

RESEARCH ARTICLE

Combined manual lymphatic drainage and exercise for lymphedema in breast cancer survivors: A randomised controlled trial



Mohammed Emran¹ | Md. Israt Hasan² | Nazmul Alam³ | Shamim Farhad⁴

¹Department of Physical Medicine and Rehabilitation, Khwaja Yunus Ali Medical College and Hospital, Sirajganj, Bangladesh

²Department of Physical Medicine and Rehabilitation, Sher-E-Bangla Medical College and Hospital, Barishal, Bangladesh

³Department of Clinical Oncology, Khwaja Yunus Ali Medical College and Hospital, Sirajganj, Bangladesh

⁴Department of Physical Medicine and Rehabilitation, Sarkari Karmochari Hospital, Dhaka, Bangladesh

Abstract

Correspondence
Mohammed Emran
emran.pmr@gmail.com

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Background: Breast cancer-related lymphedema (BCRL) is a common and disabling complication of breast cancer treatment. Although exercise is recommended for BCRL management, the additional benefit of manual lymphatic drainage (MLD) remains unclear. This study compared the effectiveness of combined MLD and exercise versus exercise alone in reducing limb circumference and improving quality of life (QoL) among breast cancer survivors.

Methods: A randomised controlled trial was conducted between January 2022 and December 2023 at the Department of Physical Medicine and Rehabilitation, Khwaja Yunus Ali Medical College and Hospital, Enayetpur, Sirajganj, Bangladesh. Forty-two women with Stage I and II unilateral BCRL were randomly assigned to an exercise-only group (Group A, n=21) or a combined MLD and exercise group (Group B, n=21). Limb circumference at four anatomical sites and QoL, using the Bangla Lymphedema Life Impact Scale Version 2, were measured at baseline and after six weeks. Effects were evaluated using two-way repeated measures of analysis of variance. Adjusted mean differences between groups were further estimated using analysis of covariance, controlling for age, overweight, duration of oedema, chemotherapy, and radiotherapy.

Results: Both groups demonstrated significant improvements in limb circumference and QoL after six weeks; however, reductions were significantly greater in the combined MLD and exercise group (Group B), $P<0.001$. The largest mean difference in limb circumference was observed above the elbow (6.6 cm) in Group B. For QoL, the greatest improvement was noted in the physical domain, with a mean reduction of 5.2 points in Group B.

Conclusion: Combining MLD with exercise provides greater reduction in limb swelling and greater improvement in QoL compared with exercise alone in patients with BCRL.

Key messages

Breast cancer-related lymphedema remains a common complication despite the availability of several management options. This study demonstrated that incorporating manual lymphatic drainage (MLD) with exercise results in greater reductions in limb swelling and enhance quality of life compared to exercise alone. These findings advocate for the routine use of combined MLD and exercise in the rehabilitation of women with breast cancer-related lymphedema.

Introduction

Breast cancer-related lymphedema (BCRL) is a chronic and potentially debilitating complication arising from breast cancer surgery and adjuvant therapies, characterised by lymphatic fluid accumulation, limb swelling, pain, and functional impairment, which substantially reduces health-related quality of life (QoL) among survivors [1, 2, 3]. The prevalence of BCRL remains noteworthy, with variable estimates depending on treatment modalities and follow-up duration, and survivors often experience long-term physical and psychosocial sequelae [4]. Conservative interventions remain the cornerstone of management due to the absence of universally effective pharmacological therapies [5, 6].

The accepted standard of care available for BCRL includes manual lymphatic drainage (MLD), multilayer compression bandaging, skin care, and prescribed exercise. However, both MLD and exercise aim to enhance lymphatic transport, reduce extracellular fluid accumulation, and improve limb function. Despite widespread clinical use, the individual contributions of these components particularly MLD, remain the subject of ongoing investigation and debate [6].

Evidence indicates mixed outcomes regarding the effectiveness of MLD as an adjunct to exercise or other conservative treatments. Meta-analyses of RCTs have demonstrated that MLD may confer statistically significant improvements in pain intensity and may influence the incidence of lymphedema onset but have not consistently shown significant benefits in limb volume reduction or QoL outcomes when compared to control regimens without MLD [7].

Exercise interventions, including combined aerobic and resistance training, have increasingly been recognised for their potential to safely influence

lymphatic function and mitigate lymphedema symptoms. Recent systematic reviews suggest that structured exercise, specifically high-intensity and combined modality programmes, can improve fluid balance and functional outcomes without exacerbating lymphedema and may enhance physical fitness and QoL in breast cancer survivors [8]. However, there remains limited high-quality evidence directly comparing the additive effect of MLD when combined with exercise versus exercise alone on objective measures such as limb circumference and patient-reported QoL. Given these gaps in the literature, the present randomised controlled trial was undertaken to compare the effectiveness of combining MLD with exercise versus exercise alone in reducing limb circumference and improving quality of life among breast cancer survivors with established lymphedema.

Methods

Study design and setting

This was randomised controlled trial conducted at the Department of Physical Medicine and Rehabilitation (PMR), Khwaja Yunus Ali Medical College and Hospital, Enayeturpur, Sirajganj, Bangladesh, a tertiary referral hospital. The trial was conducted over a two-year period from January 2022.

Participants and eligibility criteria

Women aged 18 years or older with unilateral BCRL were eligible for inclusion. Participants had previously undergone modified radical mastectomy and received radiotherapy, chemotherapy, with or without hormonal therapy. Additional inclusion criteria were the presence of Stage I or II lymphedema without stiffness, a stable level of physical activity, and the absence of shoulder joint dysfunction, upper limb lymphatic disease, or cognitive impairment.

Patients were excluded if they had primary lymphedema, metastatic breast cancer, stage III lymphedema, bilateral upper limb involvement, a history of upper limb surgery other than breast cancer treatment, active infection, recent lymphedema-related interventions, or unwillingness to participate.

Eligible participants were identified from the PMR outpatient department following referral from the Department of General Surgery and Oncology. Screening was conducted by a physiatric team prior to enrolment.

Sample size and participant flow

Fifty patients were assessed for eligibility. Four were excluded (two did not meet the inclusion criteria and two declined participation). Forty-six participants were randomised equally into two groups (n=23 per group). During follow-up, four participants were lost (two from each group) due to discontinuation of intervention or inability to attend follow-up sessions. Consequently, 42 participants (21 per group) completed the study and were included in the final analysis. Participant flow is presented in the CONSORT diagram (Figure 1).

Randomisation and blinding

Participants were randomised using a computer-generated random numbers into either the exercise-

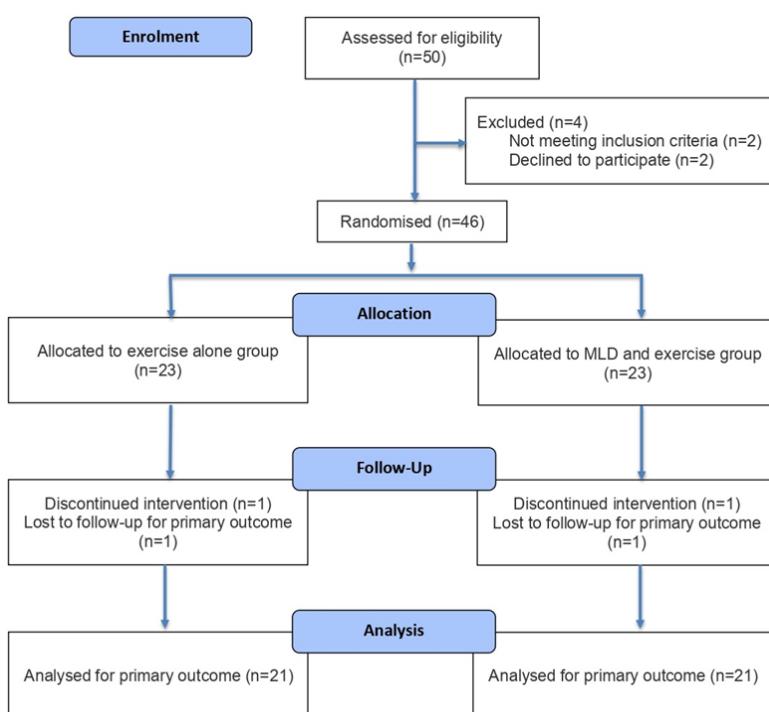


Figure 1 CONSORT flowchart of subject recruitment

only group (Group A) or the combined MLD plus exercise group (Group B). Allocation concealment was ensured using sealed, opaque envelopes prepared by an independent staff member not involved in recruitment or intervention delivery. Outcome assessors were blinded to group allocation throughout the study period.

Diagnosis of lymphedema

Lymphedema was diagnosed by circumferential measurement of both upper limbs at four standardised anatomical sites: 7.5 cm above the elbow crease, 7.5 cm below the elbow crease, the metacarpophalangeal joints, and the ulnar styloid process. A circumferential difference of ≥ 2 cm at any site between the affected and unaffected limbs was considered diagnostic for lymphedema [9].

Interventions

The patients' functional outcomes were assessed using Glasgow Outcome Scale (GOS) at 2-month follow-up, and the following categories were used: GOS 1 (Death), GOS 2 (Persistent vegetative state), GOS 3 (Severe disability), GOS 4 (Moderate disability), and GOS 5 (No disability).

Exercise-only group

Participants in Group A received supervised functional exercise sessions twice weekly for six weeks. Each 40-minute session consisted of approximately 30% stretching exercises targeting the neck, shoulder, and upper thoracic musculature; 60% active and assisted range-of-motion exercises for the shoulder; and 10% relaxation techniques. All sessions were supervised by trained physiotherapists. Participants also received standardised education on limb care, including prevention of trauma, infection, excessive load, and repetitive strain.

MLD plus exercise group

Participants in Group B received the same exercise protocol and limb care education as Group A, in addition to manual lymphatic drainage. MLD was administered by trained physiotherapists, following a modified standard protocol involving proximal lymphatic clearance, trunk drainage, and distal-to-proximal limb drainage using gentle, rhythmic strokes [10]. Each MLD session lasted approximately 30–40 minutes and was delivered twice weekly for six weeks. MLD was performed in a supine or half-lying position without the use of oils or emollients.

Outcome measures

Limb circumference

Limb circumference was assessed as an objective outcome measure of lymphedema severity using standardised circumferential measurements at four predefined anatomical sites of the affected upper limb. Measurements were obtained using a non-elastic measuring tape with the limb positioned in a standardised posture to ensure consistency. All measurements were recorded at baseline and repeated after completion of the six-week intervention period.

Quality of life

Quality of life was assessed using the Bangla version of the Lymphedema Life Impact Scale Version 2 (B-

Table 1 Socio-demographic and clinical profile of study participants stratified into exercise alone (Group A) and manual lymphatic drainage plus exercise (Group B) groups

Variables	Group A (n=21)	Group B (n=21)	P ^a
Age in years			
18–40	4 (19.0)	7 (33.3)	0.29
41–51	17 (81.0)	14 (66.7)	
Area of residence			
Rural	9 (42.9)	13 (61.9)	0.22
Urban	12 (57.1)	8 (38.1)	
Occupation			
Employed	4 (19.0)	1 (4.8)	0.34
Homemaker	17 (81.0)	20 (95.2)	
Body mass index in kg/m ²			
Normal (18–24.9)	12 (57.1)	14 (66.7)	0.53
Overweight (≥ 25.0)	9 (42.9)	7 (33.3)	
Treatment received			
Chemotherapy (n=42)	14 (66.7)	20 (95.2)	0.05
Radiotherapy (n=42)	10 (47.6)	15 (71.4)	0.12

Values are presented as number (%); ^aP values were obtained using chi square test and Fisher's exact test, as appropriate

LLIS v2). This validated instrument evaluates physical, psychological, and functional domains of lymphedema-related quality of life, with scores ranging from 0 to 100; lower scores indicate better quality of life and reduced disease burden [11]. The B-LLIS v2 was administered at baseline and after completion of the six-week intervention.

Covariates

Potential confounding variables were selected a priori based on clinical relevance and existing evidence. These included age (in years), overweight status defined as a body mass index ≥ 25 kg/m², duration of oedema (in months), and receipt of chemotherapy and radiotherapy (yes/no).

Statistical analysis

Continuous variables were summarised as means with standard deviations, while categorical variables were presented as frequencies and percent. The normality of continuous data was assessed using the Shapiro–Wilk test and visual inspection of distributions. Baseline comparisons between groups were performed using independent *t* tests (Mann–Whitney U test for non-normal distribution) for

Table 2 Limb circumference at different level at baseline and 6 weeks after intervention and comparison between and within the groups

Limb circumference in cm	Group A ^a (n=21)	Group B ^a (n=21)
7.5 cm above the elbow crease		
Baseline in cm	35.4 (2.5)	34.9 (4.2)
6 th weeks in cm	34.1 (2.3)	28.3 (3.5)
Mean difference (95% CI)	1.2 (1.0–1.5)	6.6 (6.4–6.8)
7.5 cm below the elbow crease		
Baseline in cm	31.9 (3.4)	31.2 (3.6)
6 th weeks in cm	30.3 (3.2)	26.0 (4.5)
Mean difference (95% CI)	1.6 (1.7–1.4)	5.2 (5.4–5.1)
Metacarpophalangeal joint		
Baseline in cm	25.1 (1.4)	24.8 (3.0)
6 th weeks in cm	23.5 (1.1)	20.0 (1.6)
Mean difference (95% CI)	1.6 (1.2–2.0)	4.81 (4.4–5.2)
Ulnar styloid		
Baseline in cm	20.7 (2.0)	20.6 (1.7)
6 th weeks in cm	19.7 (2.0)	17.6 (2.1)
Mean difference (95% CI)	1.1 (1.1–1.0)	3 (3.1–2.9)

^aGroup A: Exercise alone; Group B: Manual lymphatic drainage and exercise
CI indicates confidence interval; All differences were significant at 1% level

continuous variables and Chi-square or Fisher's exact tests for categorical variables, as appropriate.

To examine intervention effects over time and between groups, a two-way repeated-measures of analysis of variance (ANOVA) was conducted, with time (baseline and six weeks) as the within-subject factor and group (exercise alone versus combined MLD and exercise) as the between-subject factor. Additionally, analysis of covariance (ANCOVA) was performed to estimate adjusted between-group mean differences at six weeks while controlling for prespecified covariates, including age in years (quantitative), overweight as body mass index ≥ 25 kg/m² (yes=1, no=0), duration of edema in months (quantitative), chemotherapy (yes=1, no=0), and radiotherapy (yes=1, no=0) at baseline. Results are reported as mean differences with 95% confidence intervals. A two-sided $P<0.05$ was considered statistically significant. All analyses were conducted using JAMOVI version 2.6.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki. Participation was voluntary, and refusal or withdrawal did not affect routine clinical care. Written informed consent was obtained from all participants prior to enrolment. We didn't blind the participants and therapists, which may create treatment bias.

Results

A total of 42 participants were analysed, with 21 in each group. Most participants were aged 41–51 years, and there were no significant between-group differences in age, area of residence, occupation, overweight, radiotherapy, or mean duration of lymphedema (Table 1). A marginally higher proportion of participants in the combined MLD and exercise group received chemotherapy compared with the exercise-only group (95.2% versus 66.7%; $P=0.05$).

Both groups demonstrated significant improvements in limb circumferences at all anatomical levels after six weeks of intervention. However, the magnitude of reduction was significantly greater in Group B than in Group A ($P<0.001$). The greatest differences were observed above and below the elbow crease, with mean reductions of 6.6 cm and 5.2 cm, respectively, in Group B compared with reductions of 1.2 cm and 1.6 cm in Group A (Table 2).

Both groups demonstrated significant improvements in QoL across all domains of the B-LLIS v2 after six weeks of intervention. However, improvements were significantly greater in group B compared with group A ($P<0.001$). The greatest differences were observed in physical and functional, with mean reductions of 5.2 cm and 4.1 cm, respectively, in Group B compared with reductions of 0.6 cm and 0.9 cm in Group A (Table 3).

After adjusting for age, overweight, duration of oedema, chemotherapy, and radiotherapy, the combined MLD and exercise group demonstrated significantly greater improvements in both limb circumference and quality of life compared with the exercise-only group at 6 weeks (Table 4).

Table 3 Quality of life using Bangla Lymphedema Life Impact Scale version 2 (B-LLIS V2) score at baseline and after 6 weeks of intervention and comparison between the two groups

Domains of the B-LLIS V2 scale	Group A ^a (n=21)	Group B ^a (n=21)
Physical		
Baseline in cm	5.9 (1.3)	8.5 (1.7)
6 th weeks in cm	5.3 (1.4)	3.3 (2.0)
Mean difference (95% CI)	0.6 (0.6–0.5)	5.2 (5.3–5.1)
Psychosocial		
Baseline in cm	3.8 (1.7)	3.9 (3.2)
6 th weeks in cm	2.8 (1.5)	0.9 (1.2)
Mean difference (95% CI)	1.0 (0.4–1.5)	3.0 (2.4–3.5)
Functional		
Baseline in cm	3.3 (1.7)	5.5 (0.9)
6 th weeks in cm	2.4 (1.5)	1.5 (0.5)
Mean difference (95% CI)	0.9 (0.8–0.9)	4.1 (4.0–4.1)
Total score		
Baseline in cm	12.9 (4.2)	17.9 (5.2)
6 th weeks in cm	10.5 (3.8)	5.7 (3.0)
Mean difference (95% CI)	2.4 (1.8–3.0)	12.2 (11.6–12.8)

^aGroup A: Exercise alone; Group B: Manual lymphatic drainage and exercise
CI indicates confidence interval; All differences were significant at 1% level;

Discussion

This randomised controlled trial demonstrated that the addition of MLD to a structured exercise programme resulted in significantly greater reductions in limb circumference and improvements in quality of life among breast cancer survivors with Stage I-II lymphedema compared with exercise alone. These findings highlight the potential clinical benefits of combining MLD with exercise in the management of BCRL.

The observed reductions in limb circumference with combined MLD and exercise align with previous studies suggesting that MLD can enhance lymphatic transport, facilitate fluid mobilisation, and reduce extracellular fluid accumulation when delivered alongside exercise or compression therapy [12, 13]. While exercise alone was effective in reducing limb swelling, the magnitude of change was consistently smaller, supporting the additive effect of MLD in enhancing lymphatic drainage. Our findings are consistent with systematic reviews indicating that combined conservative interventions may achieve superior limb volume reductions compared to single modalities [14].

Table 4 Adjusted mean differences of limb circumference and quality of life scores between groups from analysis of covariance (n=42)

Outcome variables	Adjusted mean difference (95% CI) ^a
Limb circumference in cm	
7.5 cm above the elbow crease	5.2 (5.8–4.7)
7.5 cm below the elbow crease	4.5 (5.0–4.0)
Metacarpophalangeal joint	3.2 (3.6–2.9)
Ulnar styloid	
Quality of life (B-LLIS V2 scale) ^b	
Physical	3.8 (4.2–3.4)
Psychological	1.7 (2.1–1.3)
Functional	2.9 (3.1–2.6)
Total score	7.9 (8.8–7.0)

^aMean difference were adjusted for age in years, overweight (yes=1, no=0), duration

of edema in months, chemotherapy (yes=1, no=0) and radiotherapy (yes=1, no=0).

All differences were significant at 1% level.; B-LLIS V2 indicates Bangla Lymphedema Life Impact Scale version 2

CI indicates confidence interval

In addition to objective improvements, combined MLD and exercise also led to greater improvements in health-related quality of life, particularly in physical, functional, and psychosocial domains. These results suggest that reductions in limb swelling translate into meaningful patient-reported benefits, reinforcing the importance of integrating MLD into routine rehabilitation programmes for BCRL. Previous research has reported mixed effects of MLD on quality-of-life outcomes, with some trials failing to demonstrate significant improvements beyond exercise alone [15, 16]. In contrast, our study employed a structured, supervised exercise programme in combination with standardised MLD sessions, which may have enhanced adherence and therapeutic efficacy.

The study also demonstrated the feasibility and safety of delivering MLD alongside exercise. No adverse events were reported, supporting the established safety profile of these interventions in BCRL management [17]. Importantly, all interventions were standardized and monitored, ensuring consistency and allowing for reproducible clinical application.

Several strengths of this study should be noted. The trial employed a randomised, controlled design enhancing internal validity. The use of objective limb measurements alongside a validated, culturally adapted quality-of-life instrument (B-LLIS v2) provided a comprehensive assessment of treatment effects. Furthermore, multivariable adjustment for potential confounders such as age, overweight, duration of oedema, and adjuvant therapies strengthened the robustness of the findings.

However, certain limitations should be acknowledged. The study was conducted in private medical college hospital with a relatively small sample size, the follow-up period was limited to six weeks, and the longer-term effects of combined therapy on limb volume and quality of life remain unknown. Additionally, although outcome assessors were blinded, participants and intervention providers were not, which might have introduce performance bias overall restrict the generalisability.

Conclusion

The findings of this trial indicate that MLD combined with structured exercise produces greater reductions in limb circumference and improvements in QoL compared with exercise alone among breast cancer survivors with early-stage lymphedema. These results support the integration of MLD into multidisciplinary rehabilitation programmes and provide evidence for optimising conservative management strategies for BCRL.

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Author contributions

Concept or design of the work; or the acquisition, analysis, or interpretation of data for the work: ME, SF. Drafting the work or reviewing it critically for important intellectual content: ME, MIH, SF. Final approval of the version to be published: ME, MIH, SF, NA. Accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: ME, SF, NA.

Conflict of interest

We do not have any conflict of interest.

Data availability statement

We confirm that the data supporting the findings of the study will be shared upon reasonable request.

Supplementary file

None

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