their originating dates) using the search terms "breast cancer," "exercise," and "lymphedema" (and their associated MeSH terms), with the searches limited to human, female, and English-language studies. After a review of the abstracts by the first 5 authors, irrelevant articles were excluded (ie, review articles, clinical practice guidelines, studies in which exercise was not an independent variable, and studies in which the type of exercise therapy was not defined). If there were discrepancies as to whether a study should be included, the parties in disagreement discussed the studies until a resolution was attained. "Gray literature," such as unpublished studies, dissertations, and conference proceedings, were not included in our search. Eight studies were located that related directly to breast cancer–related lymphedema and aerobic or resistance exercise. The 6 studies that involved women who were at risk for breast cancer–related lymphedema will be presented first, in the order in which they were published, followed by the 2 studies involving women with pre-existing lymphedema. The type of design used, Sackett level of evidence,[24] and methodological quality of the studies reviewed will be described.

Sackett's rules of evidence rank studies according to 5 hierarchical levels: (1) level I—large randomized controlled trial with low false positive or false negative errors; (2) level II—small randomized controlled trial with high false positive or false negative errors; (3) level III—nonrandomized, concurrent cohort comparisons between contemporaneous subjects who did and did not receive the intervention; (4) level IV—nonrandomized, historical cohort comparisons between current subjects who received the intervention and former subjects who did not receive the intervention; and (5) level V—case series without controls.[24]

Research on Exercise for Women at Risk for Breast Cancer–Related Lymphedema

A case series published by Harris and Niesen-Vertommen[4] in 2001 (level V) suggested that women who had undergone treatment for breast cancer could engage in UE exercise without developing lymphedema. Data from 20 women, aged 31 to 63 years, were included. Six women reported that they currently had lymphedema (although no measurable differences were seen at baseline), and 7 women reported having feelings of heaviness or tightness. At the beginning of the study, time since breast cancer diagnosis ranged from 1 to 17 years. All women had undergone level I or II axillary node dissection, and 13 women also had undergone radiation treatment. The training program consisted of 20 to 30 minutes of aerobic exercise (eg, brisk walking, jogging, bicycling, or swimming), plus stretching and resistance training for the UE and back muscles (eg, bench press, seated row, latissimus dorsi muscle pull-downs). Exercises were conducted 3 times a week, for 9 months, in preparation for and during dragon boat racing. The women were advised to wear compression sleeves, although adherence to this advice was not reported.

Upper-extremity circumference measurements were taken at the beginning of training, before racing, and 7 to 8 months after the end of the dragon boat racing season. Interrater reliability of the circumferential measurements was assessed for 3 women (15% of participants), and percentage of agreement was 96%. A clinically important change of greater than 0.5 in was reported in the involved UE for 2 women. However, there were no clinically important differences (≥1 in) in circumference between the ipsilateral and contralateral upper limbs for any of the women.

Limitations reported by the authors included recording in inches rather than centimeters, lack of control for the type and intensity of aerobic activities in which the participants were engaged outside of the standardized strength-training program, nonstandardized time of day that UE measurements were taken, and lack of a control group. An additional limitation that we identified was lack of reporting on patients' adherence in wearing compression garments.

As the authors noted, case reports represent the lowest level of experimental evidence in Sackett's 5 original levels of evidence[24] because there is no control for potential threats to internal validity. They stated further that the research question posed as to safe levels of exercise for women who are at risk for lymphedema could only be "answered definitively through a prospective, well-controlled trial."[4(p98)]

In a pilot study published in 2002, Kolden et al[25] examined the feasibility, safety, and benefits of a structured group exercise program. In this one-group, pretest-posttest study (level V), 40 women who had been surgically treated for breast cancer were included. These women had been diagnosed with stage I to III breast cancer with no reported lymphedema. Eighty-three percent of the women were within 12 months of diagnosis; most were currently undergoing adjuvant therapies.

Participants completed a 16-week (1 hour, 3 times per week) intervention consisting of a 10- to 15-minute warm-up of slow, rhythmic ROM and stretching, 20 minutes of aerobic exercise, and 20 minutes of resistance training and cool-down combined. The aerobic component consisted of walking, cycling, and step and dance movements, as well as "other aerobic activities" (not described). Resistance training was accomplished through use of resistance bands, dumbbells, and resistance machines. Outcome measures included blood pressure, heart rate, weight, body fat, aerobic capacity, flexibility, and strength (force-generating capacity of muscle). Quality of life also was assessed using a variety of scales.

A 78.4% retention rate supported the feasibility of the study. Safety and tolerability were shown by the fact that participants completed an average of 88% of the sessions. Significant improvements were noted in resting systolic blood pressure, flexibility, aerobic capacity, and strength on the bench press and leg press, as well as in 4 of the 5 mood/distress measures, the global measure of well-being, and scores of global functioning on all 3 measures (ie, Cancer Rehabilitation Evaluation System, Global Assessment Scale, and Life Functioning Scales). None of the participants reported any adverse events, including lymphedema.

Limitations identified by the authors were the fact that the participants were sedentary women who were especially motivated and therefore may not have been representative of all women with breast cancer, that there was no control group, and that there was no opportunity to predict long-term effects of the intervention. An additional limitation that we noted was the lack of description of what, if any, measurements of the UE were taken to measure possible lymphedema, although the authors reported measuring skinfold fat thickness at the triceps surae muscle. Furthermore, no reliability data were provided for any of the outcome measures used in the study.

In 2003, Courneya and colleagues[26] published a randomized controlled trial (level II) examining the effects of exercise training using recumbent upright cycle ergometers on cardiopulmonary and QOL outcomes in 53 post-menopausal women with breast cancer (1 participant in the experimental group dropped out due to gastrointestinal complications). Experimental group participants (n=24) exercised 3 times per week for 15 weeks. Duration of training progressed from 15 minutes for the first 3 weeks to 35 minutes for the final 3 weeks. The control group participants (n=28) did not train. The occurrence of lymphedema was not an outcome that was measured in this study but was recorded instead as an adverse event. Three participants in the exercise group developed lymphedema during the course of the study compared with no cases of lymphedema in the control group, a difference that was not statistically significant (P=.054), but the possibility of a type II error exists.

Although the incidence of lymphedema between the 2 groups failed to reach statistical significance, the difference was likely of clinical importance, leading the authors to recommend that "future exercise trials should monitor lymphedema rates closely."[26(p1667)] We concur with this recommendation and suggest that UE circumference should be monitored in all exercise trials involving women with or at risk for lymphedema.

Using a one-group, pretest-posttest design (level V), Turner et al[3] examined the acceptance and effects of a mixed-type, moderate-intensity exercise program for women who had been treated for breast cancer. The participants in their study were 10 women between the ages of 33 and 62 years, with a median number of 17 months since breast cancer diagnosis. Baseline arm circumference measurements and analysis of the impedance ratio confirmed that 2 of the women had pre-existing lymphedema (differences of 8 and 11.5 cm, based on a sum of circumferences at 6 points on the UEs). All participants had undergone surgery, radiation, and chemotherapy. All 10 women adhered to an 8-week exercise program that began with aerobic exercise, including low-impact aerobics and use of ergometers. This phase of the exercise program was followed in weeks 4 and 5 by water-based exercise that focused on aerobic training with the water inducing mild resistance as well. During the last few weeks, moderate-resistance weight training using machines and free weights was introduced. The women attended instructional exercise sessions once a week and exercised on their own 2 additional times per week following a similar-type program. Exercise intensity was kept at a moderate level as monitored by each participant using heart rate measurements and the Borg Rating of Perceived Exertion Scale. Each woman kept an activity logbook that detailed her exercise regimen, personal goals, and perceptions of the program. Measurements were taken at intake, at completion of the 8-week program, then at 6-week and 3-month follow-ups.

A one-way analysis of variance with repeated measures for testing phase was used to determine the effect of the 8-week testing phase. Presence of lymphedema, body composition, fitness, fatigue, QOL, mood, and general well-being were measured. No significant changes were observed in occurrence of lymphedema as measured by arm circumference and bioelectrical impedance. For the 2 women with pre-existing lymphedema, there were no significant changes in the status of their lymphedema. There was no significant improvement in either aerobic capacity or body composition, although the women stated that accessibility to instructors and guidance had helped them understand the long-term benefits that can be gained from an exercise program. A significant increase in QOL was reported and sustained at all follow-up sessions. In addition, participants' quotes in their logbooks revealed a "general theme" indicating increased motivation, hope, confidence, and self-esteem, although the authors did not report how this theme was identified. Many women also indicated that they experienced an increase in well-being. Although the data did not show improvements in lymphedema status in women with breast cancer–related lymphedema, the use of a mixed-type, moderate-intensity program did not lead to any adverse effects. Study limitations identified by the authors were small sample size and lack of a control group. Although mention was made of prior reliability having been established for measuring lean body mass in the calculation of bioelectrical impedance, the authors reported that the validity of such measurements is questionable. There was no mention of reliability assessment for the UE circumference measurements.

In a one-group, pretest-posttest study (level V), Lane et al[10] studied 16 women who had been diagnosed with stage I to III breast cancer and had undergone a lumpectomy or mastectomy. The women were at least 6 months posttreatment and had no history of lymphedema. The study consisted of a 20-week exercise program that included both resistance and aerobic training. Resistance training 3 times per week continued throughout the 20-week program and included the following exercises: seated row, bench press, latissimus dorsi muscle pull-down, one-arm bent-over rowing, triceps muscle extension, and biceps muscle curl. Aerobic exercise of the participants' own choice also was completed 3 times per week for 30- to 45-minute sessions throughout the program. Dragon boat training was introduced at week 8. Height, weight, body mass index, UE circumference, UE volume, and upper-body strength (1-repetition maximum) were measured at 0, 8, and 20 weeks. Two-sided statistical tests were used to analyze any changes in UE circumference and volume. Upper-extremity circumference, volume, and strength showed significant increases throughout the program. These increases, however, were thought to have resulted from muscle hypertrophy because there were no significant differences between the affected and unaffected UEs. The resistance training program was similar to that in a previous study[27] that demonstrated a significant increase in UE circumference bilaterally after 4 to 6 weeks.

Lane and colleagues' results suggest that women treated for breast cancer may be able to engage in UE resistance training without precipitating lymphedema. A limitation of this study (and 2 previous studies[4,11]) noted by the authors was that the measurement techniques assessed only UE volume and circumference; therefore, the results could not directly detect a change in lymphatic function. An additional concern that we identified was the fact that only the dragon boat training was supervised. Adherence to the resistance and aerobic training program was not specifically monitored. Furthermore, no reliability data were reported for any of the outcome measures used.

In a 2005 randomized, controlled, crossover trial (level II), Sandel and colleagues[28] examined the effects of a dance and movement therapy program for women with breast cancer. Thirty-eight women, aged 38 to 82 years, who had been diagnosed with breast cancer and had undergone a lumpectomy or more extensive breast surgery were recruited through the MidState Medical Center and the University of Connecticut Cancer Center. The women were randomly assigned to the dance and movement therapy program or the "wait list" control group. Three women dropped out during the course of the study due to fatigue, other commitments, or shoulder discomfort. At week 14, the wait list group crossed over and performed the dance and movement therapy program while the initial dance and movement therapy group discontinued the program and resumed their daily activities.

Before participating in the dance and movement therapy program, 7 women had summed UE circumference differences of greater than 5 cm between the affected and unaffected sides, but only 3 women (including 1 who wore a compression sleeve) had reported having lymphedema. The 12-week dance and movement therapy program consisted of 2 sessions per week for the first 6 weeks and then one session per week for the remaining 6 weeks. Each session started with a warm-up of "light" stretching and breathing exercises. Core exercises then were carried out to music, including ROM of shoulders, elbows, and wrists (4 or fewer repetitions per side), with resistance bands added at week 5. Lower-extremity movements such as side-to-side hip swings, walking around with various "attitudes," and balance exercises also were done. These activities were followed by 25 to 30 minutes of dance movements, with the women initially being taught 4 simple movements and progressing to following the instructor's spontaneous flowing dance by week 5. The session ended with a wrap-up consisting of gentle stretching, meditative movements, and quiet music. The Functional Assessment of Cancer Therapy–Breast (FACT-B), Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36), and Body Image Scale were administered at weeks 1, 13, and 26, as well as measurements of shoulder ROM and arm circumference, by an experienced physical therapist who was unaware of the group assignments.

An analysis of variance was used to assess overall changes in outcome measurements. There were no changes in arm circumference at week 13 or week 26 in any of the women. The initial treatment group's FACT-B scores improved significantly at the 13-week mark compared with the control group's scores. During the crossover portion, the wait list group's FACT-B scores improved while the initial treatment group's scores remained constant. Both groups had improved Body Image Scale and SF-36 scores at weeks 13 and 26 and improvements in shoulder ROM.

Although it appeared that the dance and movement therapy program did not adversely affect existing lymphedema or precipitate new cases, the UE exercises with resistance bands were not well described. Other limitations of the study include the small sample size and failure to include a power analysis.

Of the 6 studies that examined the effects of exercise on precipitating lymphedema in women who were at risk for developing lymphedema, 4 were Sackett level V,[3,4,10,25] the lowest level of experimental evidence and a design that fails to control for extraneous variables due to lack of a control group. The fifth study, albeit a randomized controlled trial (level II), did not include lymphedema as an outcome but rather as an adverse event.[26] The sixth study also was level II.[28] As noted by the authors of several of these studies, further research is needed using stronger experimental designs[4,25] with longer-term follow-up[25] and measurement techniques that will provide information on changes in lymphatic function (in addition to UE circumference and volume).[10]

Research on Exercise for Women With Pre-existing Lymphedema

Two studies have examined the effects of aerobic or resistance exercise on women with pre-existing, breast cancer–related lymphedema and will be presented in the order in which they were published.

McKenzie and Kalda,[11] in 2003, examined the effect of progressive upper-body exercise on women with breast cancer–related lymphedema. Fourteen women were randomly assigned to treatment or control groups (Sackett level II, due to small sample size and no power analysis). Women were included if they had completed more than 6 months of treatment for stage I or II breast cancer and had developed unilateral lymphedema. Women were excluded if they had stage III lymphedema, bilateral breast cancer, or were taking medication that could affect UE swelling.

The women in the experimental group completed an 8-week progressive upper-body program that included a series of resistance training exercises (using light weights initially and progressing as tolerated) 3 times per week. Progressive resistance training included the following exercises: seated row, bench press, latissimus dorsi muscle pull-down, one-arm bent-over rowing, triceps muscle extension, and biceps muscle curl. After 2 weeks, an additional progressive upper-body aerobic exercise was implemented on an arm ergometer. During the exercise sessions, the women in the experimental group wore fitted compression sleeves (and both groups of women wore these sleeves daily). The control group was given no specific exercises. Each subject was tested at baseline and every 2 weeks thereafter for height, weight, bilateral UE circumference, and volume by water displacement. There were no significant differences in UE volume, as measured by water displacement, or UE circumference as a result of the exercise program. Quality of life was measured using the SF-36 on the first and last measurement dates. Three domains of the SF-36 significantly increased ($P<.01$) in the exercise group: physical function, general health, and vitality.

This progressive, upper-body exercise program did not adversely affect UE volume in women with breast cancer–related lymphedema. According to the authors, study limitations included the small sample size, inadequate duration and intensity of the intervention to elicit an effect, and the fact that obesity and arm dominance may have confounded circumference and volume measurements (9 of the 14 subjects were overweight or obese). Other limitations that we identified were failure to assess reliability of the arm circumference measurements and lack of inclusion of a power analysis.

In a one-group, pretest-posttest study (level V) published in 2005, Johansson and colleagues[29] examined the effects of low-intensity arm exercises with weights on UE lymphedema in 31 women who had been treated for breast cancer and had "mild or moderate" lymphedema (10%–40% greater volume than the unaffected UE). Volume of the UE was measured via water displacement, with reliability of this measure established prior to commencing the study. The UEs of 10 of the participants also were examined with a bioimpedance meter.

A standardized exercise program consisting of shoulder flexion, abduction, and horizontal adduction and elbow extension and flexion using small dumbbells (1–2 kg) was carried out on days 1 and 4. Upper extremity volume was measured before the initial exercise session, directly after each exercise session, and again 24 hours later. Prior to initiating the exercise program, volume was significantly greater in the affected UE (2,726±404 mL versus 2,331±352 mL).

In addition, all women were randomly assigned to wear a compression sleeve on either day 1 or day 4 of exercise training. Immediately following the exercise sessions, the total volume of the affected UE showed a significant increase compared with pre-exercise measurements (2,737±411 mL without compression sleeve and 2,731±407 mL with compression sleeve), but there was no significant difference after 24 hours (2,726±401 mL without compression sleeve and 2,717±408 mL with compression sleeve). This finding suggests that exercise may have transient effects on increasing lymphedema. However, there were no significant differences in UE volume within the women when wearing or not wearing the compression sleeve.

Attainment of high levels of interrater reliability on UE volume data before commencing the study was commendable. Limitations include the lack of a no-treatment control group and the failure to collect bioimpedance data on all 31 subjects. In addition, the authors noted that their results could not be generalized to women with severe lymphedema.

In the 2 studies that examined the effects of exercise on women with pre-existing lymphedema,[11,29] only 45 women with lymphedema were included. One was described as a pilot study,[11] and only one study included reliability assessments of UE measures.[29] Although the study by McKenzie and Kalda[11] included a control group, no power analysis was reported. However, the authors stated that significance was set at $P<.01$ to compensate for the number of tests being conducted on this small sample (n=14).

Conclusions

Previously, the idea that aerobic exercise and UE resistance training should be contraindicated for women with breast cancer was widely accepted. Recent studies, although limited in number and sample size, have provided preliminary evidence to suggest that exercise may be safe. The studies reviewed in this article examined the effects of various exercise programs and concluded that exercise neither initiated nor exacerbated lymphedema, although more cases of new lymphedema were reported as adverse events in the exercise group in one study.[26]

Of the 8 studies reviewed, 5 were Sackett level V,[3,4,10,25,29] the least rigorous type of experimental design. Three studies could be categorized as level II—small, randomized controlled trials,[11,26,28] one of which explored lymphedema as an adverse event rather than as an outcome.[26]

Additional research with larger samples, more rigorous designs (eg, randomized controlled trials), and more sophisticated outcome tools to measure lymphatic flow (eg, lymphoscintigraphy) is needed to address the safety and effectiveness of exercises for women with breast cancer–related lymphedema, one of the most concerning and prevalent secondary complications of breast cancer treatments.

References

1 Jemal A, Murray T, Ward E, et al. Cancer statistics, 2005. *CA Cancer J Clin.* 2005;55(1):10–30.

2 Erickson VS, Pearson ML, Ganz PA, et al. Arm edema in breast cancer patients. *J Natl Cancer Inst.* 2001;93:96–111.

3 Turner J, Hayes S, Reul-Hirche H. Improving the physical status and quality of life of women treated for breast cancer: a pilot study of a structured exercise intervention. *J Surg Oncol.* 2004;86:141–146.

4 Harris SR, Niesen-Vertommen SL. Challenging the myth of exercise-induced lymphedema following breast cancer: a series of case reports. *J Surg Oncol.* 2000;74:95–98.

5 Hull MM. Lymphedema in women treated for breast cancer. *Semin Oncol Nurs.* 2000;16:226–237.

6 Cheville AL, McGarvey CL, Petrek JA, et al. Lymphedema management. *Semin Radiat Oncol.* 2003;13:290–301.

7 Brennan MJ, Miller LT. Overview of treatment options and review of the current role and use of compression garments, intermittent pumps, and exercise in the management of lymphedema. *Cancer.* 1998;83(12 Suppl American):2821–2827.

8 Harris SR, Hugi MR, Olivotto IA, Levine M; Steering Committee for Clinical Practice Guidelines for the Care and Treatment of Breast Cancer. Clinical practice guidelines for the care and treatment of breast cancer, 11: lymphedema. *Can Med Assoc J.* 2001;164:191–199.

9 National Lymphedema Network. National Lymphedema: A Brief Overview. Available at: http://www.lymphnet.org/whatis.html. Accessed July 19, 2005.

10 Lane K, Jespersen D, McKenzie DC. The effect of a whole body exercise programme and dragon boat training on arm volume and arm circumference in women treated for breast cancer. *Eur J Cancer Care.* 2005;14:353–358.

11 McKenzie DC, Kalda AL. Effect of upper extremity exercise on secondary lymphedema in breast cancer patients: a pilot study. *J Clin Oncol.* 2003;21:463–466.

12 Petryk JA, Pressman PI, Smith RA. Lymphedema: current issues in research and management. *CA Cancer J Clin.* 2000:50:292–307.

13 Kissin MW, Querci della Rovere G, Easton D, Westbury G. Risk of lymphoedema following the treatment of breast cancer. *Br J Surg.* 1986;73:580–584.

14 Werner RS, McCormick B, Petrek JA, et al. Arm edema in conservatively managed breast cancer: obesity is a major predictive factor. *Radiology.* 1991;180:177–184.

15 Lin PP, Allison DC, Wainstock J, et al. Impact of axillary lymph node dissection on the therapy of breast cancer patients. *J Clin Oncol.* 1993;11:1536–1544.

16 Brennan MJ. Lymphedema following the surgical treatment of breast cancer: a review of pathophysiology and treatment. *J Pain Symptom Manage.* 1992;7:110–116.

17 Radina ME, Armer JM, Culbertson SD, Dusold JM. Post-breast cancer lymphedema: understanding women's knowledge of their condition. *Oncology Nursing Forum Online.* 2004;31:97–104.

18 Price J, Purtell JR. Prevention and treatment of lymphedema after breast cancer. *Am J Nurs.* 1997;97:34–37.

19 Rinehart-Ayres ME. Conservative approaches to lymphedema treatment. *Cancer (Suppl).* 1998;83:2828–2832.

20 Vignes S, Champagne A, Poisson O. Management of lymphedema: experience of Cognacq-jay Hospital. *Revue de Medecine Interne.* 2002;23: 414–420.

21 Witte CL, Witte MH, Unger EC, et al. Advances in imaging of lymphatic flow disorders. *Radiographics.* 2000;20:1697–1719.

22 Lane K, Worsley D, McKenzie DC. Exercise and the lymphatic system. implications for breast-cancer survivors. *Sports Med.* 2005;35: 461–471.

23 Witte CL, Witte MH. Contrasting patterns of lymphatic and blood circulatory disorders. *Lymphology.* 1987;20:171–178.

24 Sackett DL. Rules of evidence and clinical recommendations on the use of antithrombotic agents. *Chest.* 1989;95(suppl):2S–4S.

25 Kolden GG, Strauman TJ, Ward A, et al. A pilot study of group exercise training (GET) for women with primary breast cancer: feasibility and health benefits. *Psycho-oncology.* 2002;11:447–456.

26 Courneya KS, Mackey JR, Bell GJ, et al. Randomized controlled trial of exercise training in postmenopausal breast cancer survivors: cardiopulmonary and quality of life outcomes. *J Clin Oncol.* 2003;21: 1660–1668.

27 Abe T, DeHoyos DV, Pollock ML, Garzarella L. Time course for strength and muscle thickness changes following upper and lower body resistance training in men and women. *Eur J Applied Physiol.* 2000;81:174–180.

28 Sandel SL, Judge JO, Landry N, et al. Dance and movement program improves quality-of-life measures in breast cancer survivors. *Cancer Nurs.* 2005;28:301–309.

29 Johansson K, Tibe K, Weibull A, Newton RU. Low intensity resistance exercise for breast cancer patients with arm lymphedema with or without a compression sleeve. *Lymphology.* 2005;38:167–180.