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**Effects of Yoga on Arm Volume among
Women with Breast Cancer Related Lymphedema: A Pilot Study**

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ABSTRACT

Lymphedema affects 3-58% of survivors of breast cancer and can result in upper extremity impairments. Exercise can be beneficial in managing lymphedema. Yoga practice has been minimally studied for its effects on breast cancer related lymphedema (BCRL). The purpose of this study was to determine the effect of yoga on arm volume, quality of life (QOL), self-reported arm function, and hand grip strength in women with BCRL. Six women with BCRL participated in modified Hatha yoga 3x/week for 8 weeks. Compression sleeves were worn during yoga sessions. Arm volume, QOL, self-reported arm function, and hand grip strength were measured at baseline, half-way, and at the conclusion of yoga practice. Arm volume significantly decreased from baseline (2423.3ml±597.2) to final measures (2370.8ml±577.2) ($p=.02$). No significant changes in QOL ($p=.12$), self-reported arm function ($p=.34$), or hand grip strength ($p=.26$) were found. Yoga may be beneficial in the management of lymphedema.

Key Words: breast cancer, lymphedema, yoga, arm function

BACKGROUND

Early detection efforts and aggressive treatment have resulted in survival rates of approaching 90% for women with breast cancer (Howlander et al 2013). Treatments for breast cancer (BC) often result in upper extremity morbidities (Ghazinouri et al 2005; Hayes et al 2012), including the development of lymphedema (Hayes et al 2008; Johansson et al 2001). Incidence rates reported for lymphedema vary from as low as 3% for sentinel node biopsy with irradiation, to as high as 58% among women undergoing a radical mastectomy (Shah et al 2012). Impairments may result from the development of lymphedema, including decreased arm function, range of motion and strength along with increased arm swelling and heaviness (Hayes et al 2008; Johansson et al 2001). This arm swelling can be accompanied by increased tightness of the arm and chest and a general decline in the quality of life (QOL) (Oliveri et al 2008). These impairments often require lifelong management (Lawenda et al 2009). Therefore, it is important to determine effective methods to manage lymphedema.

Exercise is one aspect of lymphedema management that has been supported by research to improve physiologic function of the lymphatic system. A review done by Lane et al (2005) concluded that it is possible for enhanced lymph flow to result in female survivors of breast cancer (BCS) who participate in long-term resistance and aerobic exercise programs. Physiological changes accompanying extensive exercise training included increased muscular contractions and increased ventilation, both of which can enable the return of lymph to the circulatory system (Lane et al 2005). Furthermore, exercise has been shown to augment sympathetic outflow, and lymphatic vessels often

respond to this sympathetic activation (Lane et al 2005). Exercise may produce other beneficial lymphatic changes such as lymphangiogenesis in the affected arm and recruitment of inactive lymphatic vessels (Lane et al 2007). Importantly, this research has shown that breast cancer related lymphedema (BCRL) has not been shown to result from, nor be exacerbated by, exercise (Lane et al 2005). Additional benefits of resistive, aerobic, and stretching exercise have been reported, including improved shoulder ROM or ease of movement of the upper extremities as well as strength gains (Chung et al 2011; McNeely et al, 2010; Schmitz et al 2009). Furthermore, studies evaluating the impact of resistive exercise on lymphedema have concluded that not only is resistive exercise safe for women with lymphedema, but results in reduced arm volume and symptoms following engagement in such a program (Ahmed et al 2006; Hayes et al 2009; Sander 2008; Schmitz et al 2009a; Schmitz et al 2009b; Schmitz et al 2010). Although resistive exercise programs have been shown to be safe and effective to augment lymphedema management, the effect of yoga practice on lymphedema has been minimally studied in this population.

The practice of yoga has recently risen in popularity in the United States and yoga studios or clinics frequently offer specialized classes in yoga for BCS. Yoga practice was one of several complementary and alternative therapies used by women with BCRL (Finnane et al 2011). A review of literature to date discovered only one recent study examining the effect of yoga on BCRL. In a single cohort study, women with BCRL (n=35) were enrolled in a 4 week yoga program which consisted of one 90 minute instructor led yoga class/week, and 6 daily home yoga sessions (Douglass et al 2012). Eighteen of the original 35 participants responded to requests for follow up 6 months after

the conclusion of the 4-week yoga program. At this follow-up time period, 9 BCS had continued to practice yoga at least one day/week over the previous 6 months, and 9 had not. Measurements included arm volume using bioimpedance spectroscopy, perometry, tonometry, and subjective report of arm swelling, as well as a QOL measurement using a 10 cm visual analog scale. The difference in volume between the affected and unaffected limbs for each group was calculated and compared at baseline and again after 6 months. Researchers concluded that there was no statistical difference in this limb volume change after yoga practice compared to those who did not engage in a yoga program, but this measurement did not directly examine arm volume change in the affected limb before and after yoga practice (Douglass et al 2012). Research directly examining volume change after completion of a yoga program and the level of exposure to yoga is needed.

Other studies have investigated the effects of low impact yoga on QOL perceptions (inclusive of pain, depression and fatigue) in cancer populations. Lower sleep disturbances were reported among a group of patients with lymphoma who participated in yoga (Cohen et al 2004). Decreased overall stress and improved QOL were reported by other researchers investigating yoga practice among cancer patients (Joseph 1983; Speca et al 2000). In a qualitative study examining quality of life in group of 125 cancer patients currently undergoing radiation therapy, yoga had positive effects on increasing QOL (Joseph 1983). Ninety cancer patients exposed to mindfulness meditation during a once-weekly session including yoga practice over 7 weeks demonstrated statistically significant improvement in scores on the Profile of Mood States and Symptoms of Stress Inventory (Speca et al 2000). Among BCS, Iyengar yoga has been purported to improve peace of mind and hope in 10

participants practicing yoga once a week for 6 weeks (Thomas & Shaw 2011), decreased fatigue among 11 participants practicing yoga once a week for 12 weeks (Bower et al 2011), and improved self-reported QOL among 24 participants practicing yoga twice a week for 6-12 weeks (Speed-Andrews 2010).

Although physiologic outcomes have not yet been fully investigated in women with BCRL participating in a yoga program, the physiological effects of low impact yoga have been investigated in other populations with chronic illnesses such as hypertension and diabetes. These studies have reported positive physiological outcomes, including decreased blood pressure and body weight, and increased functional abilities such as grip strength and timed chair stands (Bower et al 2011; Cohen et al 2011; Malhotra et al 2002; Rajesh et al 2006; Selvamurthy et al 1998; Yang et al 2011). It is reasonable to believe that BCS will experience similar gains when engaged in a yoga program.

The primary purpose of this pilot study was to examine the effect of yoga on arm volume in women with BCRL. Secondary objectives were to determine the effect of yoga on QOL and self-reported arm function, and grip strength in breast cancer survivors with lymphedema. We hypothesized that participation in an 8 week yoga program would result in a reduction of arm volume, as well as improvement in QOL and arm function.

METHODS

Participants

A convenience sample of 6 women with physician diagnosed BCRL with a mean age of 57 years (range 49 to 69), and body mass index (BMI) of 27.8 kg/m² (\pm 5.6), were enrolled in this pilot study. The participants were recruited between September 2012 and

April 2013, through word of mouth, networking with physicians, breast cancer support groups, and flyers in the Dayton, Ohio area. Recruitment targeted 10-20 participants; however, 6 women were eligible to participate within the available timeframe. Inclusion criteria consisted of: female survivors of breast cancer who had lymphedema of the involved upper extremity diagnosed by a physician and independence in mobility without the use of an assistive device. Participants were excluded if they had any of the following conditions: congestive heart failure, chronic obstructive pulmonary disease, pacemakers, pregnancy, previous heart surgery, were undergoing chemotherapy or radiation therapy, or currently engaged in a yoga program. All eligible participants received written approval from their physician to participate in yoga, and had to have a properly fitting compression garment for their involved arm to wear during the yoga sessions. The Institutional Review Board at the University of Dayton (UD) approved this study.

Outcome Measures

Written informed consent was obtained from the participants by one of the investigators prior to collection of measurements. Outcomes for each participant were recorded at three different times throughout the study: Baseline (T0), mid-way through study (4 weeks) (T1), and post intervention (8 weeks) (T2). Time since BC diagnosis, duration of lymphedema, breast cancer treatments received, height and weight of participants were recorded. Outcome measures included self-reported QOL using the Functional Assessment of Cancer Therapy - Breast (FACT-B), arm function via self-report using the Disabilities of the Arm, Shoulder, and Hand (DASH) and grip strength, and bilateral arm volume. All measurements were performed in the UD Doctor of Physical

Therapy Program lab by researchers trained in assessing volume and using a hand grip dynamometer.

The FACT-B is a 36 item QOL questionnaire for BCS with good construct validity ($r = .90$) and test-retest reliability (ICC = .88) (Brady et al 1997). The DASH is a 30 item disability scale scored 0-100 with lower scores indicating less disability, with good construct validity and adequate to good test-retest reliability (ICC = .77-.98) (Beaton et al 2001; Roy et al 2009). Participants completed these questionnaires independently during measurement sessions.

Bilateral arm volume was measured with the use of a volumeter (North Coast Medical, Gilroy, CA). Use of a volumeter is recommended to accurately measure limb volume and is considered to have excellent reliability (ICC = 0.94-0.98) (Taylor 2006). Participants submerged their arm and hand into a water-filled column up to their axilla, and the volume of displaced water was recorded. To maintain consistency, a rung was placed at the same level inside the volumeter for each of the participant's trials so that each participant submerged her arm the same amount for each trial. Bilateral grip strength was measured with a Jamar hand-held grip dynamometer (Sammons Preston Roylan, Bolingbrook, IL); the best of three measurements was used for analysis.

Intervention

Within one week following baseline measurements, all participants began an 8 week yoga intervention that consisted of 3 sessions per week (2 live studio sessions and 1 recorded home session). Participants attended two Hatha yoga classes per week at a local professional yoga studio; each lasting for one hour. Yoga sessions were led by a certified

yoga instructor who had training in yoga for those with breast cancer. The yoga classes included a progression of low-impact, modified poses, stretching and isometric exercises focused on the shoulders, arms, and chest, and meditation. Breathing and poses to drain the lymphatic system were incorporated throughout the yoga practice to assist with lymphatic flow. See Appendix 1 for detail of yoga postures. The third session took place in the home where participants followed a 45 minute yoga DVD, which was a recording of the first instructor-led yoga class. Compliance was recorded on a weekly calendar. Participants were required to wear an approved compression sleeve on the involved limb throughout all yoga interventions as this is the recommended standard of care for exercise with lymphedema (Foldi 2006).

Statistical analysis

Descriptive statistics for age, BMI, time since breast cancer diagnosis, and duration of lymphedema diagnosis were calculated. Non-parametric statistical analysis was used in this small pilot sample. The Wilcoxon signed rank test was used to compare baseline (T0) and final (T2) measurements for the DASH, FACT-B Total Score, grip strength, and involved limb volume change. Effect sizes on outcomes were also calculated. Intention-to-treat analysis was employed such that T1 measurements were carried over if the final T2 measurements were unavailable. Significance was set at *a priori* at $p < .05$.

RESULTS

Baseline characteristics of participants are presented in Table 1. One participant demonstrated a sharp increase in limb volume between T1 and T2 in both limbs, likely secondary to measurement error. The T1 limb volume was therefore carried over for

analysis. Another participant was not available for final grip strength and limb volume measures; T1 data was carried over for analysis. The remaining participants were able to complete all final outcome testing.

Means and standard deviations for the FACT-B, DASH, grip strength, and limb volume for T0 and T2 are presented in Table 2. The Wilcoxon Signed Ranks Test revealed no significant differences between T0 and T2 measurements on the FACT-B ($T=2$, $p=.12$, $r=-.33$), DASH ($T=2$; $p=.34$, $r=-.13$), and hand grip strength ($T=2$, $p=.26$, $r=-.18$). However, even with a small sample size, the difference between T0 and T2 measurement of limb volume was statistically significant ($T=1$, $p=.02$, $r=-.58$). The mean volume change for all participants between T0 and T2 was 52.50 ml (± 41.81).

DISCUSSION

In this pilot study with 6 women who have BCRL, results indicate that among women with BCRL who participated in a modified Hatha yoga program over the course of 8 weeks arm volume significantly decreased. This supported our primary hypothesis that yoga practice would result in a decrease of arm volume in limbs affected by lymphedema. However, no significant change occurred in QOL or arm function measured by self-report and grip strength, and the secondary hypotheses were not supported.

Investigations examining the effect of yoga practice on arm volume in women with BCRL have been minimal, and have not directly measured limb volume change from baseline to post intervention. Our study is unique in directly investigating the change in arm volume immediately following completion of a yoga program, and these early findings

are promising. Douglass et al (2012) measured the difference between the involved and uninvolved limbs at baseline and 6 months after the conclusion of a 4-week yoga program, and found no difference between a group of BCS who remained engaged in yoga after the intervention was complete, and a group who had not. This study did not directly measure the effect of regular yoga practice on the volume of the involved limb at baseline and immediately post intervention. It is possible that changes in volume were seen after conclusion of the 4 week yoga period, but not seen at 6 months as the group which continued yoga may not have done so at enough exposure (1x/week) to maintain volume change.

Decreased arm volume following resistive exercise has been reported in multiple studies (Ahmed et al 2006; Sander 2008; Schmitz et al 2009a; Schmitz et al, 2009b; Schmitz et al 2010), and is consistent with our findings. The action of motion during yoga, although lacking a resistive component, results in muscular contraction. Proponents of complete decongestive therapy for the management of lymphedema include exercise as an important component in the management of lymphedema (Foldi 2006). This muscular contraction is believed to be an essential component in assisting the lymphatic system to move fluids via a pumping motion (Foldi 2006; Lane et al 2005). Yoga, without the added resistance, appears to engage the muscles in enough of contraction-relaxation action to enhance lymphatic fluid pumping, resulting in improved lymphatic flow and decreased arm volume.

The effect of yoga practice on QOL has been studied more extensively than other measures. Overall, improvements in QOL with yoga practice have been demonstrated in

studies measuring QOL during and after completion of a 12 week yoga program (Bower et al 2011; Speed-Andrews 2010). A systematic review and meta-analysis analyzing the effect of yoga on QOL reported that in 12 randomized controlled trials examined, moderate short term improvements in health-related QOL were found (Cramer et al 2012). That our study did not show statistically significant QOL improvements may be due to our small sample size, or a shorter duration of yoga practice. Studies reviewed had greater total exposure times (ranging from 1980 to 2160 minutes) than in our study (Speed-Andrews 2010; Bower et al 2011). The participants in the present study were engaged in a total of 1440 minutes of yoga over 8 weeks. Modifying study design to increase exposure to yoga may result in different outcomes.

Arm function among BCS is frequently impaired after treatment, yet few studies have examined the impact of yoga practice on arm function. In a qualitative study examining the effect of yoga on arm morbidities, participants reported that yoga improved mobility and helped them resume activity after breast cancer treatments (Thomas & Shaw 2011). In a meta-analysis of 13 randomized control trials of the physical benefits of yoga among BCS, physical function improvements were small and not significant (Buffart et al 2012). Physical function was measured by a variety of means, but primarily by physical subscales on QOL measures such as the SF-36 (Short Form Health Survey), FACT-B, or EORTC-QLQ-C30 (European Organization for Research and Treatment of Cancer Quality of Life Questionnaire), such that direct measures of arm function were not completed. Our results did not show a statistically significant change in arm function measured by the DASH ($p = .34$), which specifically measures arm disability. It is important to note,

however, the DASH score at T0 (11.2 ± 9.4) and T2 (10.3 ± 9.3) was lower (indicating less disability) than those reported in a normal population (14.3 ± 14.9) (Jester et al 2005). It is possible that the participants in this study had minimal functional deficits in their involved limb at the onset of the study. To further support this assessment is that 4 of the 6 participants had lymphedema on their non-dominant limb. This is important to consider as the DASH does not direct questions at a particular limb, but rather the ability to complete a task, regardless of which limb is used (Solway et al 2002). It is possible that the DASH was unable to assess arm function of the involved limb since in two-thirds of participants, the dominant and most frequently used limb was not affected by lymphedema. Thus, a larger sample with more diverse levels of arm function would be required to adequately examine the impact of yoga on arm function.

Grip strength is frequently assessed as a measure of overall health, and has been examined in BCS. Hand grip strength was fair to moderately correlated with arm motion ($\rho = 0.358-.0531$) (Cantarero-Villanueva et al 2011). As such, measuring hand grip strength among yoga participants was intended to measure overall functional health. The results in this study did not show a statistically significant gain in grip strength ($p = .26$). Comparing our results to normative grip strength among women, our results are similar to those of the general population (Peters et al 2011), suggesting that these women did not begin the study with any strength deficits. As arm motion measurements were not taken, we cannot draw conclusions about any correlation with arm function or overall health in this population. Future studies should include more specific strength and range of motion measures to determine whether yoga can make a positive change in these measures.

Limitations of this study combined with promising findings in relation to arm volume present opportunities to further investigate the effect of yoga among women with BCRL. Along with our small sample size, the volumeter was problematic to use since the participant must remain completely still for the duration of the measure, otherwise additional fluid would drain, increasing the risk of measurement error. Furthermore, the choice of outcome measures did not fully reflect changes in arm function. The small sample size needs to be addressed through further study with more participants. Utilizing clinically relevant measurement techniques, such as measuring arm volume with a non-flexible tape measure using a truncated cone volume formula will likely reduce measurement error that we observed with the volumeter. Lastly, measuring arm motion and strength directly will provide a clearer picture of the impact of yoga on upper extremity function.

CONCLUSION

The results of this pilot study examining the effect of yoga on arm volume in women with BCRL are promising, showing a statistically significant decline in arm volume following 8 weeks of yoga participation, providing women with BCRL with another exercise to assist in managing lymphedema. Further study is needed to determine whether yoga practice has a positive impact on QOL as well as self-reported arm function and grip strength.

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Table 1: Participant Demographics

	Age (years)	BMI	Length of BC Diagnosis (months)	Duration of Lymphedema (months)	Dominant Arm Involved
N = 6	57 (± 7)	27.8 (± 5.6)	174.75 (± 83.69)	94.50 (± 70.06)	2

Table 2: Outcome Measures at Baseline and Post Intervention

	FACT-B Total		DASH		Grip Strength (kg)		Limb Volume (ml)*	
	T0	T2	T0	T2	T0	T2	T0	T2
N=6	120.2	124.5	11.2	10.3	27.8	28.8	2423.3	2370.8
	(±15.2)	(±12.8)	(±9.4)	(±9.3)	(±2.2)	(±5.6)	(±597.2)	(±577.2)

T0 = baseline; T2 post intervention

*Significant $p < .05$

Appendix: Yoga Sequence

Warm-ups and Centering

Poses	Modifications
<ul style="list-style-type: none"> • Ujjayi breath in seated • Neck stretches and rolls • Shoulder shrugs and rolls • Isometric shoulder blade squeeze • Isometric chest press • Shoulder circles • Wrist stretches • Fist clench • Gentle backbend • Seated forward fold with legs crossed • Seated Spinal Twist • Cat/Cow • Spinal balance • Downward facing dog 	<ul style="list-style-type: none"> • Half spinal balance • Table top

Standing Poses

Poses	Modifications
<ul style="list-style-type: none"> • Warrior I Flow (bending and straighten arms and legs in a flow) • Exalted Warrior • Warrior II • Triangle Pose • Tree Pose 	<ul style="list-style-type: none"> • Hands at heart center or hips • Reaching arm up instead of reaching back into the backbend • Hands at heart center or on hips • Use a block or bend extended leg if the hamstrings are tight • May come to the wall and place a hand on wall if balance is unsteady Intensity adjusted by walking toes out to the center of the room or by adjusting the placement of extended arm at the wall.

Seated Poses

Poses	Modifications
<ul style="list-style-type: none"> • Seated Forward Fold • Seated Spinal Twist with bottom leg extended • Bound Angle with hands interlaced behind the back • Cow Face with arms • Pigeon Pose • Child's Pose 	<ul style="list-style-type: none"> • Use a strap wrapped around the balls of the feet or bend the knees • If shoulders are tight, can grab for wrist instead, or hold the feet • Use a strap for tight shoulders • Lie on back and place one ankle on top of the opposite thigh in “number 4 pose”. Then either interlace hands behind thigh or shin and draw legs in towards the chest • Legs wide a part with big toes touching

Finishing Poses

Poses	Modifications
<ul style="list-style-type: none"> • Pelvic tilts on back • Bridge pose • Crunches • Stretch out long on mat – full body • Knees to chest with side-side roll • Supine twist • Legs-up-the-wall • Savasana 	<ul style="list-style-type: none"> • Block under the sacrum for support • Feet can stay on the floor • Can keep knees together instead of crossing knee over opposite thigh • Bolster or blanket under hips for support and extra height • Bolster under the knees to protect low back

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