The Effects of Upper Limb Exercise Through Yoga on Limb Swelling in Chinese Breast Cancer Survivors – A Pilot Study

Yen-Ting Lai[1,2], MD, City C. Hsieh[3,4], PhD, Li-Sheng Huang[1], MD, Wen-Sheng Liu[5,6,7], MD, Shu-Huan Lin[1], MD, Ling-Li Wang[4], MS, Shyh-Fang Chen[1], MD & Chih-Ching Lin[6,8], MD, PhD

Abstract

Purpose: Breast cancer is the most common female cancer. The aim of this study was to assess the impact of yoga on lymphedema in breast cancer survivors. Design: Repeated measures before and after the intervention. We enrolled 15 women with breast cancer who had not previously worn elastic clothing to treat lymphedema.

Methods: The program was led by a certified trainer and consisted of 60-minute sessions, three times a week for 12 weeks. The volumes of the affected and normal limbs were measured. A self-assessed edema score was also recorded.

Findings: Fifteen patients completed the program, none of whom suffered from complications related to exercise. There was no significant edema after exercise. No significant differences were noted in subgroup analysis by age or the affected arm.

Conclusions: Yoga does not induce lymphedema.

Clinical Relevance: Lymphedema is usually treated with uncomfortable elastic clothing, and high-resistance exercise may induce edema. Yoga may be suitable for these patients.

Keywords: Breast cancer; lymphedema; resistance exercise; yoga.

Introduction

Breast cancer is the most common female cancer in Taiwan, with a reported incidence of 49 per 100,000 women in 2005 (Chang, Kuo, & Wang, 2008). As a result, a significant number of breast cancer survivors have to face a range of health issues due to the side effects of the disease in addition to surgery, radiotherapy, and chemical therapy. Lymphedema is one of the most common side effects of surgery for breast cancer.

Mortimer defined breast cancer-related lymphedema (BCRL) as axillary lymph node removal or radiation therapy during the breast cancer treatment process that results in chronic swelling of a hand or upper extremity (Mortimer, 1998). The incidence rate of BCRL has been reported to be about 20%–30% (Erickson, Pearson, Ganz, Adams, & Kahn, 2001; Mortimer, 1998). The etiology of BCRL is removal of the axillary lymph node during surgery and the use of axillary radiation therapy, both of which disrupt the normal functioning of the lymphatic system in the upper limbs. This results in excessive lymph stagnation, which then causes edema. The risk factors for BCRL include the number and extent of lymph node removal, receiving radiation therapy, obesity, and an advanced cancer stage. Reported treatment methods include multilayered bandages, compression garments, the use of a lymphatic circulation machine, exercise therapy, self-massage, freehand lymphatic drainage, and raising of the limb, as well as electrical stimulation and other treatments. Clinical treatment strategies consist of two phases,

Correspondence: *Wen-Sheng Liu, Division of Nephrology, Department of Medicine, Taipei City Hospital, Zhongxing Branch, No. 145, Zhengzhou Rd., Datong Dist., Taipei City 103, Taiwan. E-mail: robertliu2001@yahoo.com*

1 Department of Physical Medicine and Rehabilitation, National Taiwan University Hospital Hsin-Chu Branch, Hsinchu, Taiwan

2 Department of Nursing, Yuanpei University, Hsinchu, Taiwan

3 Department of Health and Leisure Management, Yuanpei University, Hsinchu, Taiwan

4 Department of Physical Education, National Hsinchu University of Education, Hsinchu, Taiwan

5 Division of Nephrology, Department of Medicine, Taipei City Hospital, Zhongxing Branch, Taipei, Taiwan

6 Faculty of Medicine, School of Medicine, National Yang-Ming University, Taipei, Taiwan

7 Fu-Jen University, New Taipei City, Taiwan

8 Division of Nephrology, Department of Medicine, General Hospital, Taipei, Taiwan

Yen-Ting Lai and City C. Hsieh contributed equally to this work.

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namely the intensive treatment phase and the maintenance phase (Foldi, Foldi, & Weissleder, 1985). The intensive treatment phase includes freehand lymphatic drainage, elastic bandage compression therapy, exercise therapy, and health education, while the maintenance phase is based on the use of elastic clothing to replace the elastic bandages. Exercise programs for patients with lymphedema include stretching, strength training, breathing exercises, and aerobic exercise. Other aspects include health education such as informing the patient to avoid lifting heavy objects to reduce the formation of lymph.

The side effects of surgery for breast cancer treatment include pain, fatigue, decreased heart and lung function, decreased bone density, muscle weakness, and joint contracture (Lee et al., 2007). Breast cancer chemotherapy may cause weight gain with an increase in body fat percentage and a decrease in lean body mass (Visovsky, 2006; van Weert et al., 2008). Lymphedema caused by surgery and radiation therapy can cause swelling, numbness, pain, stiffness, weakness, and damage to upper limb function (Bosompra, Ashikaga, O'Brien, Nelson, & Skelly, 2002; Brennan, DePompolo, & Garden, 1996). Furthermore, these physiological changes can result in changes to the patients' lifestyle and behavior, as the inconvenience of using the affected limb and changes to their body image may lead to anxiety, depression, reduced activity, and social withdrawal, ultimately worsening the quality of life (Beaulac, McNair, Scott, LaMorte, & Kavanah, 2002; Passik, Newman, Brennan, & Holland, 1993; Velanovich Szymanski, 1999).

Exercise interventions for cancer patients can improve patient cardiopulmonary function, reduce fatigue, improve physical function, and help with other related symptoms (McNeely et al., 2006; Schmitz, Holtzman, et al., 2005). In addition, exercise is also beneficial in terms of psychological adjustment and quality of life (Kirshbaum, 2007; Knols, Aaronson, Uebelhart, Fransen, & Aufdemkampe, 2005). The currently recommended types of exercise focus on cardiopulmonary training involving aerobic and high-resistance anaerobic exercises. Resistance exercise can alleviate the side effects of cancer treatment (Galvao & Newton, 2005) and improve muscle power; however, it may not be suitable for breast cancer patients due to concerns of inducing lymphedema (Rietman et al., 2004). A number of studies have challenged this concept in recent years by trying to identify the most suitable types of exercise for patients with breast cancer and lymphedema (Ahmed, Thomas, Yee, & Schmitz, 2006; Cheema, Gaul, Lane, & Fiatarone Singh, 2008; Harris & Niesen-Vertommen, 2000; Schmitz, Ahmed, Hannan, & Yee, 2005) with the aim of benefiting patients without the consequential occurrence of lymphedema, or any deterioration in lymphedema (Schmitz et al., 2010). In addition, some studies have reported that regular and persistent exercise training can increase the tolerance of the affected limb through adaptation of the lymph system (McNeely, Campbell, Courneya, & Mackey, 2009).

An exercise training program combined with education can help patients to break the aforementioned vicious cycle. In this study, we focused on the side effects of training-related edema, as to the best of our knowledge, no previous clinical studies in Taiwan have researched this issue. Furthermore, previous studies have mainly involved multilayer bandages and compression clothing, which are not suitable in areas with a hot and humid climate such as Taiwan (Ahmed et al., 2006; Cheema et al., 2008; Lane, Jespersen, & McKenzie, 2005; McNeely et al., 2009; Schmitz, Ahmed, et al., 2005; Schmitz et al., 2010). Thus, the primary aim of the present study was to confirm the effect of exercise on lymphedema in patients with breast cancer, including whether yoga exercise induces swelling of the affected limb due to lymphedema. The secondary aim was to investigate whether exercise exacerbates or relieves edema. We hope that the results of this study can help to define the benefits and harmful effects of exercise for such patients, and improve patient compliance with recommended exercise programs.

Methods

This study enrolled 16 breast cancer survivors and was approved by the Human Committee Review Board. The clinical data of the patients before the exercise training program were collected, including the dominant hand, affected side, surgical method, whether or not the patient had undergone radiotherapy, and the subjective swelling score of the patient.

This study was a pilot study and therefore it focused on the changes before and after the exercise program, and we did not analyze the staging or treatment of the patients. Patients with breast cancer who were willing to undertake the 12-week exercise training were eligible for enrollment. The exclusion criteria were patients who had suffered from relapse or metastasis of breast cancer, or had any other physical discomfort that would not allow them to tolerate the exercise program such as chest tight-ness, near syncope, palpitation, dyspnea, or cold sweating. The patients who needed active medical treatment such as for wounds affecting their arms, using elastic bandages/clothing, or undergoing any kind of physical therapy were also excluded.

The 12-week exercise training program was based on aerobic yoga training developed by an exercise trainer (Irene Lu) in 2001. This program integrates all

the move-ments of yoga: aerobic exercise, posture-related resistance exercise, stretching exercise, breathing exercises, and meditation. Furthermore, it was conducted in 60-minute sessions, three times per week. Each 60-minute session consisted of three sections: warm-up for 10 minutes, aerobics for 20 minutes, and muscle training using the back, abdominal, and limbs muscles together with stretching exercises for 20 minutes. The second and third sections were concluded with 5 minutes of cool-down. The exercise gradually increased in intensity and duration by changing the yoga pose during the program. All sessions were conducted by a certified professional aerobic yoga trainer with one assistant. Nursing staff were also present, whose role was to monitor the physical condition of all participants. The sessions included five to six patients who were allowed to discuss the program and chat after each session (Johns et al., 2014; Khalsa, Greiner-Ferris, Hofmann, & Khalsa, 2014).

The subjective evaluation of lymphedema was performed by the patients using a visual edema score (from 0 to 10), with a score of zero indicating no edema feeling at all, and a score of 10 indicating most uncomfortable edema. The actual volume of each patient's arm was mea-sured by a water-expelling method. Each participant opened her hand, straightened their elbow, and then slowly immersed her arm in a custom-made volumetric cylinder filled with water (Figure 1). After slowly withdrawing the arm from the volumetric cylinder, the volume of water expelled was measured. The volume of each arm was measured twice, and the average of the two measurements was then used in the analysis. We used two sizes of volumetric cylinder according to the size of the patients' arms, with the bigger cylinder being used for an arm with a circumference of more than 30 cm.

Differences in the volume of the arms and the subjective visual scores for edema were compared before and after the exercise training program to identify any changes in edema caused by the program. Differences in the volume between the affected and normal arms were calculated as the volume of the affected side minus the normal side, divided by the affected side, and expressed as a percentage.

We also collected clinical data before the training pro-gram, including the use of elastic clothing, receiving an-tiedema treatment, the presence of any wound on the upper extremities, and the actual volume change in both upper arms. All data were analyzed using SPSS software version 19.0 and paired t tests. A p value of less than .05 was regarded as being statistically significant.

Results

This study enrolled 16 breast cancer survivors, 15 of whom finished the 12-week exercise program, completed the self-assessed visual edema score, and had the volumes of both arms measured. One patient dropped out due to family/personal issues unrelated to the exercise program. No patient dropped out due to lymphedema or for any other health-related reasons. These 15 patients were aged from 42 to 72 years, and all had undergone surgery with postoperative chemotherapy, hormone therapy, or radiation therapy. Their cancer treatment courses ranged from 1 to 20 years. All of the patients were right-handed, and none of them had a wound on their arms. None of the patients had been wearing elastic clothing or had undergone antiedema treatment other than the exercise. Eight of them had lymphedema on their left side, six of them on their right side, and one was affected on both sides. The basic clinical data of the patients are presented in Table 1.

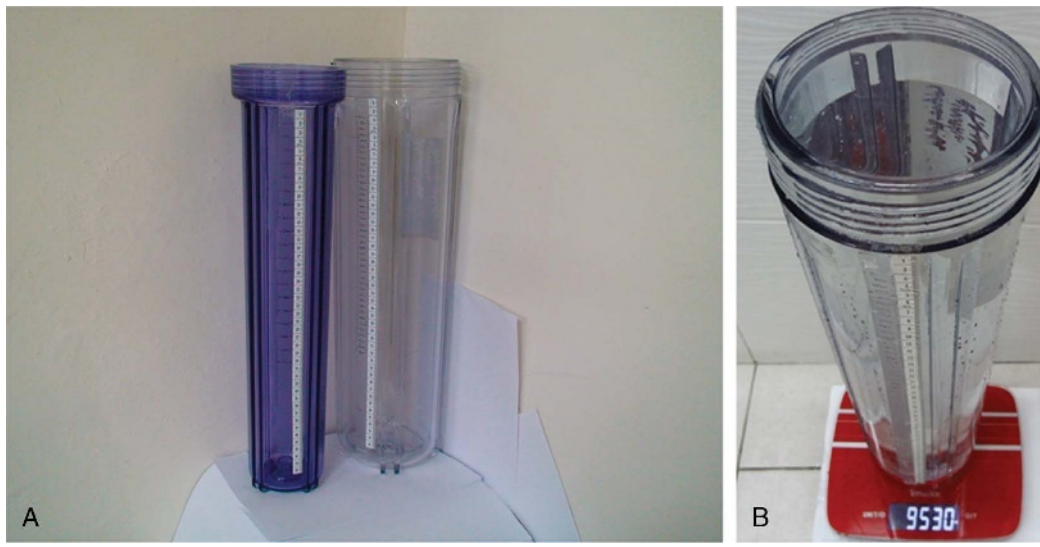

Figure 1. (A) Custom-made volumetric cylinders (smaller and bigger). (B) Volumetric cylinder was filled with water and placed on a weight scale.

Table 1 Clinical data of the 15 patients

No.	Age (years)	Dominant Hand	Lesion Site	Postoperative Radiotherapy	Postoperative Chemotherapy	Postoperative Hormone Therapy	Staging	Lymph Node Removal
1	57	Right	Left	Yes	Yes	No	IB	Yes
2	49	Right	Left	No	Yes	No	IA	Yes
3	54	Right	Left	Yes	Yes	No	IB	Yes
4	66	Right	Left	No	No	Yes	IA	Yes
5	55	Right	Right	Yes	Yes	Yes	IA	Yes
6	50	Right	Left	Unknown (treated at another hospital)				
7	70	Right	Right	No	No	Yes	0	No
8	50	Right	Left	Yes	Yes	Yes	IIA	Yes
9	59	Right	Bilateral	R:Yes	R:Yes	R:No	R: IA	R:Yes
				L:Yes	L:Yes	L:No	L: IIIC	L:Yes
10	63	Right	Left	Unknown (treated at another hospital)				
11	54	Right	Right	Unknown (treated at another hospital)				
12	42	Right	Right	Yes	Yes	Yes	IIIB	Yes
13	60	Right	Right	Yes	Yes	Yes	IIA	Yes
14	72	Right	Left	No	Yes	No	IIA	Yes
15	45	Right	Right	No	Yes	No	IA	Yes

The subjective visual edema scores and the volume of each arm (before and after the intervention) are presented in Table 2. Comparisons of the data before and after the exercise program were carried out, and no significant differences in the subjective visual edema scores and changes in arm volume were noted. Furthermore, there were no significant changes in the affected arm compared to the normal arm after completion of the exercise program (Table 3, Figure 2).

Further subgroup analysis between two age groups (age < 55 vs. age > 55 years) and the affected side (left vs. right) was performed. The results are shown in Table 4 with Figure 3 and Table 5 with Figure 4, respectively, and no significant differences were found.

Discussion

Whether resistance exercise affects lymphedema in breast cancer survivors postsurgery has been debated for many years. Traditionally, physicians do not recommend high-resistance exercise because of the adverse effects such as inducing lymph production in the affected arm thereby leading to lymphedema (Schmitz et al., 2010). However, several studies in Europe and America have reported that high-resistance exercise does not seem to induce edema

Table 2 Visual edema score, affected and unaffected arm volume, and differences in limb volume before and after the intervention

No.	Visual Edema Score: Pretest	Visual Edema Score: Posttest	Visual Edema Score: Change	Affected Arm Volume (mL): Preexercise	Affected Arm Volume (mL): Postexercise	Affected Arm Volume (mL): Change (%)	Unaffected Arm Volume (mL): Preexercise	Unaffected Arm Volume (mL): Postexercise	Unaffected Arm Volume (mL): Change (%)	Difference in Limb Volume (%)*: Preexercise	Difference in Limb Volume (%)*: Postexercise	Difference in Limb Volume (%)*: Change (%)
1	4	3	−1	1237.6	1304.6	5.41%	1146.2	1176.7	2.66%	7.39%	9.80%	2.42%
2	0	0	0	1225.4	1228.4	0.24%	1182.7	1185.8	0.26%	3.48%	3.47%	−0.02%
3	3	2	−1	1505.6	1496.4	−0.61%	1493.4	1481.2	−0.82%	0.81%	1.02%	0.21%
4	0	0	0	1191.9	1213.2	1.79%	1158.4	1118.8	−3.42%	2.81%	7.78%	4.97%
5	2	2	0	1198	1167.5	−2.55%	1140.1	1167.5	2.40%	4.83%	0.00%	−4.83%
6	0	0	0	1280.2	1292.4	0.95%	1307.6	1313.7	0.47%	−2.14%	−1.65%	0.49%
7	0	0	0	1526.9	1490.4	−2.39%	1487.3	1475.1	−0.82%	2.59%	1.03%	−1.57%
8	2	2	0	1720	1633.3	−5.04%	1726.7	1646.7	−4.63%	−0.39%	−0.82%	−0.43%
9†	2	3	1	1720	1693.3	−1.55%	1686.7	1700	0.79%	1.94%	−0.40%	−2.33%
10	2	2	0	1586.7	1526.7	−3.78%	1520	1480	−2.63%	4.20%	3.06%	−1.14%
11	3	6	3	1680	1773.3	5.55%	1620	1706.7	5.35%	3.57%	3.76%	0.18%
12	6	6	0	1258.9	1265	0.48%	1103.6	1070.1	−3.04%	12.34%	15.41%	3.07%
13	0	1	1	1459.9	1447.7	−0.84%	1328.9	1320	−0.67%	8.97%	8.82%	−0.15%
14	0	0	0	1460	1446.7	−0.91%	1533.3	1500	−2.17%	−5.02%	−3.68%	1.34%
15	0	0	0	1085.3	1079.2	−0.56%	1051.8	1039.6	−1.16%	3.09%	3.67%	0.58%

*Difference in limb volume = [(Affected arm volume minus unaffected arm volume) divided by (affected limb volume)] × 100%.
†Case 9 had bilateral breast cancer and the arm with less edema was processed as the less-affected side.

Table 3 Comparison of evaluation items before and after the intervention

Evaluation Item (mean ± *SD*)*	Preexercise	Postexercise	*p*-Value
Visual edema score	1.60 ± 1.84	1.80 ± 2.04	.424
Affected arm volume (mL)	1409.09 ± 211.38	1403.87 ± 203.15	.658
Unaffected arm volume (mL)	1365.78 ± 228.12	1358.79 ± 228.28	.496
Difference in limb volume (%)	3.23 ± 4.27	3.42 ± 5.10	.760

*Evaluation item: the variable is displayed as mean ± *SD*.

or even aggravate it. A study conducted in Canada in 2000 showed that postoperative breast cancer patients who took part in dragon boat racing showed no significant changes in arm circumference before, during, and 7–8 months after the racing training (Harris & Niesen-Vertommen, 2000). A study conducted in the United States in 2006 focused on postoperative breast cancer patients who underwent nine kinds of progressive resistance whole-body training, and revealed that the patients had increased muscle strength but no changes in arm circumference or lymphedema (Ahmed et al., 2006). Another study conducted in Canada in 2005 showed that postoperative breast cancer patients who underwent dragon boat racing training with six kinds of progressive resistance exercises targeting the upper torso had significantly increased muscle power, but no changes in the circumference or volume of their arms (Lane et al., 2005). However, whether this type of exercise can be applied to Asians is unclear.

To minimize confounding factors, patients who used elastic clothing or other related treatments for edema were excluded from this study. As a result, any effect on arm size was solely due to the yoga exercise program. The findings of this study may help to clarify the effect of yoga exercise on edema in Asian breast cancer patients.

Differences in arm volumes of the 15 enrolled patients ranged from 5.02% to +12.33% before the training program. The patient with the largest arm volume difference (+12.33%) also had the highest self-assessed edema score of 6. The correlation of edema score and arm volume difference was significant, especially before the intervention (preintervention $p = .035$, $r = .496$; postintervention $p = .089$, $r = .381$). After the training program, the differences in arm volume ranged from –3.68% to +15.41%. The volume change for the same arm was compared with the other arm to minimize any confounding of changes in the participants' physical condition. The results showed that the 12-week yoga exercise program targeting the upper limbs did not induce or exacerbate edema. Sub-group analysis between two age groups (age < 55 vs. age > 55 years) was performed, and no significant differences were found (Table 4, Figure 3), although the younger patients tended to have a lower edema score and smaller differences in limb volume ($p = .187$ and .104, respectively). The results showed that the yoga exercise program did not affect the younger and older patients differently.

Subgroup analysis between the affected side (left vs. right) was also performed (Table 5, Figure 4). No significant differences were found, although the volume

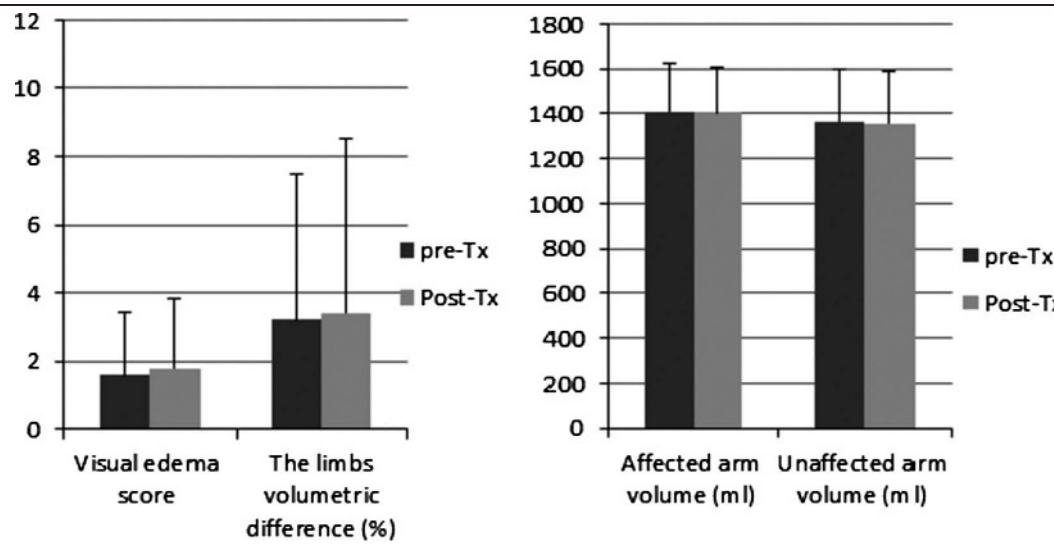

Figure 2. Comparison of evaluation items before and after the intervention (pre-Tx: before the intervention; post-Tx: after the intervention).

Table 4 Comparison of various items before and after the exercise intervention between two different age groups

Evaluation Item (mean ± *SD*)*	Preexercise	Postexercise	*p*-Value
Age < 55 years (*n* = 8)			
Visual edema score	1.00 ± 1.41	1.38 ± 2.07	.402
Affected arm volume (mL)	1427.05 ± 219.47	1424.68 ± 222.52	.895
Unaffected arm volume (mL)	1405.55 ± 227.86	1399.21 ± 227.13	.711
Difference in limb volume (%)	1.55 ± 4.25	1.82 ± 3.94	.193
Age > 55 years (*n* = 7)			
Visual edema score	2.29 ± 2.14	2.29 ± 2.06	1.000
Affected arm volume (mL)	1388.57 ± 217.12	1380.10 ± 193.11	.620
Unaffected arm volume (mL)	1320.33 ± 237.34	1312.60 ± 238.19	.538
Difference in limb volume (%)	5.16 ± 3.65	5.24 ± 5.95	.951

*The variables are displayed as mean ± *SD*.

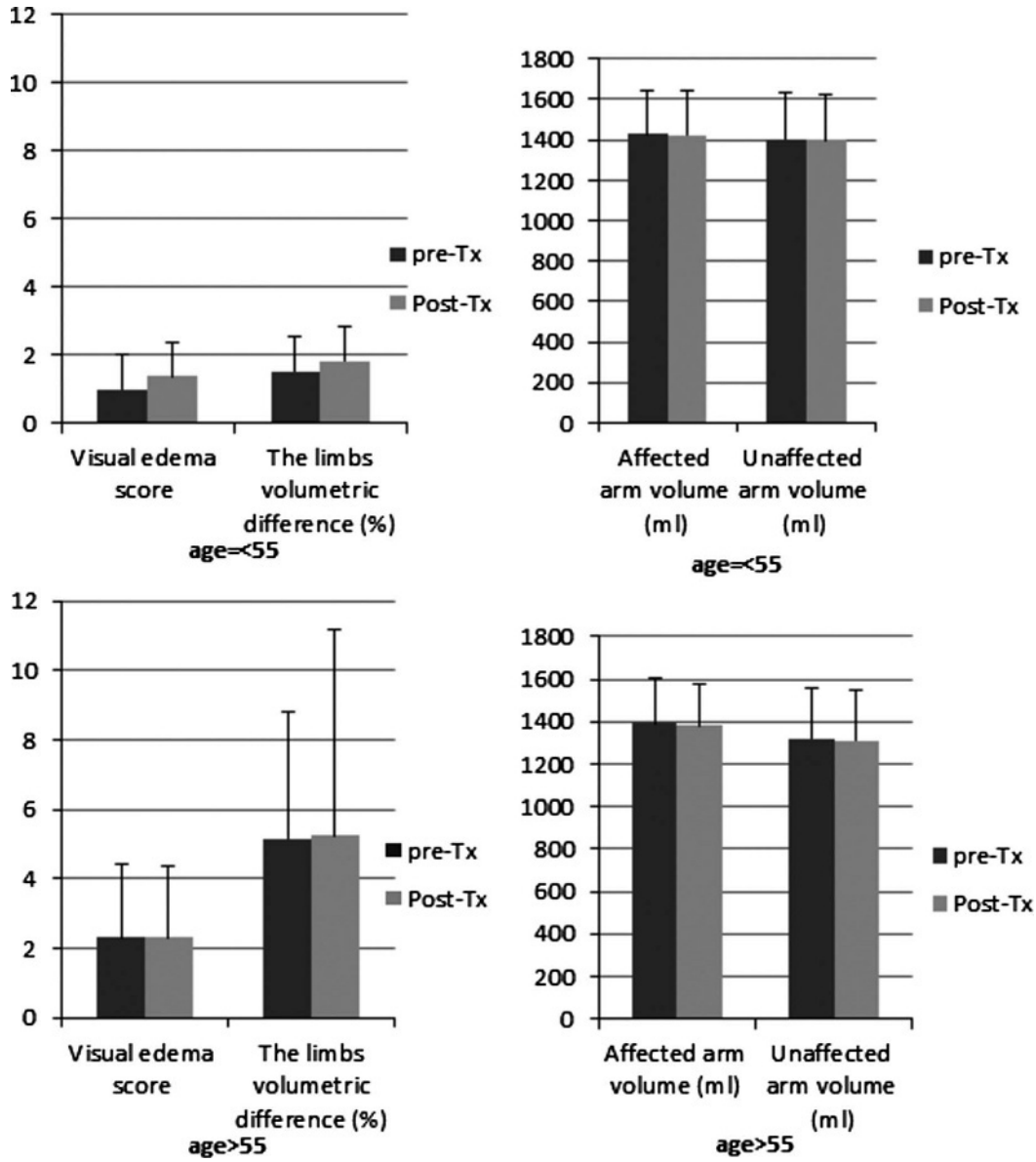

Figure 3. Comparison of various items before and after the exercise intervention between two different age groups (age < 55 vs. age > 55 years). (pre-Tx: before the intervention; post-Tx: after the intervention).

Table 5 Comparison of various items before and after the exercise between two groups with different affected arm (left vs. right, the dominant hand)

Evaluation Item (mean ± *SD*)*	Preexercise	Postexercise	*p*-Value
Affected side on left (*n* = 8)			
Visual edema score	1.38 ± 1.60	1.13 ± 1.25	.170
Affected arm volume (mL)	1400.93 ± 195.13	1392.71 ± 154.25	.641
Unaffected arm volume (mL)	1383.54 ± 215.14	1362.86 ± 190.90	.135
The limbs' volumetric difference (%)	1.39 ± 3.92	2.37 ± 4.65	.197
Affected side on right (*n* = 6)			
Visual edema score	1.83 ± 2.40	2.50 ± 2.81	.235
Affected arm volume (mL)	1368.17 ± 224.39	1370.52 ± 252.89	.908
Unaffected arm volume (mL)	1288.62 ± 229.47	1296.50 ± 258.69	.675
The limbs' volumetric difference (%)	5.90 ± 3.91	5.45 ± 5.76	.690

*The variables are displayed as mean ± *SD* (*n* = 14) Case 9 is excluded from this analysis.

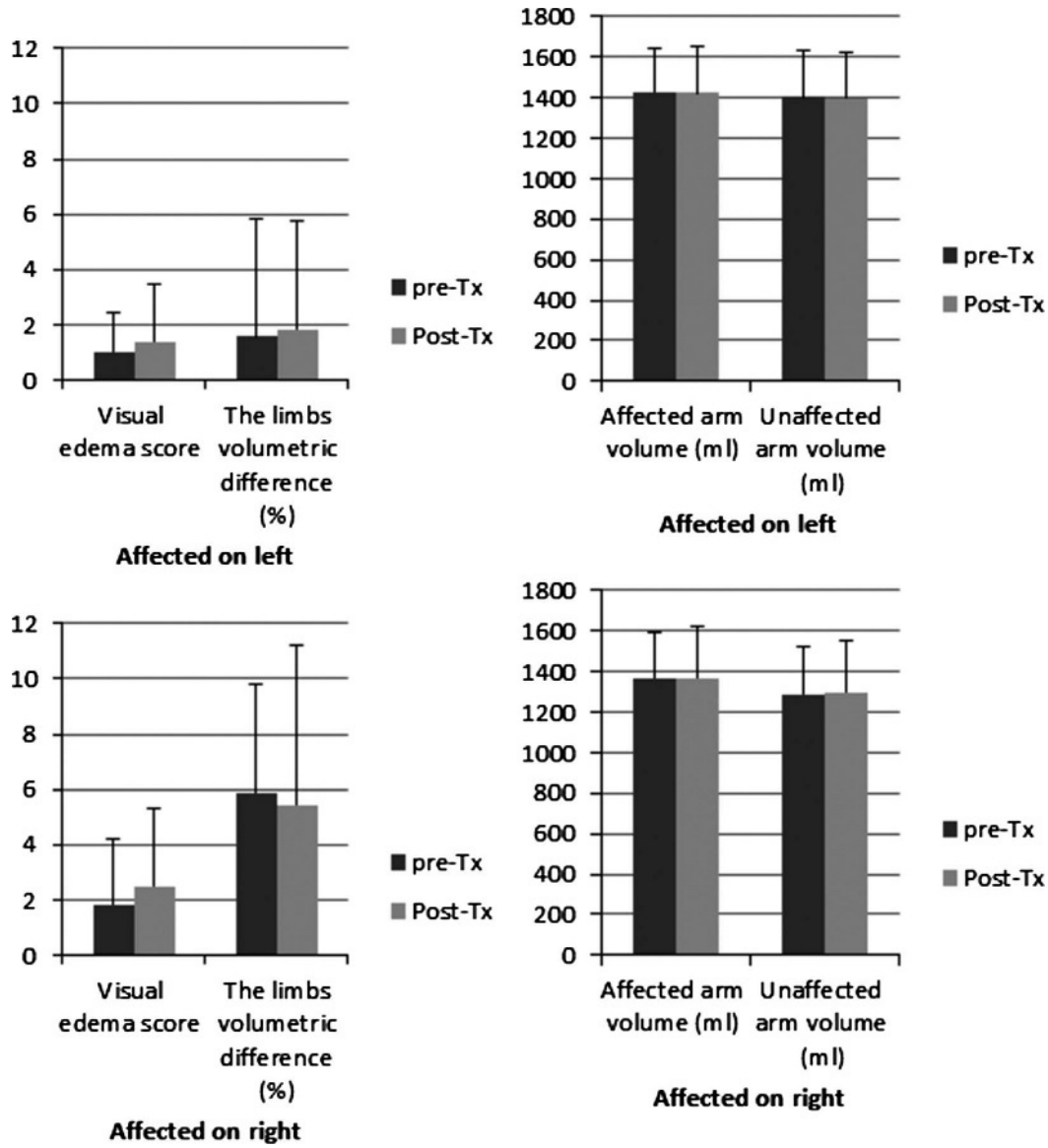

Figure 4. Comparison of various items before and after the exercise program in different groups (affected side on the left vs. affected side on the right, dominant hand) (pre-Tx: before the intervention; post-Tx: after the intervention).

of the affected arm tended to be larger than that of the normal arm before the exercise program if the affected arm was on their dominant side (all of the patients were right-handed). However, this trend was not detected after the exercise program (p = .054 before the program; p = .289 after the program; Figure 4). The dominant arm was likely to be stronger before the exercise program with more muscle component, and hence have a greater volume. This imbalance disappeared after the yoga exercise program, which may be because our exercise program trained both arms equally and strengthened the left arm.

The strength of our study is that we adopted a simple and practical method to measure arm volume, and no special equipment was required other than water and a volumetric cylinder. The volume of the arm is equal to the volume expelled from the volumetric cylinder, and this is more accurate than measuring the arm circumference as arm volume is three-dimensional. Although repeated measurement of arm circumference improves accuracy, this complicates the procedure. We used the patient's normal arm as a reference standard to exclude the confounding effects of changes in body composition over the 12-week exercise program. In addition, we overcame the difficulty of standardizing exercise intensity in postoperative care by using a unified aerobic yoga exercise program developed by a professional trainer. The same intervention was used for all of the participants, and each patient had the same intensity of exercise. A pilot study by McNeely et al. (2009), which enrolled 23 patients, used a desktop arm ergometer as the intervention treatment. This ergometer was able to measure the duration, velocity, and exact workload during arm exercise. However, this type of exercise is self-limiting in practice because the movement is repetitive, boring, and lacks interaction with other individuals. It is therefore difficult to apply such an exercise program in the longer term. Our exercise program combined both social activity and entertainment. The course lasted 12 weeks and could help to clarify the long-term effects of an exercise intervention on BCRL. The simplicity of our program and its practical training aspects make this pilot study unique in terms of postoperative care for such patients.

A weakness of our study is that appropriate volumetric cylinders are not easily accessible, and these are a prerequisite when measuring subtle changes in arm volume. Custom-made volumetric cylinders may be required for certain participants with extremely small or large arms. Another limitation is that patients with wounds on their arms are contraindicated because exposure to water may induce infections. Finally, our sample size is small, and further studies are needed to verify our results.

Key Practice Points

- Breast cancer is the most common female cancer.
- Lymphedema is a common complication after treatment and worsens the the quality of life of breast cancer survivors.
- Standardized yoga training does not affect lymphedema and is safe for breast cancer survivors, regardless of age or different affected side of arm.
- Our rehabilitation staff nurses became more familiar with lymphedema and more confident in persuading patients to join the yoga exercise program after the study.

Our exercise program did not induce or aggravate edema. To the best of our knowledge, this pilot study is the first study to confirm that arm yoga exercise is practical and safe for postoperative Asian patients with breast cancer. Additional studies with more participants are needed to confirm our findings. During the study, our rehabilitation staff nurses became more familiar with lymphedema, muscle wasting, and isolation. They also became more confident in persuading patients in a similar condition to join the yoga exercise program after knowing that it would not lead to lymphedema and may provide beneficial effect on sleep and anxiety. Therefore, nursing staff can provide more professional consultation and psychological support after this study.

Conclusion

This study focused on Asian patients with BCRL and showed that a 12-week exercise program did not induce or exacerbate edema regardless of the previous extent of edema, the age of the patient, or the affected side. Therefore, such patients are likely to benefit from similar exercise programs.

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