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Effect of Resisted Deep Breathing on Post Mastectomy Lymphedema

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Abstract

Background: Post-mastectomy lymphedema is secondary lymphedema that impairs the lymphatic drainage system of the breast. Its signs and symptoms include increased weight and limb size.

Since 60% of all lymph nodes are found right beneath the diaphragm, it serves as a lymphatic pump. By exerting a negative pressure and drawing the lymph through the lymphatic system, diaphragmatic breathing (DB) promotes the cleaning of the lymph nodes.

Aim of Study: The aim of the study is to evaluate deep resisted diaphragmatic breathing on post mastectomy lymphedema.

Patients and Methods: Sixty eight patients with post mastectomy lymphedema were chosen at random and divided into two groups of equal size, (Group A) Resisted diaphragmatic breathing (DB) exercise and complete decongestive therapy (CDT) (pneumatic compression, compression bandage, manual lymphatic drainage, active range of motion AROM exercise and skincare), 3 session per week for 4 weeks, (Group B) received complete decongestive thereby (CDT) 3 session per week for 4 weeks. The participants were selected from Out Patient clinic. The study conducted six months from February 2022 to May 2023.

Measurement: Patient's limb circumferential measurements were taken in five point (axillary, mid arm, elbow, mid for arm and wrist) for both group pretreatment and post treatment.

Results: These findings reveal that there was a decrease in lymphedema measurement in both groups A and B when comparing post treatment and pre treatment measurement ($p<0.001$). However, Statistical analysis showed significant improvement in deep resisted breathing group in axillary, mid arm, elbow, mid forearm and wrist circumferential measurement of lymphedema in comparison to that of control group after treatment ($p<0.001$).

Conclusion: Deep resisted diaphragmatic breathing exercise proved to be effective in decreasing lymphedema in post mastectomy patient.

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Key Words: *Lymphedema — CDT (complete decongestive therapy) — Deep resisted breathing — MLD (manual lymphatic derange) — AROM (active range of motion).*

Introduction

AS a result of impaired lymphatic drainage, tissue fluid accumulates causes lymphedema. Congenital or acquired abnormalities of lymphatic outflow may be to blame for the decreased lymphatic flow [1]. Breast cancer Related lymphedema (BCRL) is detected in 7-77% of patients with axillary lymph node dissection (ALND) as result of lymph vessel transection [2] lymphedema associated with a great levels of functional impairment, poorer psychological adjustment, anxiety, deficits in quality of life and depression than the healthy population [3]. Complete decongestive therapy (CDT) is the recommended treatment includes instruction, skin care, multilayer short stretch bandages, manual lymphatic MLD, and lymphedema exercises. Complete decongestive therapy should be administered by lymphedema specialists or trained lymphedema therapists **[4].** (DB) with exercise for lymphedema helps to create pressure change in the abdomen, which acts like a vacuum in the thoracic cavity, helping to drain lymphatic vessels ***[5]*** Remedial exercises. Incomplete decongestive therapy CDT, the terminology "remedial exercises" refers to basic exercises that help lymphatic motility. The technique began with 10-15 DB with resistance. DB exercises are used to stimulate deep lymphatic structures, such as the cistema chyli, the abdominal part of the thoracic duct, lumbar trunks and lumbar lymph nodes, pelvic lymph nodes, and certain organ systems. Stimulation of these structures, particularly the thoracic duct (the largest lymph vessel in the body), accelerates the transport of lymph fluid toward the circulatory system **[6].** Lymphatic system is a component of both the immunological and circulatory systems which is Lymphatic or lymphoid organs, lymphoid tissues, and a vast network of lymphatic veins. A transparent fluid called lymph is transported towards the heart ***[7].*** The diaphragm is a primary respiratory muscle which responsible for about 80% of all of the respi-

ration work in normal breathing. The diaphragm has a lymphatic drainage system, which responsible for rapid absorption from the peritoneal cavity to return to the vascular system. The diaphragm is a lymphatic pump, since about 60% of all lymph nodes in the human body are located just under the diaphragm. Diaphragmatic breathing (DB) stimulates lymph flow to lymph nodes by creating a negative pressure pulling the lymph through the lymphatic system [8].

Breast cancer has been described as the most common cancer in women worldwide. In 2018, their 2 million new reported cases Women treated form breast cancer experience up to a40% risk of developing secondary lymphedema these cases experience greater levels of functional impairment, poorer psychological adjustment, anxiety, decrease in quality of life, increase acute inflammatory episodes, pain, skin quality affected, reduced limb mobility and depression than the healthy population. therefore; this study strived to examine the efficacy of resisted deep breathing in managing Postmastectomy lymphedema, in term of improving limb measurement. This study may provide a safe, effective and non-invasive treatment modality for lymphedema.

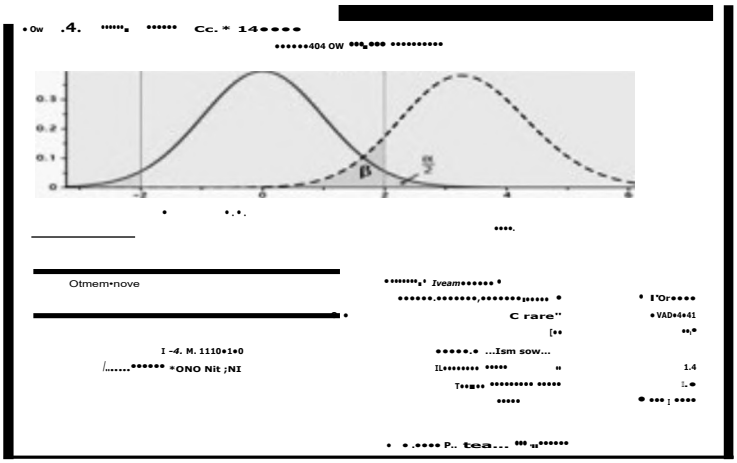
Material and Methods

Study design:

This trial was assented by the Ethical Committee of the Faculty of Physical Therapy, Cairo University. All aspects of the study were disclosed and informed consent was obtained. The patients were randomly assigned into two equal groups via the envelope mode. After patients agreement to participate in the study, cards with either `DRBE' or `Traditional exercise' recorded on them were closed in envelopes; then a blinded physical therapist was asked to select one envelope according to the selected card, patients were assigned to their corresponding group. Group A comprised 34 patients who received resisted DB exercise in addition to CDT and group B comprised 34 patients who received CDT only. Dates for starting the allocated therapy were regulated and the therapy was begun after the first week of randomization. The examiner physical therapist was not included in randomization procedures and was unaware of the therapy allocation. Patients were asked not to disclose their therapy allocation to the physical therapist during assessment. The participants were informed to report any harmful effects throughout the treatment period.

Sample size determination:

To avoid type II error, sample size calculation will be performed using G*POWER statistical software (version 3.0.10; Franz Faul, Universitat Kiel, Germany) [Exact test — correleation study, a= 0.05, 13=0.9 and moderate effect size=0.8] and revealed that the required sample size for this study is N=68 as shown.



Subjects:

Sixty eight female patients participated in this study were diagnosed by a physician as lymphedema with (grade 2 and 3), they were selected from outpatient clinic. Their age ranged from 30 to 60 years. They were distributed randomly into two groups (A, B) equal in numbers. This study included patients who involved the following requirements: Female with age range 30/60 years. diagnosis with unilateral lymphedema conformed of stage 2 to stage 3 (based on international society of lymphology lymphedema society). Post mastectomy (not less than 3 month). Participants were ruled out if they met one of the following criteria: Skin infection (erysipelas, cellulites). Current limb ischemia, venous thrombosis. Systemic edema due to impaired heart, kidney and liver function .Active cancer with metastases. Pulmonary edema Pulmonary embolism. Thrompophelibitis. Sever peripheral neuropathy. (Group A) received resisted DB breathing plus complete decongestive therapy (beginning with 0.5kg weight then weight increase to 1kg after 2 weeks) 3 session per week for 4 weeks in form of (minute pneumatic compression, manual lymphatic drainage, compression bandage, **AROM** motion exercises and skincare). (Group B) received

complete decongestive therapy CDT in the form of 3 sessions per week for 4 weeks. Circumference measurements were taken in 5 point before and after session. The participants were selected from outpatient clinic and randomly distributed into two equal groups in number.

Material:

• Assessment methods:

Tape measurement for lymphedema measurement.

• *Intervention:*

Deep resisted diaphragmatic exercise, resistance was applied with sandbag (0.5kg at the first 2 weeks then increased to lkg in the last 2 weeks). A metronome was used to control the rate of breathing. (an android application that gives an auditory feedback to allow the patient control the breathing pattern).

Assessment procedures:

Limb circumferential measurements were taken before and after treatment at five point (axillary, mid arm, elbow, mid fore arm and wrist) with tape measurement for both groups.

Therapeutic procedure:

All patient in this study received Complete decongestive therapy CDT (pneumatic compression, manual lymphatic drainage, active range of motion (AROM) and compression bandage).

The pneumatic compression devise With Power-Q1000 was set with compression of 80mmHg fore 30min

Patients received 10min of manual lymphatic drainage. The 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.

Patients performed active range of motion exercises (AROM) as flexion and extension, internal and external rotation of shoulders, flexion and extension, supination and pronation of elbows and wrist flexion, extension radial and ulnar deviation from different positions as supine lying and sitting.

Compression Bandaging was applied Three short-stretch bandages six, 10, and 12cm in width were sequentially placed around the limb with the first starting at the hand, the second at the wrist, and the third starting below the elbow. Gradient pressure was achieved by applying more layers distally, gradually reducing the number as well as overlap of bandages applied proximally along the arm. Bandages were removed the next day of scheduled treatment Exercises and removed after 24houre.

All patients are advised to avoid steam rooms, saunas, very hot baths or showers, wearing clothing (tight clothing and toning jewelry), Look for changes or cracks in the skin, keep it soft by moisturizing daily, keep fingernails short and raise the affected limb above the heart.

Resisted diaphragmatic breathing exercises:

All patients in study group (group A) were learned the diaphragmatic breathing maneuver by a therapist who demonstrated a precise breathing maneuver, subject was asked in a supine position to place one hand on the rectus abdominal muscle just below the anterior costal cartilage and to inhale slowly and deeply through only the nose, inflating the abdomen without moving the top of the chest while relaxing the shoulders. Then exhale the air slowly through pursed lips with lips parted. A breath consists of 3 seconds of inhalation, 3 seconds of pause, and 6 seconds of exhalation, subject was asked to place one hand on the chest and the other on the abdomen, to observe the movement coming from the abdomen and not from the chest. RDB was at the same time of pneumatic compression session (30min of compression session (5min without breathing exercise then 20min with deep resisted breathing exercise and 5min without breathing exercise). The breathing was controlled by A metronome. A weight (0.5kg in the first 2 weeks then increased to lkg in the last 2 weeks) was positioned above the diaphragm and tied up with strap.

Statistical analysis:

Data were expressed as mean ± SD. Unpaired t-test and chi square were used to compare between subjects Characteristics of the two groups. Shapiro-Wilk and Kolmogrov-smirnov tests were used for testing normality of data distribution. MANOVA was performed to compare within and between groups' effects for measured variables. Statistical package for the social sciences computer program (version 20 for Windows; SPSS Inc., Chicago, Illinois, USA) was used for data analysis. P less than or equal to 0.05 was considered significant.

Results

Demographic data of subjects:

A total of Sixty eight females patients participated in this study; they were assigned into 2 equal groups; group (A) (deep resisted diaphragmatic breathing with complete decongestive therapy CDT) and group (B) (control group complete decongestive therapy CDT). There were no significant difference between the mean value of age, date of surgery and occupation of both groups ($p>0.05$).

Table (1): Demographic data of subjects of both groups.

Demographic data	Group A	Group B	*t*-value	*p*-value
Age (years)	44.6±6.3	44.3±5.1	0.232	0.817
Date of surgery (month)	16.6±5.3	15.9±5.4	0.517	0.607
Occupation:	N (%)	N (%)		
Accountant	0 (0%)	2 (6%)		
Doctor	1 (3%)	1(3%)		
Employee	8 (23.5%)	8 (23.5%)		
Engineer	1 (3%)	0 (0%)	x2=	0.527
Housewife	19 (56%)	16 (47%)	7.09	
Ensurance employee:	0 (0%)	1 (3%)		
Teacher	3 (8.5%)	5 (14.5)		
Donot work	2 (6%)	1 (3%)		

Data was expressed as mean ± standard deviation.
x2 : Chi square. p-value: Significance.

Normality test:

Data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. Shapiro-Wilk and Kolmogrov-smirnov tests for normality showed that all measured variables were normally distributed (p>0.05).

The impact of deep resisted diaphragmatic breathing on arm circumference measurement:

A- Axillary level:

Between groups comparison:

There was statistical significant difference in the mean values of axillary level measurement post treatment between both groups (p=0.012) in favor to group A (Table 2). The improvement in group (A) was 9% (± SD was 40.4±3 and 36.9±2.9cm pre and post treatment respectively). In group (B) the improvement was 4.5% (± SD was 40.7±2.8 and 38.5±2.7cm pre and post treatment respectively.

B- Mid arm level:

Between groups comparison:

There was statistical significant difference in the mean values of mid arm level measurement post-treatment between both groups (p=0.011) in favor to group A (Table 2). The improvement in group (A) was 11% (± SD was 37.7±2.2 and 33.6±2.4cm pre and post treatment respectively and in group (B) the improvement was 7% (± SD37.5±2 and 35±2 cm pre and post treatment respectively.

C- Elbow level:

Between groups comparison:

There was no statistical significant difference in the mean values of Elbow level measurement post-treatment between both groups (p=0.113) (Table 2). The improvement in group (A) was 10% (± SD 30.9±2.9 and 27.8±2.7cm pre and post treatment respectively and for group (B) the improvement was 5% (± SD 30.4±3.4 and 29±3.4cm pre and post treatment respectively.

D- Mid forearm level:

Between groups comparison:

There was statistical significant difference in the mean values of mid forearm level measurement post-treatment between both groups (p43.005) in favor to group A (Table 2). The improvement in group (A) was 17% (± SD A was 27.2±3.3 and 22.5±3.2cm pre and post treatment respectively) and for group (B) the improvement was 10.5% (± SD was 27.5±3 and 24.6±2.6cm pre and post treatment respectively).

E- Wrist level:

Between groups comparison:

There was statistical significant difference in the mean values of Wrist level measurement post-treatment between both groups (p=0.001) in favor to group A (Table 2). The improvement in group (A) was 15% (± SD 19.5±1.6 and 16.6±1.3cm pre and post treatment respectively) and for group (B) the improvement was 8% (± SD 19.2±1.6 and 17.7±1.5cm pre and post treatment respectively).

Table (2): Mean ± SD of measured variables pre and post treatment of both groups.

Arm circumference measurement (cm)	Group A Mean ±SD	Group B Mean ±SD	*f*-value	*p*-value (between groups)
Axillary:				
Pre-treatment	40.4±3	40.7±2.8	0.208	0.650
Post treatment	36.9±2.9	38.5±2.7	6.68	0.012*
% of change	9%	5.4%		
p-value	0.001*	0.001*		
Mid arm:				
Pre-treatment	37.7±2.2	37.5±2	0.098	0.755
Post treatment	33.6±2.4	35±2	6.84	0.011*
% of change	11%	7%		
p-value	0.001*	0.001*		
Elbow:				
Pre-treatment	30.9±2.9	30.4±3.4	0.399	0.530
Post treatment	27.8±2.7	29±3.4	2.57	0.113
% of change	10%	5%		
p-value	0.001*	0.001*		
Mid forearm:				
Pre-treatment	27.2±3.3	27.5±3	0.192	0.662
Post treatment	22.5±3.2	24.6±2.6	8.65	0.005*
% of change	17%	10.5%		
p-value	0.001*	0.001*		
Wrist:				
Pre-treatment	19.5±1.6	19.2±1.6	0.546	0.455
Post treatment	16.6±1.3	17.7±1.5	11.01	0.001*
% of change	15%	8%		
p-value	0.001*	0.001*		

SD: Standard deviation. *: Significant.

Discussion

There were no change in lymphedema measurements between groups pre-treatment ($p>0.05$). Comparison between both groups post-treatment revealed significant difference in lymphedema measurement in favor of group A, the percent of improvement was 9% in axillary circumference, 11% of mod arme, 10% in elbow, 17% in forearme and 15% in wrist.

From the previously mentioned results, it is clear that the improvement of lymphedema in the study group is more than controlled group, this improvement may be attributed to the fact that diaphragmatic breathing exercise creates a change in pressure in the abdomen, acts like a vacuum in the chest cavity, helping to drain the lymphatic vessels

Our study results confirm the results of the following studies, as Moseley et al., **[9]** claimed that DB with upper limb exercise is one of the effective methods to control lymphedema. After application of deep DB with arm exercise, arm volume decreased by 52ml (5.8%), and the decrease was maintained after 30min (50m1, 5.3%). Although the participants were instructed to stop exercising, after one day the decrease in volume was 46m1 (4.3%) and at 1 week 33m1(3.5%). After one month of follow-up, the reduction was 101m1(9.0%). All reductions are statistically significant. Arm heaviness and tension were also statistically significantly reduced immediately after program, with the reduction maintained after 24h, 1 week and even a month after the program. The perceived limb size was significantly reduced at 1 week and 1 month of follow-up. There was improvement in the anterior thoracic tonometry reading after 1 month of follow-up. The study shows that a combination of arm exercises and DB is an easy method to achieve significant improvement in arm volume and subjective symptoms both initially after treatment and when taken over a one-month period.

As well as in a trial by Buragadda et al., **[10],** subjects who participated in the home program (DB exercises) experienced great improvements. The trial found that CDT and remedial exercises combined with an hour-long home exercise program can reduce the amount of lymphedema, relieve pain, and improve hand function.

Recent literature found that active forces from contraction of skeletal muscle and chest movement (DB exercises) can also be used to pump venous and lymphatic fluids. Remedial exercises and home programs resulted in greater upper limb volume reduction, allowing Patients participate in the study to gain confidence and move limbs without fear .the improvement was 16.9% in lymphedema with a magnitude of effect of 1.05. The mean improvement in DASH score was 175.9% with an effect level of 27.25 [11].

Gautman and Maiya, **[12]** reported that 32 patients with post-mastectomy lymphedema participated in this study to see the effect of a 2 month home exercise (progressive resistance exercises, DB and self-care) for lymphedema and patients' quality of life after mastectomy. The results showed that a home exercise program statistically significantly reduced the circumference and volume of the affected arm and improved quality of life in breast cancer patients. The provision of a logbook and continuous monitoring resulted in good adherence to the exercise program (89% based on log records). The mean change in arm volume was 122m1. Exercise acted as a therapeutic intervention rather than an exacerbation of lymphedema symptoms. Pain, limb heaviness and discomfort were decreased. The increase in physical activity scores provides evidence that resistance exercises of the affected upper extremities have a beneficial effect on post-mastectomy lymphedema. Participants said they were more confident in using the affected upper limb when doing regular housework.

Arinaga et al., **[13]** reported that the daily 10-minute of self-care program consisted of modified Japanese rajio taiso (Japanese radio calisthenics), a gentle arm exercise combined with DB, skin moisturizing care using a traditional lymphatic drainage technique, and basic self-care education) on 23 patients with unilateral breast cancer related lymphedema over a six-month improved the volume of all limb segments and resistance of the tissues to compression at all measurement points of the affected arm

There are many reasons that can be given for the adoption of progressive upper extremity physical training and DB in lymphedema rehabilitation Gradual increase in physiological stress in the affected upper limb through flexibility, resistance, and aerobic exercise would be preferred over inactivity in post mastectomy patients. These mechanisms that may help improve or prevent symptoms of lymphedema they not only improves lymph flow but also improves regeneration protein absorption. Lymphatic flow increases due to decrease in intra thoracic pressure during inspiration; This has led to speculation that increased lung work during exercise and may help reduce lymphedema. Furthermore, diaphragmatic breathing when performing lymphedema exercises has two important effect. First, DB is essential to ensure adequate oxygen supply to tissues when the body is working harder than usual. Second, DB creates a change in pressure in the abdomen, acting as a vacuum in the chest cavity, helping to drain the lymphatic vessels **[12].** DB stimulates the cleansing of the lymph nodes by creating a negative pressure pulling the lymph through the lymphatic system **[8]** limitations must be considered when explaining these results; the most significant drawback of this experiment was absence of long-term effect of treatment examination due to the dif-

ficulty of following-up after the trial, so future trials with patients' follow-up are recommended, also to minimize human suffering and financial expenses, it is vital to raise awareness regarding the protection, early diagnosis, and timely therapy of lymphedema in post-mastectomy sufferers, so trials should be conducted to evaluate early physical therapy intervention in prevention lymphedema morbidity following mastectomy, Also lack of upper limb and hand function assessment is one of our study limitation so further studies with different assessment methods should be involved, moreover evaluation the impact of different approaches of exercises therapy with longer duration should be carried out.

Conclusion:

Based on the scope and conclusions of this study, it can be concluded that adding resisted diaphragmatic breathing exercise to CDT has great benefits in lymphedema management.

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تأثير التنفس العميق بمقاومة على الوذمة الليمفاويه بعد عمليات استئصال الثدى

الغرض من الدراسة الحالية تقييم تأثير التنفس العميق بمقاومة على الوذمة الليمفاوى بعد استئصال الثدى. إشترك فى هذه الدراسة ثمانى وستون مريضاً ممن يعانون من التورم الليمفاوى في زراع واحدة أعمارهم تتراوح ما بين الثلاثين والستين عاماً وتم اختيارهم من عيادات الخارجية وتم تقسيمهم عشوائياً إلى مجموعتين متساويتين : المجموعة الأولى تكونت من أربعه وثلاثون مريضاً ممن تلقوا العلاج بالتنفس العميق مع مقاومة بجانب العلاج الطبيعى والمجموعة الثانية تكونت من أربعة وثلاثون مريضاً ممن تلقوا العلاج الطبيعى ولقد أظهرت النتائج فروق ذات دلالة إحصائية بين المجموعتين قبل وبعد العلاج ولكن العلاج بالتنفس العميق مع المقاومة كان له تاثير افضل على حجم التورم الليمفاوى بالمقارنة بالمجموعة الثانية كما اوضح شريط القياس.