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A Pilot Randomized Trial Evaluating Low-Level Laser Therapy as an Alternative Treatment to Manual Lymphatic Drainage for Breast Cancer-Related Lymphedema

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Abstract

Purpose/Objectives—To examine the impact of advanced practice nurse (APN) administered low level laser therapy (LLLT) as both a stand-alone and complementary treatment for arm volume, symptoms, and quality of life (QOL) in women with breast cancer related lymphedema.

Design—A three-group, pilot, randomized clinical trial.

Setting—A private rehabilitation practice with two locations in the southwestern United States.

Sample—46 breast cancer survivors with treatment related lymphedema.

Methods—Patients were screened for eligibility and then randomized to either manual lymphatic drainage (MLD) for 40 minutes, LLLT for 20 minutes, or, 20 minutes of MLD followed by 20 minutes of LLLT. Compression bandaging was applied after each treatment. Data were collected pre-treatment, daily, weekly, and at the end of treatment.

Main Research Variables—Independent variables consisted of three types of APN administered lymphedema treatment. Outcome variables included limb volume, extracellular fluid, psychological and physical symptoms, and QOL.

Findings—No statistically significant between group differences were found in volume reduction; however, all groups had clinically and statistically significant reduction in volume. No group differences were noted in psychological and physical symptoms, or QOL; however, treatment related improvements were noted in symptom burden within all groups. Skin improvement was noted in each group that received LLLT.

Conclusions—LLLT with bandaging may offer a time saving therapeutic option to conventional MLD. Alternatively compression bandaging alone could account for the demonstrated volume reduction.

Implications for Nursing—APNs can effectively treat lymphedema. APNs in private healthcare practices can serve as valuable research collaborators.

Introduction

Decreases in breast cancer mortality rates, combined with the relatively high five-year survival rates for local and regional tumors, suggest that the estimated 2.6 million breast cancer survivors living in the United States (American Cancer Society, 2011; Herdman et al., 2005; Siegel, Naishadham, & Jemal, 2013) represent a significant and growing population. Lymphedema swelling in the affected arm is a serious problem for many breast cancer survivors with documented rates of 6 to 40% (Armer, Fu, Wainstock, Zagar, & Jacobs, 2004; Ball, Waters, Fish, & Thomas, 1992; Ivens et al., 1992; Kissin, Querci Della Rovere, Easton, & Westburry, 1986; Petrek & Heelan, 1998; Wilke et al., 2006). This range includes the 7%-22% of women with lymphedema following sentinel node biopsies (Armer et al., 2004; Wilke et al., 2006). Lymphedema can occur during treatment, or many years later (Coward, 1999; Ramos, O'Donnell, & Knight, 1999; Stanton, Levick, & Mortimer, 1997). Lymphedema is a progressive disease. Initially, the limb will swell and pit with pressure (stage I). Overtime, the limb may become firmer, not pit with pressure, and skin changes may be noted (stage II). In its most severe form, (stage III), impaired lymph flow causes very thick skin and large skin folds, and invasive treatments may be needed to reduce bulk (Pain & Purushotham, 2000). Many problematic symptoms such as fatigue and altered sensations in the limb can occur with lymphedema (Ridner, 2005) and some breast cancer survivors with lymphedema experience poor quality of life (QOL; Park, Jang, & Seo, 2012; Ridner, 2005). To improve health outcomes in this population, access to effective therapeutic modalities is necessary.

Literature Review

Manual lymphatic drainage (MLD) with compression is the primary therapeutic component of complete decongestive therapy, the standard for volume-reduction treatment for breast cancer-related lymphedema (Rockson, 2001). MLD with compression purports to move lymphatic fluid from the extracellular spaces by manually opening lymphatic channels and assisting in fluid movement. Compression facilitates continued movement of fluid subsequent to the massage component of the therapy, reducing the volume of swelling.

Historically, certified lymphedema therapists with mixed professional backgrounds such as nursing, physical therapy, and massage therapy, sought certification and provided and successfully billed for lymphedema treatment services. However, attempts have been made, through billing procedure changes, to move lymphedema treatment primarily into the hands of physical therapists (NLN, 2012). These providers may or may not have been trained or certified as lymphedema therapists and may not be available in underserved areas. This change in reimbursement has reduced access to lymphedema therapy for many people. Advanced practice nurses (APNs) typically practice in underserved areas and can bill for services. These nurses have opportunities to provide comprehensive lymphedema care including patient and family education, management of lymphedema-associated symptoms, assessment of arm volume and skin-related changes, and administration of volume-reduction therapies.

Low level laser therapy (LLLT) (wave lengths 650-1000 nm) is a U.S. Food and Drug Administration (FDA)-approved therapeutic intervention for treatment of arm lymphedema. LLLT can be administered by individuals trained in the use of the device (Anderson, Piller, Gannon, Carati, & Angel, 2008). LLLT is believed to stimulate lymphatic motricity (movement), lymphangiogenesis, and macrophage activity, and soften fibrotic tissues, improving contractility in the tissues that assist with lymph transport through the lymphatic

vessels (Anderson, Piller, Carati, Gannon, & Angel, 2004; Lievens, 1991a, 1991b; Stergioulas, 2004; Young, Bolton, Dyson, Harvey, & Diamantopoulos, 1989). These mechanisms increase movement of pooled fluid from the extracellular spaces into the lymphatic system for transport.

Studies have evaluated the influence of LLLT on lymphedema in breast cancer survivors with mixed results regarding amount of volume reduction and degree of symptom relief (e.g., pain) (Carati, Anderson, Gannon, & Piller, 2003; Kaviani, Fateh, Yousefi Nooraie, Alinagizadeh, & Ataie-Fashtami, 2006; Kozanoglu, Basaran, Paydas, & Sarpel, 2009; Piller & Thelander, 1998). None of these studies reported complications from LLLT. Although the number of LLLT sessions and exposure time to the laser varied across studies, overall results are supportive of LLLT as a lymphedema treatment and demonstrate the feasibility of conducting LLLT studies in breast cancer survivors with lymphedema.

LLLT offers APNs trained in the use of the device an opportunity to directly provide treatment for their patients with lymphedema. Demonstrated successful use of LLLT by APNs could impact current standards of care and treatment delivery by offering alternatives to current treatment, earlier intervention, and increasing access to a pool of providers.

Based upon the physiological mechanisms of action ascribed to LLLT, the authors of this article theorized that LLLT should reduce lymphatic-associated swelling. The purpose of the pilot study was to examine the impact of APN-administered LLLT, as both a stand-alone and complementary treatment for arm volume, symptoms, and QOL in breast cancer survivors with treatment-related lymphedema and to use data obtained in this study to power future studies. The specific aims for this pilot study were:

- To compare the effectiveness of APN-administered LLLT with compression on arm volume reduction to MLD with compression.
- To determine if APN-administered combined LLLT and MLD with compression reduces arm volume more quickly than MLD with compression or LLLT with compression alone.
- To compare the impact of APN-administered MLD with compression, APN-administered LLLT with compression, and APN-administered combined LLLT and MLD with compression on physical and psychological symptoms/outcomes.
- To compare the impact of APN-administered MLD with compression, APN-administered LLLT with compression, and APN-administered combined LLLT and MLD with compression on QOL.

Design/Research

This study was a pilot randomized clinical trial. Participants were randomized into one of three treatment groups via computer-generated randomization using a permuted block scheme. The groups were LLLT alone, MLD alone, or combined MLD and LLLT. Compression bandaging was applied after each treatment.

Setting

The School of Nursing at Vanderbilt University in Nashville, TN was the coordinating site for this study. All treatment was provided by the same APN at Rehabilitation Associates of Naples (RAN), a private medical practice in Florida. All patients were seen over a 30-month period of time. They were recruited from patients presenting for lymphedema treatment at RAN, via letters to area oncologists and breast cancer and lymphedema support groups, through restroom advertising, and through a flyer posted on the National Lymphedema

Network Website. Some participants also learned of the study through searches on the Clinical Trials.gov website.

Sample

Participants were breast cancer survivors with treatment related lymphedema. Inclusion criteria were: being age 21 or older, requiring professional treatment for stage I or II lymphedema as determined by a physician and defined by the International Society of Lymphology (1995), having an order for lymphedema treatment, and were willing and able to drive to the study sites. Individuals were excluded if they were actively undergoing intravenous chemotherapy or radiation therapy, experiencing bilateral lymphedema that prohibited comparison to an unaffected limb, unable to stand upright for measurement of height and weight, known to have active cancer, were pregnant, known to have artificial joints in areas where electrode placement is critical, or have a pacemaker/internal defibrillator, and known to have congestive heart failure, chronic/acute renal or hepatic disease, pulmonary edema, thrombophlebitis, deep vein thrombosis, acute infection of any kind, or inflammation in the trunk or arms.

Methods

Institutional review board approval was obtained from two separate entities, Vanderbilt University and the RCRC Independent Review Board prior to solicitation of participants. Written informed consent was obtained prior to enrollment and randomization.

Procedures

Baseline and outcome data were collected pre-treatment and the last day of treatment after therapy was concluded. Arms were measured during treatment. All participants received lymphedema therapy administered by the second author, an APN who is also a certified lymphedema therapist experienced in administering all treatment modalities. Treatment for each group was performed and compression bandaging was applied immediately after treatment regardless of group assignment.

Low-level laser therapy—Treatment was administered using a RianCorp LTU 904, FDA-approved, Class 1 laser. The second author was experienced in the use of the laser and RAN had incorporated this laser into its practice for eight months prior to initiation of this study. Grids for the areas to be treated were identified. The laser was applied and using the timer exposure was limited to 20 to 30 seconds per point in each grid. Time for each session using this this procedure was approximately 20.

Manual lymphatic drainage—Treatment followed international standards (Földi, Földi, Kubik, & Asmussen, 2006). A standard number of strokes was used at each anatomical location. Each MLD session took about 40 minutes.

Combined manual lymphatic drainage and low-level laser therapy—Participants received 20 minutes of LLLT, followed by 20 minutes of MLD. The same treatment procedures as described above for each modality were used.

To ensure treatment fidelity, the first author made an initial and annual observational visits to the study sites from 2009 to 2012 to observe the second author for protocol adherence across all three treatment modalities. No deviations were noted on any visit. Bioelectrical impedance (as measured in units of L-Dex values) and volume measurements were completed by the second author and by a trained certified lymphedema therapist who

randomly conducted measurements to reduce potential bias. The first author also observed measurements by each person to insure standardization of techniques.

Instruments

Outcome variables included L-Dex scores (extracellular fluid), arm volume, psychological and physical symptoms, and QOL. Data were obtained for all participants using the following instruments.

Demographic, breast cancer and lymphedema history and treatment forms— Demographic information included date of birth (used for calculating age), years of education completed, race, marital status, income, employment status, the presence of any concurrent medical conditions, current medication use, area of residence, and insurance status. Cancer treatment and history information included date of breast cancer diagnosis, location, stage, and type and dates of treatment. Lymphedema history and treatment information included diagnosis of lymphedema, location, stage, type and dates of initial treatment, and current treatment.

Extracellular fluid with bioelectrical impedance—An XCA single-frequency bioimpedance device manufactured by Impedimed of Mansfield, Australia was used to determine L-Dex scores.

Arm volume with circumferential measurement—A non-stretch tape measure was used. Measurement started at the ulnar styloid and the skin was marked in 4 cm increments up the arm from the ulnar styloid to the axilla with a washable marker for use in additional measurements. Measurements were made twice and the average was used to calculate arm volume.

Height and weight—Height and weight were measured twice using scales with height bars. Averages were used to determine final values.

Skin assessment checklist—A 19-item checklist created by the researchers and used by the team in prior studies, was used to document skin condition on affected and unaffected arms as determined by a physical examination of the limbs.

Lymphedema Symptom Intensity and Distress Scale-Arm (physical and psychological symptoms)—This 36-item Lymphedema Symptom Intensity and Distress Scale-Arm (LSIDS-A) symptom checklist requires participants to indicate the presence of a symptom in the past week (“yes” or “no” responses). If participants indicate that, yes, a symptom was experienced, they then rate its intensity and associated distress on two separate 10-point numeric scales, from 1 (slight) to 10 (severe) intensity and distress (Ridner & Dietrich, 2010). Face validity and reliability (Cronbach alpha = 0.95) have been established (Ridner & Dietrich, 2010).

Brief Fatigue Inventory (fatigue)—The **Brief Fatigue Inventory (BFI)** is a nine-item scale designed to measure fatigue in patients with cancer. Concurrent and discriminant validity have been documented and alpha coefficients of 0.96 have been established (Mendoza et al., 1999). Individuals rate various aspects of fatigue on a scale of 0 (no fatigue) to 10 (as bad as one can imagine) (Mendoza et al., 1999). The internal consistency of the score was 0.95 (Cronbach alpha) at both times of assessment in this study.

Profile of Mood States–Short Form—Among oncology populations, the **Profile of Mood States–Short Form (POMS-SF)** possesses reliability and validity equal to that of the

full-length POMS (Curran, Andrykowski, & Studts, 1995; McNair, Lorr, & Droppleman, 1981; Shacham, 1983). Cronbach alphas for the POMS-SF total mood disturbance and subscale scores ranged from 0.82–0.94 in this study.

Center for Epidemiologic Studies–Depression—The Center for Epidemiologic Studies–Depression (CES-D) is a 20-item, self-report measure that assesses the presence and severity of depressive symptoms occurring in the prior week (Radloff, 1977). Validity and reliability of the CES-D were established by comparison of depressed individuals to healthy controls which revealed statistically significant differences noted in depression scores ($p < 0.001$) and alpha coefficients of 0.89 (patient group) and 0.87 (healthy group) (Hann, Winter, & Jacobsen, 1999). Cronbach alpha for the scores in this study were 0.82 at baseline and 0.85 at last assessment.

Upper Limb Lymphedema-27—The **Upper Limb Lymphedema-27 (ULL-27)** instrument measures QOL related to arm limb lymphedema (Launois & Megnigbeto, 2001). During the instrument development process, construct validity was determined by correlation with the SF-36 and Cronbach alphas were less than 0.82 for all dimensions (Launois & Megnigbeto, 2001). Cronbach alphas for the ULL-27 overall and subscale scores ranged from 0.76–0.93 in this study.

Functional Assessment of Cancer Therapy–Breast—The 36-item Functional Assessment of Cancer Therapy–Breast (FACT-B) has five domains: physical well-being, social/family well-being, emotional well-being, functional well-being, and breast cancer concerns (Cella, 1997). Cronbach alphas for the FACT-B overall score were 0.95 and 0.90 at baseline and the last assessment in this study, respectively. The internal consistency of the subscale scores ranged from 0.59–0.89.

Statistical Analyses

Statistical summaries and analyses were conducted using SPSS version 20. Nominal and ordinal participant characteristics were summarized using frequency distributions. Tests for differences in those characteristics between the two study groups were conducted using chi-square tests of independence. Most of the continuous study and patient characteristic data distributions were heavily skewed; therefore, with the exception of the two age characteristics which were normally distributed, those distributions were summarized using the median as the indicator of central tendency. The 25^{th}-75^{th} interquartile range (IQR) was used as an indicator of variability because, regardless of the shape of a distribution, it defines the middle 50% of cases.

Mann-Whitney U tests were used to compare the demographic and clinical characteristics of the two groups. All data were rank transformed to meet the parametric assumptions of the analysis strategies used for testing the study hypotheses. Mixed general linear modeling analysis was used for testing those hypotheses. The two factors included in the analysis were group (LLLT, MLD, and MLD and LLLT) and time of assessment (baseline, last treatment). The interaction effect (group by time of assessment) provided the primary test of the hypotheses (i.e., that the changes in an outcome variable would be greater over time for one group than for another). In addition to this primary test, each analysis also provided a test of overall change in outcome variables over time regardless of group (i.e., main effect of time) as well as a test of whether groups differed overall regardless of time (i.e., main effect of study group).

Finally, effect sizes for the changes from baseline to end-of-study were generated using the standard Cohen effect size measure. They are presented to further illuminate the effects of

the three different types of therapy. For example, a change of 10 points means something very different if the baseline value was 50, compared to that respective change from a baseline of 20. The effect sizes reported standardize those baseline differences. All tests of statistical significance maintained a maximum alpha value of .05 ($p < .05$).

Findings

Characteristics

The sample (N=46) consisted primarily of Caucasian females and had an average age of 66.6 years (SD=10.4). The demographic and medical characteristics of the participants randomly assigned to each of the three study conditions are summarized in Table 1. With the exception of some slight differences among the distributions of location of residence, there were no statistically or clinically meaningful differences among the groups in terms of demographic and medical characteristics (e.g. lymphedema duration).

Extracellular Fluid and Arm Volume

Extracellular fluid was assessed using bioelectrical impedance (L-Dex) and arm volume using circumferential measurement. No statistically significant differences among the groups were observed at baseline. Statistically significant reductions in L-Dex values did occur in all of the groups from their respective baseline values (main effect of time of assessment, $p < 0.001$). The difference in reduction among the study groups was not statistically significant ($p = 0.984$) with all of the effect sizes being essentially equivalent (see Table 2).

As with impedance, a statistically significant reduction in circumferential measurement and resulting arm volume calculations was seen overall for all groups ($p<0.001$); however, no statistically significant difference in the patterns of changes among the study groups ($p=0.422$). Slightly larger and comparable effect sizes were seen in the LLLT and combined LLLT-MLD groups (*effect size*= −0.64) than that observed in the MLD group (*effect size*= −0.42). The average number of treatment sessions by group was eight for MDL, ten for LLLT, and ten for combined MLD and LLLT. This too was not statistically significant.

Physical and psychological symptoms and skin condition

The number of symptoms reported at each assessment, as well as the self-reported symptom burden, determined by multiplying intensity and distress scores reported on the LSIDS-A, are summarized in Table 3. No statistically significant differences among the groups were observed at baseline. Similar to the findings for arm volume, no statistically significant differences among the groups in terms of change in the symptom number, type, or burden. The median number of symptoms was between 13-14 for all groups at baseline and did not change substantially for any of the groups at the end of the study (median 12-14). Overall symptom burden saw a statistically significantly decrease for all groups from baseline to end of study ($p<0.05$) with effect sizes being essentially equivalent within all three groups (−0.41 to −0.46). Summaries of the effects of each of the therapies on subsets of symptoms, as well as specific symptoms with a prevalence of at least 50% at baseline are also presented in Table 3. No clear, consistent patterns of greater or lesser effects of the therapies were observed.

Finally, the number of skin conditions reported by the participants is reported at the bottom of Table 3. While the number of conditions reported were typically quite low (median values between 2 and 3 for the affected arm), there was a statistically significant greater reduction in that number within LLLT and combined LLLT-MLD groups than within the MLD group (effect sizes: −1.15, −1.65, −0.44 respectively).

QOL

QOL and indicators of functioning were relatively high for all participants at baseline entry into the study (see table 4). As such, most indicators demonstrated little change over the course of the study and no differences among the groups were statistically significant. The FACT- B subscale demonstrated the strongest amount of change of all of the measures for all of the groups ($p<0.001$). While not statistically significantly different, the strongest effects were observed within the LLLT and combined LLLT-MLD groups (*effect sizes* = 0.49 and 0.47 respectively) than those observed in the MLD group (*effect size* = 0.27). Also, although not statistically significant, a similar pattern of effect sizes for change over the course of the study was demonstrated by the ULL-27.

Discussion

Previous studies have demonstrated that MLD and LLLT are potentially effective in treatment of breast cancer lymphedema (Carati et al., 2003; Kaviani et al., 2006; Kozanoglu et al., 2009; Piller & Thelander, 1998; Sitzia, Sobrido, & Harlow, 2002). Therefore our findings that participants in all groups experienced significant arm volume reduction are supported by current literature. The findings of no statistically significant difference in the amount of such reductions between the three groups also suggests that a 20 minute dose of LLLT when followed immediately by compression bandaging is potentially as effective in reduction of arm volume as 40 minute sessions of MLD or combined MLD and LLLT followed by compression bandaging . This preliminary finding is noteworthy, as the shorter duration of each LLLT session is less burdensome to patients and less time consuming for therapists. Given the lengthy wait times in many lymphedema centers, shorter treatment times could increase the volume of patients seen in such center on a daily basis.

Despite these findings, it is important to note that an alternative explanation for the volume reduction, although untestable by this study design, is that compression bandaging alone could account for the demonstrated volume reduction. This too, if true, could reduce patient burden and duration of treatment sessions. The authors' data do not appear to support a synergistic relationship between more burdensome combined MLD and LLLT in volume reduction and no comparative data could be located in the current literature. Because all of the effect sizes for volume reduction were essentially equivalent, future studies would require a substantially larger number of patients to detect differences

Significant improvement in symptom burden was noted within each group. This suggests that all treatment modalities provide symptomatic relief. The lack of improvement in QOL may be explained by the relatively high QOL for all participants at baseline, or instead, QOL benefits may not manifest until days or weeks after the end of acute treatment (Kim, Yi, & Kwon, 2007). Skin conditions improved in both groups that received LLLT. This finding is supported by recent studies that have demonstrated the effectiveness of LLLT when combined with combined fractional radiotherapy in the treatment of human acne (Yeung, Chan, Shek, & Chan, 2012) and open wounds in rat models (Dadpay, Sharifian, Bayat, Bayat, & Dabbagh, 2012; Hussein, Alfars, Falih, & Hassan, 2011).

This study demonstrates that an APN, who has lymphedema training and certification, can perform multiple types of lymphedema therapy and achieve acceptable clinical outcomes. This raises questions as to the necessity of having a degree in a rehabilitative care profession to effectively treat lymphedema and may be indicative that specialized lymphedema training is a key component to achieving positive outcomes. Therefore, this study has potential implications for current reimbursement guidelines and access to treatment. In 2005, the Center for Medicare and Medicaid Services issued a policy/document that only licensed physical therapists, occupational therapists, speech therapists, physical therapist assistants,

or certified occupational therapist assistants, and nurse practitioners in special instances would be reimbursed for rehabilitation services (NLN, 2012). Lymphedema treatment falls under rehabilitation. Specialized lymphedema training and certification was not required.

Findings from this study clearly support that reimbursement to APNs who are certified to treat lymphedema should continue. Prior to 2005, nurses without advanced degrees with lymphedema training/certification, could provide lymphedema treatment. The 2005 change removed these qualified nurses as providers, overnight reducing the supply of lymphedema therapists. Long wait lists for lymphedema treatment remain common today and large geographical areas of the country have no therapists. RNs have varying levels of formal education (associates degree to doctorate), as do many of the professionals currently being reimbursed for lymphedema treatment (e. g. physical therapist assistants with an associate degree and physical therapists with a doctorate). Although this study demonstrated that APNs who are certified to treat lymphedema could be effective, given the current reimbursement model that allows for more formally educated professionals to directly provide therapy and to supervise others with less formal education as they conduct the therapy, it seems logical to consider the possibility that RNs with less formal education who are trained and certified as lymphedema therapists might also be successful if supervised by an APN. Given that Department of Labor statistics show that RNs outnumber the combined number of physical therapists, occupational therapists, speech therapists, physical therapist assistants, or certified occupational therapist assistants approximately 5:1, access to treatment and potential cost of treatment might improve if lymphedema-trained RNs were allowed to be therapists.

Findings from this study must be considered in light of its limitations and strengths. Regarding limitations, this is a small, pilot study and there may not have been enough power to detect group differences among treatment modalities. Also, the dose of each intervention varied by individual patient because current reimbursement does not cover lymphedema therapy once reduction has slowed or stopped and the authors' findings should not be interpreted to imply that LLLT using a different strength laser will produce similar results. Although not ideal, this does reflect the current state of practice. Finally, the data collectors were not consistently blinded to treatment group.

The study also has a number of strengths. As far as the authors can determine, this study is the first to simultaneously compare LLLT, MLD, and a combined MLD and LLLT treatment. All treatment modalities were delivered by a highly trained APN who is certified as a lymphedema therapist. Two separate measurement methods were used to determine volume reduction and similar results were found. In addition, the success of this study supports additional research between academic health science centers and private healthcare practices.

Implications for Nursing Practice

This study demonstrates the APN can effectively use multiple modalities to effectively treat lymphedema and that APNs, if trained, could implement lymphedema therapy in their clinical practice. As many lymphedema training schools accept nurses as students, advanced practice nurses with an interest in lymphedema may wish to consider special training in treatment of lymphedema. For those nurses who are already providing lymphedema therapy, LLLT with bandaging may offer a time saving therapeutic option to conventional MLD that reduces burden not only for the therapist, but also for the patient. This study also demonstrates that advanced practice oncology nurses in private healthcare practices can serve as valuable research collaborators and should consider becoming more involved in clinical research.

Implications for Research

The findings support the need for future research regarding both lymphedema treatment and healthcare professional treatment delivery. Treatment research is indicated that compares MLD and LLLT in a larger study that also examines the role of compression bandaging in volume reduction and evaluates use of LLLT in patients with lymphedema who experience skin problems. Healthcare professional research could compare lymphedema therapies delivered by lymphedema-trained and -certified RNs to physical therapists or occupational therapists with and without lymphedema certification, speech therapists, or occupational therapists without lymphedema certification.

Conclusions

LLLT with bandaging may offer a time saving therapeutic option to conventional MLD; alternatively, compression bandaging alone could account for the demonstrated volume reduction. APNs who have been trained in lymphedema therapy can successfully treat lymphedema. Additional research is needed to examine LLLT and healthcare professional treatment delivery alternatives.

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References

American Cancer Society. Breast cancer facts and figures 2011-2012. Author; Atlanta, GA: 2011.

Anderson, SN.; Piller, NB.; Carati, CJ.; Gannon, B.; Angel, AP. Treating lymphoedema with low level laser therapy. 2004. Retrieved from http://services.bepress.com/eci/tissue_regen/16

Anderson, SN.; Piller, NB.; Gannon, B.; Carati, CJ.; Angel, AP. Randomised, double blinded, placebo controlled, crossover trial determining the effect of treating post-mastectomy lymphoedema with LTU-904H laser therapy. 2008. Retrieved from http://riancorp.com/media/ClinicalTrialSummary.pdf

Armer J, Fu R, Wainstock JM, Zagar E, Jacobs LK. Lymphedema following breast cancer treatment, including sentinel lymph node biopsy. Lymphology. 2004; 37:73–91. [PubMed: 15328760]

Ball AB, Waters R, Fish S, Thomas JM. Radical axillary dissection in the staging and treatment of breast cancer. Annals of the Royal College of Surgeons of England. 1992; 74:126–129. [PubMed: 1567131]

Carati CJ, Anderson SN, Gannon BJ, Piller NB. Treatment of postmastectomy lymphedema with low-level laser therapy: A double blind, placebo-controlled trial. Cancer. 2003; 98:1114–1122. doi: 10.1002/cncr.11641. [PubMed: 12973834]

Cella, D. Manual of the Functional Assessment of Chronic Illness Therapy (FACIT) measurement system. Northwestern University, University Feinberg School of Medicine; Evanston, IL: 1997.

Coward DD. Lymphedema prevention and management knowledge in women treated for breast cancer. Oncology Nursing Forum. 1999; 26:1047–1053. [PubMed: 10420422]

Curran SL, Andrykowski MA, Studts JL. Short form of the Profile of Mood States (POMS-SF): Psychometric information. Psychological Assessment. 1995; 7:80–83. doi: 10.1037/1040-3590.7.1.80.

Dadpay M, Sharifian Z, Bayat M, Bayat M, Dabbagh A. Effects of pulsed infra red low level-laser irradiation on open skin wound healing of healthy and streptozotocin- induced diabetic rats by biomechanical evaluation. Journal of Photochemistry and Photobiology B: Biology. 2012; 111:1–8. doi: 10.1016/j.jphotobiol.2012.03.001.

Földi, M. Földi's textbook of lymphology. Urban and Fischer Verlag; München, Germany: 2006.

Hann D, Winter K, Jacobsen P. Measurement of depressive symptoms in cancer patients: Evaluation of the Center for Epidemiological Studies Depression Scale (CES D). Journal of Psychosomatic Research. 1999; 46:437. doi: 10.1016/S0022-3999(99)00004-5. [PubMed: 10404478]

Herdman, R.; Norton, L.; Breast Cancer Research Foundation. Institute of Medicine. National Cancer Policy Board. Committee on New Approaches to Early Detection and Diagnosis of Breast Cancer. National Research Council. Saving women's lives: Strategies for improving breast cancer detection and diagnosis. A Breast Cancer Research Foundation and Institute of Medicine symposium. National Academies Press; Washington, DC: 2005.

Hussein AJ, Alfars AA, Falih MA, Hassan AN. Effects of a low level laser on the acceleration of wound healing in rabbits. North American Journal of Medical Sciences. 2011; 3:193–197. doi: 10.4297/najms.2011.3193. [PubMed: 22540090]

International Society of Lymphology. The diagnosis and treatment of peripheral lymphedema. Consensus document of the International Society of Lymphology executive committee. 1995. Retrieved from http://www.u.arizona.edu/~witte/ISL.htm

Ivens D, Hoe AL, Podd TJ, Hamilton CR, Taylor I, Royle GT. Assessment of morbidity from complete axillary dissection. British Journal of Cancer. 1992; 66:136–138. doi:10.1038blc.1992.230. [PubMed: 1637663]

Kaviani A, Fateh M, Nooraie RY, Alinagi-zadeh M, Ataie-Fashtami L. Low- level laser therapy in management of postmastectomy lymphedema. Lasers in Medical Science. 2006; 21:90–94. doi: 10.1007/s10103-006-0380-3. [PubMed: 16673054]

Kim SJ, Yi CH, Kwon OY. Effect of complex decongestive therapy on edema and the quality of life in breast cancer patients with unilateral leymphedema. Lymphology. 2007; 40:143–151. [PubMed: 18062617]

Kissin MW, Querci Della Rovere G, Easton D, Westburry G. Risk of lymphoedema following the treatment of breast cancer. British Journal of Surgery. 1986; 73:580–584. doi:10.1002/bjs1800730723. [PubMed: 3730795]

Kozanoglu E, Basaran S, Paydas S, Sarpel T. Efficacy of pneumatic compression and low-level laser therapy in the treatment of postmastectomy lymphoedema: A randomized controlled trial. Clinical Rehabilitation. 2009; 23:117–124. doi: 10.1177/0269215508096173. [PubMed: 19164399]

Launois R, Megnigbeto AC. A specific quality of life scale in upper limb lymphoedema: The ULL-27 questionnaire. Quality of Life Research. 2001; 35(Suppl.):181–187.

Lievens PC. The effect of a combined HeNe and IR laser treatment on the regeneration of the lymphatic system during the process of wound healing. Lasers in Medical Science. 1991a; 6:193–199. doi:10.1007/BF02032548.

Lievens PC. The effect of IR laser irradiation on the vasomotricity of the lymphatic system. Lasers in Medical Science. 1991b; 6:189–191. doi:10.1007/BF02032547.

McNair, PM.; Lorr, M.; Droppleman, L. POMS Manual. Educational and Industrial Testing Service; San Diego, CA: 1981.

Mendoza TR, Wang XS, Cleeland CS, Morrissey M, Johnson BA, Wendt JK, Huber SL. The rapid assessment of fatigue severity in cancer patients. Cancer. 1999; 85:1186–1196. doi: 10.1002/(SICI)1097-0142(19990301)85:5<1186::AID-CNCR24>3.0.CO;2-N. [PubMed: 10091805]

National Lymphedema Network. Action Alert: Change to Medicare Reimbursement Ruling. 2012. Retrieved from http://www.lymphnet.org/lymphedemaFAQs/legislation/actionAlert/legMedicare.htm

Pain SJ, Purushotham AD. Lymphoedema following surgery for breast cancer. British Journal of Surgery. 2000; 87:1128–1141. doi: 10.1046/j.1365-2168.2000.01569.x. [PubMed: 10971418]

Park JE, Jang HJ, Seo KS. Quality of life, upper extremity function and the effect of lymphedema treatment in breast cancer-related lymphedema patients. Annals of Rehabilitation Medicine. 2012; 36:240–247. doi: 10.5535/arm.2012.36.2.240. [PubMed: 22639749]

Petrek JA, Heelan MC. Incidence of breast carcinoma-related lymphedema. Cancer. 1998; 83(Suppl. 12):2776–2781. doi: 10.1002/(SICI)1097-0142(19981215)83:12B+<2776::AID-CNCR25>3.0.CO;2-V. [PubMed: 9874397]

Piller N, Thelander A. Treatment of chronic postmastectomy lymphedema with low level laser therapy: A 2.5 year follow-up. Lymphology. 1998; 31:74–86. [PubMed: 9664272]

Radloff LS. The CES-D scale: A self-report depression scale for research in the general population. Applied Psychological Measurement. 1977; 1:385–401. doi:10.1177/014662167700100306.

Ramos SM, O'Donnell LS, Knight G. Edema volume, not timing, is the key to success in lymphedema treatment. American Journal of Surgery. 1999; 178:311–315. doi:10.1016/S0002-9610(99)00185-3. [PubMed: 10587190]

Ridner SH. Quality of life and a symptom cluster associated with breast cancer treatment-related lymphedema. Supportive Care in Cancer. 2005; 13:904–911. doi:10.1007/s00520-005-0810-y. [PubMed: 15812652]

Ridner, SH.; Dietrich, MS. Development of the lymphedema symptoms intensity and distress survey arm [Abstract 9125].. Journal of Clinical Oncology. 2010. Retrieved from: http://search.asco.org/ASCOv2/Meetings/Abstracts?&vmview=abst_detail_view&confID=74&abstractID=42018

Rockson SG. Lymphedema. American Journal of Medicine. 2001; 110:288–295. doi:10.1016/S0002-9343(00)00727-0. [PubMed: 11239847]

Shacham S. A shortened version of the Profile of Mood States. Journal of Personality Assessment. 1983; 47:305–306. [PubMed: 6886962]

Siegel R, Naishadham D, Jemal A. Cancer statistics, 2013. CA: A Cancer Journal for Clinicians. 2013; 63:11–30. doi: 10.3322/caac.21166. [PubMed: 23335087]

Sitzia J, Sobrido L, Harlow W. Manual lymphatic drainage compared with simple lymphatic drainage in the treatment of post-mastectomy lymphoedema: A pilot randomised trial. Physiotherapy. 2002; 88:99–107. doi:10.1016/S0031-9406(05)60933-9.

Stanton AW, Levick JR, Mortimer PS. Chronic arm edema following breast cancer treatment. Kidney International. 1997; 59(Suppl.):S76–S81. [PubMed: 9185110]

Stergioulas A. Low-level laser treatment can reduce edema in second degree ankle sprains. Journal of Clinical Laser Medicine and Surgery. 2004; 22:125–128. doi: 10.1089/104454704774076181. [PubMed: 15165387]

Wilke LG, McCall LM, Posther KE, Whitworth PW, Reintgen DS, Leitch AM, Hunt KK. Surgical complications associated with sentinel lymph node biopsy: Results from a prospective international cooperative group trial. Annals of Surgical Oncology. 2006; 13:491–500. doi: 10.1245/ASO.2006.05.013. [PubMed: 16514477]

Yeung CK, Chan NP, Shek SYN, Chan HL. Evaluation of combined fractional radiofrequency and fractional laser treatment for acne scars in Asians. Lasers in Surgery and Medicine. 2012; 44:622–630. doi: 10.1002/lsm.22063. [PubMed: 22899398]

Young S, Bolton P, Dyson M, Harvey W, Diamantopoulos C. Macrophage responsiveness to light therapy. Lasers in Surgery and Medicine. 1989; 9:497–505. [PubMed: 2811573]

Knowledge Translation

- Lasers may provide effective, less-burdensome treatment for lymphedema.
- APNs with lymphedema certification can effectively treat this population with the use of LLLT.
- In addition, bioelectrical impedance and tape measurements can both be used to measure lymphedema.

Table 1

Patient Characteristics (N=46)

Characteristic	Study Group		
	LLLT (N=15)	MLD (N=16)	Combined MLD & LLLT (N=15)
	n (%)	n (%)	n (%)
Marital Status			
Married	12 (80.0)	9 (56.2)	6 (40.0)
Not married	3 (20.0)	7 (43.7)	9 (60.0)
Work Status			
Retired	8 (53.3)	12 (75.0)	9 (60.0)
Employed	5 (33.3)	3 (18.7)	3 (20.0)
Unemployed	2 (13.3)	1 (6.2)	3 (20.0)
Insurance Status			
Government Insurance	10 (66.7)	11 (68.8)	9 (60.0)
Private Insurance	4 (26.7)	5 (31.2)	5 (33.3)
None	1 (6.7)	0 (0.0)	1 (6.7)
Residence*			
City	11 (73.3)	9 (56.2)	6 (40.0)
Other	3 (20.0)	2 (12.5)	8 (53.3)
Country	1 (6.7)	5 (31.2)	1 (6.7)
Income			
≤$50,000	9 (60.0)	10 (66.6)	6 (40.1)
>$50,000	5 (33.4)	4 (26.7)	6 (40.0)
Do not care to respond	1 (6.7)	1 (6.7)	3 (20.0)
Race			
Caucasian	14 (93.3)	15 (93.8)	15 (100.0)
African American	1 (6.7)	1 (6.2)	0 (0.0)
Education			
Grades 1-12	5 (33.3)	5 (31.2)	3 (20.0)
Grades 13-16	8 (53.3)	9 (56.2)	8 (53.3)
Grades >16	2 (13.3)	2 (12.5)	4 (26.7)
	Mean (SD)	Mean (SD)	Mean (SD)
Age	66.4 (11.3)	67.5 (10.3)	66.0 (10.2)
Type of Cancer Treatment			
Surgery, radiation & chemotherapy	10 (71.4)	9 (60.0)	12 (80.0)
Surgery & radiation	2 (14.3)	4 (26.7)	2 (13.3)
Surgery & chemotherapy	1 (7.1)	2 (13.3)	1 (6.7)
Surgery	1 (7.1)	0 (0.0)	0 (0.0)
	Median [IQR]	Median [IQR]	Median [IQR]
Time from surgery to lymphedema diagnosis (months)	7.2 [4,27]	14.8 [5,108]	30.0 [2,84]
Lymphedema duration (months)	27.0 [6,58]	18.9 [5,73]	25.2 [6,142]

Characteristic	Study Group		
	LLLT (N=15)	MLD (N=16)	Combined MLD & LLLT (N=15)
	n (%)	n (%)	n (%)
	Mean (SD)	Mean (SD)	Mean (SD)
Age at lymphedema diagnosis (years)	61.6 (9.9)	63.9 (10.7)	58.6 (11.0)
Location of lymphedema			
Left	10 (66.7)	10 (62.5)	5 (33.3)
Right	5 (33.3%)	6 (37.5%)	10 (66.7)
Stage of lymphedema			
I	1 (6.7)	3 (18.8)	0 (0.0)
II	14 (93.3)	12 (75.0)	14 (93.3)
III	0 (0.0)	1 (6.2)	1 (6.7)

* $p < .05$

Table 2

Summaries of Impedance and Arm Volume (N=46)

	Study Group		
	MLD (N=16)	**LLLT (N=15)**	**Combined MLT & LLLT (N=15)**
	Median [IQR] (Min,Max)	**Median [IQR] (Min,Max)**	**Median [IQR] (Min,Max)**
Exratcellular Fluid (LDEX)[a] (*p* = .984)			
Baseline	27.7 [6,53] (−3,77)	39.3 [22,48] (3,104)	35.0 [15,56] (−14,93)
End of Study	17.8 [3,38] (−39,50)	28.0 [17,35] (0,47)	22.2 [11,37] (−3,44)
Effect Size	**−0.54**	**−0.55**	**−0.53**
Arm Volume[a] (*p* = .422) (% Difference)			
Baseline	11.7 [3,28] (−2,45)	23.2 [12,40] (3,66)	20.4 [10,35] (6,70)
End of Study	6.8 [0,17] (−4,33)	15.0 [3,23] (−2,39)	13.4 [2,24] (−4,43)
Effect size	**−0.42**	**−0.64**	**−0.64**

Note: The specific p-values report the results from the primary hypotheses of differences in the changes among the three study groups.

[a] Main effect of time of assessment, $p < .001$

Table 3

Summaries of Symptom Measures at Baseline and End of Study (N=46)

	Study Group		
	MLD (N=16)	**LLLT (N=15)**	**Combined MLT & LLLT (N=15)**
	Median [IQR] (Min,Max)	**Median [IQR] (Min,Max)**	**Median [IQR] (Min,Max)**
Number of symptoms (*p* = .249)			
Baseline	14.5 [8,20] (3,35)	13.0 [8,16] (4,31)	14.0 [9,19] (4,31)
End of study	12.5 [6,16] (0,33)	12.0 [4,16] (2,34)	14.0 [10,19] (5,36)
Effect size	**−0.41**	**−0.16**	**0.15**
Overall symptom burden[a] (*p* = .930)			
Baseline	2.4 [0,11] (0,26)	1.7 [1,13] (0,73)	6.1 [0,12] (0,22)
End of study	0.6 [0,6] (0,46)	0.4 [0,12] (0,53)	4.1 [0,8] (0,14)
Effect size	**−0.45**	**−0.41**	**−0.46**
Symptom Burden Subsets Effect Sizes			
Arm pain	0.15	−0.19	−0.06
Arm skin movement	−0.16	−0.31	0.00
Arm size[a]	−0.22	−0.59	−0.42
Insurance	−0.09	0.42	−0.02
Systemic[a]	−0.13	−0.48	−0.62
Neurological	−0.28	0.23	−0.21
Specific Symptoms [†]			
Heavy arm	0.01	−0.40	−0.33
Tight arm	−0.41	−0.43	0.02
Numb arm	−0.19	−0.17	−0.01
Aching arm	0.24	−0.31	−0.07
Swelling arm	−0.34	−0.53	−0.62
Hard arm	−0.03	−0.14	−0.11
Appearance concerns	−0.05	−0.15	−0.26
Fatigue	−0.12	−0.34	−0.46
Loss of sleep	−0.48	−0.43	−0.32
Lack of interest in sex	0.40	−0.45	−0.12
Decrease in physical activity	0.24	−0.19	−0.03
Decrease in sexual activity	0.73	−0.48	−0.02
Number of Skin Conditions Affected Arm[b] (*p* = .031)			
Baseline	2.0 [2,3] (1,7)	3.0 [2,4] (1,6)	3.0 [2,5] (1,8)
End of Study	2.0 [1,3] (1,4)	1.0 [1,2] (1,3)	2.0 [1,2] (1,3)
Effect Size	**−0.44**	**−1.15**	**−1.65**

	Study Group		
	MLD (N=16)	**LLLT (N=15)**	**Combined MLT & LLLT (N=15)**
	Median [IQR] (Min,Max)	**Median [IQR] (Min,Max)**	**Median [IQR] (Min,Max)**
Unaffected Arm (*p* = .923)			
Baseline	1.5 [1,2] (1,3)	1.0 [1,2] (1,2)	1.5 [1,2] (1,3)
End of Study	1.0 [1,2] (1,6)	1.0 [1,2] (1,2)	1.0 [1,2] (1,2)
Effect Size	**−0.11**	**−0.13**	**−0.22**

IQR—interquartile range; LLLT—low-level laser therapy; MLD—manual lymphatic drainage

Note: The specific p-values report the results from the primary hypotheses of differences in the changes among the three study groups.

[a] Main effect of time of assessment, $p < 0.05$

[b] Main effect of time of assessment, $p < 0.001$

[†] Effect sizes; At least 50% of the participants reported having the symptom at baseline.

Table 4

Summaries of Depression, Fatigue, Psychological Distress, and Quality of Life (N=46)

	Study Group		
	MLD (N=16)	**LLLT (N=15)**	**Combined MLT & LLLT (N=15)**
	Median [IQR] (Min,Max)	**Median [IQR] (Min,Max)**	**Median [IQR] (Min,Max)**
CESD (*p* = .985)			
Baseline	13.0 [11,19] (8,31)	12.0 [9,15] (7,20)	12.0 [10,13] (9,38)
End of Study	14.0 [9,21] (8,29)	12.0 [8,14] (7,23)	11.0 [9,15] (8,22)
Effect Size	**0.00**	**−0.06**	**−0.04**
Brief Fatigue Inventory (*p* = .748)			
Baseline	2.4 [0,6] (0,7)	1.3 [0,4] (0,10)	1.2 [0,5] (0,8)
End of Study	1.4 [0,4] (0,8)	1.2 [0,3] (0,7)	1.6 [0,4] (0,6)
Effect size	**−0.32**	**−0.28**	**−0.07**
FACT B Total Score (*p* = .252)			
Baseline	111.88 [98,122] (52,136)	111.0 [97,118] (40,134)	116.0 [99,125] (64,133)
End of Study	116.25 [98,123] (51,136)	113.5 [100,129] (62,134)	110.0 [102,123] (91,136)
Effect Size	**0.12**	**0.41**	**−0.02**
Fact G Total Score (*p* = .319)			
Baseline	86.0 [75,100] (41,106)	87.8 [79,93] (32,107)	91.0 [75,99] (32,107)
End of Study	88.0 [74,99] (40,105)	91.5 [79,102] (50,105)	86.0 [74,95] (60,105)
Effect Size	**−0.01**	**0.31**	**−0.11**
Fact Subscales Effect Sizes			
Physical Well-being	0.30	0.20	0.00
Social Well-being	0.13	0.23	−0.13
Emotional Well-being	−0.20	0.27	0.04
Functional Well-being	−0.22	0.31	−0.07
Fact B Subscale[b]	0.27	0.49	0.47
POMS Total Score (*p* = .878)			
Baseline	34.5 [37,47] (25,58)	29.0 [26,32] (24,111)	35.0 [24,40] (24,88)
End of Study	35.5 [28,44] (24,60)	29.0 [25,41] (24,112)	31.0 [25,35] (24,49)
Effect Size	**0.04**	**0.03**	**−0.10**
POMS Subscales Effect Sizes			
Tension	−0.13	−0.05	−0.18
Depression	0.03	0.02	−0.01
Anger	−0.05	0.04	−0.10
Vigor[a]	0.08	0.70	0.31
Fatigue	−0.25	−0.15	−0.18
Confusion	−0.05	−0.04	−0.08
ULL-27 Total Score (*p* = .586)			

	Study Group		
	MLD (N=16)	**LLLT (N=15)**	**Combined MLT & LLLT (N=15)**
	Median [IQR] (Min,Max)	**Median [IQR] (Min,Max)**	**Median [IQR] (Min,Max)**
Baseline	81.5 [78,86] (74,92)	80.4 [69,89] (65,91)	68.5 [61,87] (52,88)
End of Study	82.2 [77,92] (58,95)	90.0 [71,96] (54,98)	78.9 [73,85] (62,91)
Effect Size	**0.13**	**0.52**	**0.42**
ULL Subscales Effect Sizes			
Physical	0.13	0.47	0.26
Psychological	0.28	0.01	−0.03
Social	−0.13	0.25	0.23

BFI—Brief Fatigue Inventory; CES-D—Center for Epidemiologic Studies–Depression; FACT-B—Functional Assessment of Cancer Therapy-Breast; FACT-G—Functional Assessment of Cancer Therapy–General; IQR—interquartile range; LLLT—low-level laser therapy; MLD—manual lymphatic drainage; POMS—Profile of Mood States; ULL-27—Upper Limb Lymphedema–27