Effect of active resistive exercise versus manual lymphatic drainage in patients with secondary lymphedema

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Abstract

Lymphedema is an abnormal extracellular accumulation of interstitial fluid containing proteins, cytokines, extravascular blood cells, and products of parenchymal and stromal cells. It occurs as a result of an insufficient lymphatic system or decreased lymphatic transport. This study aimed to compare between active resistive exercises and lymphatic drainage on upper limb size and function in patients with secondary lymphedema. Thirty females diagnosed clinically by physician as having upper limb secondary lymphedema. They suffered from moderate lymphedema based on clinical investigations. Their age ranged from 40 to 50 years. They were assigned randomly into two groups (A, B) equal in number. Group A received active resistive exercises plus intermittent pneumatic compression. Group B received manual lymphatic drainage plus the intermittent pneumatic compression. Treatment sessions was three times per week for 12 weeks. Lymphedema and upper limb functions were assessed by tape measurement and the ULL-27 questionnaire after 12 weeks. There was no statistically significant difference between both groups in upper limb size and function. Both active resistive exercises and manual lymphatic drainage were effective in the management of upper limb secondary lymphedema.

Key words: ***Active Resistive Exercises, Manual Lymphatic Drainage, Secondary Lymphedema.***

Introduction

Lymphedema is an abnormal extracellular accumulation of interstitial fluid containing proteins, cytokines, extravascular blood cells, and products of parenchymal and stromal cell. It occurs as a result of an insufficient lymphatic system or decreased lymphatic transport, which can be caused by inflammation, trauma, surgery, or irradiation. Chronic impairment of the lymphatic system produces secondary changes in the soft tissue, resulting in fibroblast, keratinocyte, and adipocyte proliferation, eventually destroying the elastin fibers of the skin [(1)]. Lymphedema swelling may cause discomfort and sometimes disability. It can lead to cellulitis and lymphangitis, predisposing the patient to systemic and sometimes life-threatening infection if left untreated. The physical and psychological aspects of the condition greatly impact the daily lives of those diagnosed with lymphedema. In addition to having surgery, risk factors have been identified that increase the likelihood of development of secondary lymphedema, including elevated body mass index, type of surgery, infection and injury [(2)].

Secondary lymphedema (LE) of the arm is a chronic and distressing condition that affects approximately 30% of women who undergo breast cancer treatment; worldwide, it accounts for more than 20 million cases. Improvement in limb swelling from LE can usually be achieved by conservative therapy but it should be provided throughout the patient's life accompanied by psychosocial support. All conservative therapies may produce a reduction in the volume of an extremity, with more intensive therapies resulting in greater improvement [(3)].

Manual lymphatic drainage (MDL), may improve the dysfunction of the lymphatic system in people with abnormal body mass index. It is also founded on the stimulation of the lymphatic system by increasing lymph circulation, expediting the removal of harmful metabolites from body tissues and enhancing body fluid dynamics [(4)].

There is growing interest in the role of active resistive exercise (ARE) as a standalone or complementary intervention. The rationale stems from physiological principles where muscle contractions enhance lymphatic return via extrinsic pressure gradients. Despite both therapies being used in practice, the comparative effectiveness, safety, and long-term outcomes of ARE versus MLD remain inadequately explored in structured clinical settings [(5)].

Subject and methods:

This study was carried on 30 female patients with upper limb secondary lymphedema. Their ages ranged from 40 - 50 years old. They were free from any other disease that might affect the results and they were selected from Shebeen Elkoom educational hospital and randomly distributed into two equal groups. The study protocol was approved by research ethical committee of faculty of physical therapy Cairo University (No: P.T.REC\012\004018). Group A was composed of 15 patients managed by active resistive exercise plus the intermittent pneumatic compression. Group B was composed of 15 patients managed by manual lymphatic drainage massage plus intermittent pneumatic compression. The training consisted of three sessions per week for 12 weeks (figure1).

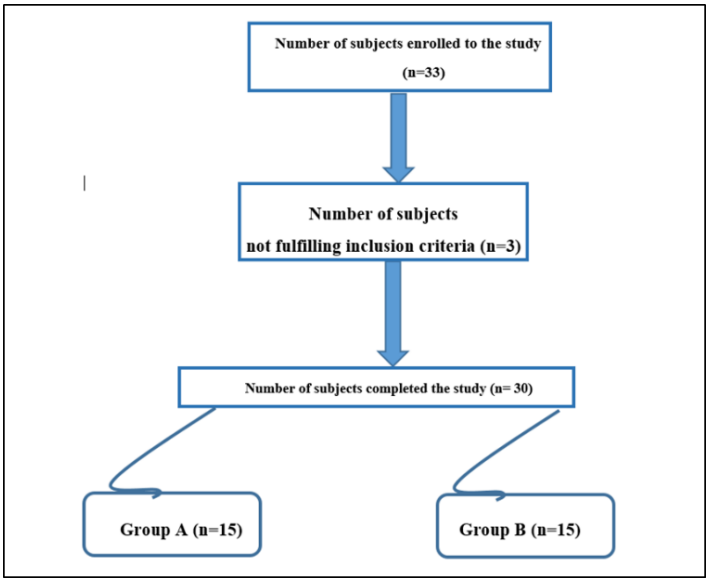

Figure 1: Flow chart for group distribution.

Inclusion criteria:

- Females only were selected.
- Patient age ranged from 40 – 50 years old.
- All patients were clinically and medically stable during the study.
- Patients were free from any acute condition.
- All patients had unilateral upper limb secondary lymphedema.
- All patients had moderate lymphedema (20% - 40% increase in extremity volume).

Exclusion criteria:

- Skin infection.
- Current ischemia or venous thrombosis.
- Current metastases.
- Unstable cardiovascular problems.
- Auditory and visual problems.
- Patients with orthopedic or neurological limitations to exercise.

Equipment and procedures of the study:

Measurement and assessment were done before the starting of the exercise program and after 12 weeks. Detailed medical history was taken by the physician. All data and information of each patient in this study was recorded in the datasheet.

Measurement equipment:

Tape measurement (circumferential measurement):

Limb circumference was measured in centimeters with non-flexible tape. It is used to determine the circumference of the limb at selected anatomic locations [(6)].

A specific quality of life scale in upper limb lymphedema (The ULL-27 questionnaire):

Developed by Launois et al. [(7)], the ULL-27 includes 27 items that evaluate three main domains: physical, psychological, and social functioning. It provides a comprehensive understanding of the patient's subjective experience, offering insights into how lymphedema affects daily life, emotional well-being, and social interactions.

Therapeutic equipment:

Intermittent pneumatic compression:

Both groups received the intermittent pneumatic compression. It is an effective method of reducing upper limb edema in patient with lymphedema. Treatment consisted of 20 intermittent pneumatic compression sessions and physical exercises (3 times per week).

Specifications of the device:

Name: Compression limb therapy system. Model: WHF-324(power-Q1000PLUS). Size:260. Rated voltage:AC220-240v,50/60HZ. Power consumption: 50VA. Maximum pressure: 300mmhg

Procedures of the study:

Measurement procedures:

Tape measurement

Patients removed all limb coverings; patient was sitting extending the upper limb at shoulder level with palm of the hand facing down while measurement points are marked on their skin. Limb measurements were taken at six anatomic locations: (1) the axilla, (2) mid arm between axilla and elbow, (3) elbow level, (4) mid forearm between elbow and wrist, and (5) The wrist level (6) mid hand.

Measurement was taken then retaken after 12 weeks. Lymphedema definitions used were volume increase ≥ 10% or limb circumference increase ≥ 2 cm, as compared to baseline and/or the contralateral limb (figure 2) [8].

Figure (2): Tape measurement.

The ULL-27 questionnaire:

The questionnaire is self-administered. Explain that the questionnaire is not a test but a way to understand their condition better. It took approximately 10–15 minutes to complete. It was administered in paper format. Each item was scored on a Likert scale (1 to 5). Lower scores indicated greater impairment or lower quality of life. Spreadsheets were used for scoring and visualizing results. Scores were recorded then recorded again after three months

Therapeutic procedure:

Active resistive exercises:

Group (A) received active resistive exercises in which patients begun gradual training in sessions with one set of exercise for a maximum of 3 sets and 10 to 15 repetitions at 70% of 1-RM. The exercising muscle groups included (Shoulder: flexors, extensors, abductors and horizontal adductors; Arm: flexors and extensors, wrist and hand muscles) [9]. The resistance with done using manual resistance, Thera band, sandbag and weights. Patient position was sitting and supine. Then patients were taught group therapy

Intermittent pneumatic compression procedure:

Both groups received intermittent pneumatic compression therapy device. Duration 20 minutes. Cuff pressure was 60 mm Hg and did not cause any discomfort. Patients supplied with compression clothing wore it during exercise, which lasted 40 minutes [10]. Patients were remained in a passive seated position with the IPC arm sleeve device (on their trial arm with it set at an approximate 70-degree angle. The IPC device has four chambers that inflate distally to proximally with an inflation time of 26 seconds and a deflation time of 15 seconds. A pressure of 60 mmHg, which is generally recommended for treatment of lymphedema. The total treatment period was 12 weeks for three months [11].

Manual lymphatic drainage:

Manual lymphatic drainage (MLD) consisted of four basic techniques (stationary circle, rotary technique, pump technique, scoop technique) initiated from unaffected quadrants of the trunk (the neck, chest, abdomen) and after preparation of these regions, the affected areas of the trunk were treated. Finally, MLD was applied to the edematous limb starting proximally at the shoulder, moving in segments

progressively down the limb. The techniques were performed with higher pressure and slower maneuvers than used in less advanced edema. During MLD, deep diaphragmatic breathing was performed [12].

Patients in group (B) received MLD massage. It is a gentle skin massage that helps move extra fluid from an area that is swollen (or is at risk of becoming swollen), into an area where the lymph nodes are working properly. This is done by stimulating contractions of lymphatic vessels [13].

Instructions for doing self-massage

Use a light pressure and keep your hands soft and relaxed. Use just enough pressure to gently stretch the skin as far as it naturally goes and then release the pressure. Let your skin come back as it was. If you can feel your muscles underneath your fingers, then you are pressing too hard. Use the flats of your hands instead of your fingertips. This allows more contact with the skin to stimulate the lymph vessels. Make sure you are comfortable while doing the massage. You can try a seated, standing or lying down position. Try to do self-massage every day. If you need to do the massage on both sides of your body, start on one side of your body and go through each step. Once you have completed the steps on one side, repeat them on the other side of your body [14].

Statistical analysis

SPSS software version 22 was used to conduct all statistical analyses. A comparison between both groups' features, including age, weight, height, and BMI were performed using an unpaired T-test, while Mann-Whitney U was performed for the affected side comparison. Subsequently, MANOVA was conducted to compare the variables between groups. The significance level for all statistical tests was set at $P < 0.05$.

Results

A total of 30 participants were allocated randomly into two equal groups, with 15 subjects in every group. According to Table 1, there was no significant difference in the participants' characteristics, including age, weight, height, BMI, and affected side ($p > 0.05$).

Table 1. Comparison of characteristics between groups A and B.

		Group A (n:15) Study		**Group B (n:15) Control**			
		$\bar{X}$ ± SD		**$\bar{X}$ ± SD**		**p-value**	**t-value**
Age (years)		44.6±2.7		44.2±2.9		0.704	0.384
Weight (kg)		83.4±13.3		84.9±11.8		0.752	0.320
Height (cm)		165.1±4.1		163.2±3.9		0.214	1.270
BMI (kg/m2)		30.5±3.7		31.8±3.8		0.34.	0.964
		N	**%**	**N**	**%**		
Affected side	**Rt**	7	46.3%	8	53.3%	p-value	z-value
	Lt	8	53.3%	7	46.7%	0.720	0.359

$\bar{X}$: Mean, SD: Standard deviation, p-value: Probability value, *: significance

The outcomes indicated that the measurement of axilla, mid arm, and elbow were significantly decreased in both groups. Furthermore, no significant variations were observed between both groups before or after intervention ($P>0.05$). Group B revealed an elevated percentage of alteration in measurement of axilla, mid arm, and elbow (8.04%, 7.9%, and 9.1%, respectively) compared with the group A (5.7%, 7.1%, and 7.9%, respectively) (Table. 2).

Table 2. Comparison between groups A and B regarding the measures of axilla, mid arm, and elbow.

		Group A (Study) (n:15)	Group B (Control) (n:15)	Comparison between groups	
		$\bar{X}$ ± SD	$\bar{X}$ ± SD	F-value	P-value
Axilla	**Pre-intervention**	47.5±7.7	46±3.5	0.447	0.509
	Post-intervention	44.8±7.4	42.3±3.2	1.460	0.237
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	5.7%	8.04%		
Mid arm	**Pre-intervention**	42.1±8.2	41.9±4.5	0.012	0.913
	Post-intervention	39.1±7.8	38.6±4	0.042	0.839
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	7.1%	7.9%		
Elbow	**Pre-intervention**	34.1±4.5	36.1±3.7	1.647	0.210
	Post-intervention	31.4±4.3	32.8±3.7	0.911	0.348
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	7.9%	9.1%		

$\bar{X}$*: Mean, SD: Standard deviation, p-value: Probability value, *: significance*

The results revealed that the measurement of mid forearm and wrist were significantly reduced in both groups. Additionally, no significant differences were detected between both groups before or after intervention (P>0.05). Group B revealed an elevated percentage of reduction in measurement of mid forearm and wrist (11.1% and 8.8%, respectively) compared with the group A (10.1% and 8.1%, respectively) (Table. 3).

The findings revealed that the measurement of mid hand was significantly reduced in both groups. Additionally, no significant differences were detected between both groups before intervention (P=0.878) but there was a significant variation post intervention P<0.05. Group A showed an elevated percentage of reduction in measurement of mid hand (15.4%) compared with the group B (9.5%) (Table. 3).

Table 3. Comparison between groups A and B regarding measurements of Mid Forearm, wrist, and mid hand.

		Group A (Study) (n:15)	Group B (Control) (n:15)	Comparison between groups	
		$\bar{X}$ ± SD	$\bar{X}$ ± SD	F-value	P-value
Mid Forearm	**Pre-intervention**	33.7±6.8	33.3±4.3	0.050	0.824
	Post-intervention	30.3±6.1	29.6±3.9	0.125	0.726
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	10.1%	11.1%		
Wrist	**Pre-intervention**	23.2±2.6	22.6±0.7	0.741	0.397
	Post-intervention	21.3±1.7	20.6±0.5	1.923	0.176
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	8.1%	8.8%		
Mid Hand	**Pre-intervention**	25.4±0.98	25.3±1.3	0.024	0.878
	Post-intervention	21.5±0.9	22.9±1	2.314	0.139
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	15.4%	12.6%		

$\bar{X}$*: Mean, SD: Standard deviation, p-value: Probability value, *: significance*

The results indicated that the score of UII was significantly increased in both groups. Additionally, no significant differences were detected between both groups before or after intervention (P= 0.349 and 0.273, respectively). Group B showed an elevated percentage of change in the score of UII (36.9%) compared with the group A (35.8%) (Table 4).

Table 4. Comparison between groups A and B regarding UII score.

		Group A (Study) (n:15)	Group B (Control) (n:15)	Comparison between groups	
		$\bar{X}$ ± SD	$\bar{X}$ ± SD	F-value	P-value
UII	Pre-intervention	53.3±4.9	54.8±3.7	0.909	0.349
	Post-intervention	72.4±5.8	75±5.9	1.250	0.273
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	35.8%	36.9%		

*$\bar{X}$: Mean, SD: Standard deviation, p-value: Probability value, *: significance*

Discussion:

The results of the study revealed that there was no statistically significant difference between active resistive exercises and both intermittent pneumatic pressure and manual lymphatic drainage on the size of lymphedema and the upper limb functions in patients with secondary lymphedema. All the treatment techniques reduced the upper limb size and improved the upper limb function.

Consequently, the results of the current study offer preliminary support for the premise that active resistive exercises and both intermittent pneumatic pressure and manual lymphatic drainage could be beneficial for these patients. These findings are consistent with the following previous studies which reported that these modalities are beneficial in treating the patient with upper limb secondary lymphedema.

However, Haspolat et al. [15] investigated the acute effects of MLD, compression with exercise on the local tissue water percentage, pain, and stiffness following breast-conserving surgery and radiotherapy. The pain and stiffness severity were measured with VAS. Measurements of water percentages in local tissue were performed in all quadrants of the breast with the Moisture Meter D Compact device. All measurements were performed baseline, after MLD, and after compression with exercise. In the treatment of breast lymphedema, MLD and compression bandage with exercise may be beneficial in the management of the symptoms of swelling, pain, and stiffness.

In the same context, Xiong et al. [16] investigated the effectiveness of orthopedic manual lymphatic drainage techniques to move fluid and soften hardened tissues using functional assessment of the upper extremity of patients after breast cancer surgery, as well as edema and pain scales. Their study included 24 patients diagnosed with lymphedema following mastectomy surgery, who received the intervention twice a day, three times a week for six weeks, and were evaluated for upper extremity swelling volume assessment and shoulder joint range of motion and pain sensory. In conclusion, their study demonstrated that the integrated lymphatic therapy approach of orthopedic manual lymphatic physiotherapy is an effective treatment for reducing edema, improving shoulder joint range of motion, and reducing pain sensory in the upper extremity in postoperative patients with breast cancer.

Moreover, Shamsesfandabadi et al. [17] investigated the safety and effectiveness of adding a moderate/high intensity resisted exercise (RE) programme for 6 weeks on arm circumference, muscular

strength and quality of life (QoL) measure in patients with breast cancer-related lymphoedema. This study included 35 patients with a history of breast cancer who were in phase two of their lymphoedema rehabilitation. intervention consisted of resistance band exercises four times a week for 6 weeks. Limb circumference measurements, muscular strength, Disabilities of Arm, Shoulder, and Hand (DASH), Lower Extremity Functional Scale (LEFS) and Lymphoedema Quality of Life (LYMQOL) questionnaires were administered at baseline and at 6 weeks. Unexpectedly, there was a significant decrease in UL measurements in the hand, forearm, elbow and proximal arm in the intervention group ($p<0.05$). The results indicate that RE demonstrates a positive effect on arm function, symptoms and QoL without increasing arm volume in breast cancer-related lymphedema.

In addition to that, Johansson [18] conducted a systematic review on exercise interventions for lymphedema, concluding that progressive resistive training is safe and effective, and does not exacerbate lymphedema symptoms. Importantly, the improvements in limb volume and function were not statistically distinct from other therapies like MLD or IPC.

In the same context, Torres et al. [19] carried out a controlled clinical trial to examine the effect of resistance and aerobic exercise compared to conventional decongestive therapies. They reported similar reductions in limb volume and gains in shoulder mobility across all groups, reinforcing that physical activity can be as effective as passive modalities.

Conclusion:

All the treatment techniques reduced the upper limb size and improved the upper limb functions in patients with secondary lymphedema. This may help for the effective rehabilitation for these patients. So, these results suggest that there could be useful therapeutic modalities that assist in the rehabilitation process. Therefore, it could provide knowledge regarding improving functions and consequently providing a good work and daily living performance of those patients.

Disclosure statement
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Conflict of interest
The authors state no conflict of interest.
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