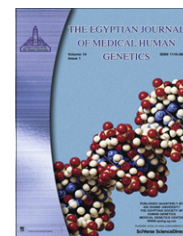




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ORIGINAL ARTICLE

# Helium Neon laser therapy for post mastectomy lymphedema and shoulder mobility

Mohamed M. Khalaf <sup>\*,1</sup>, Maha A. Hassan, Zizi M. Ibrahim

Department of Physical Therapy for Surgery, Faculty of Physical Therapy, Cairo University, Giza, Egypt

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## KEYWORDS

Helium Neon laser;  
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**Abstract** The aim of this work was to evaluate the efficacy of Helium Neon (He–Ne) laser therapy on post mastectomy lymphedema and shoulder mobility. Thirty female patients with axillary lymph node dissection (ALND), with or without radiotherapy had been participated in this study. The patients were randomly divided into two groups of equal numbers. Group A received He–Ne laser therapy and decongestive lymphatic therapy. Group B received placebo laser therapy in addition to decongestive lymphatic therapy. Measurements of limb volume and shoulder mobility (by tape measurement and standard goniometer) were collected before treatment and after six months of treatment. The mean values of limb volume and Shoulder mobility after 6 months of treatment showed a significant improvement ( $p < 0.05$ ) for the two groups of the study with a greater improvement for patients in group A.

**Conclusion:** Helium Neon laser therapy has a positive effect in reducing post mastectomy lymphedema and increasing range of motion of shoulder joint.

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## 1. Introduction

Breast cancer is recognized as a major problem because of its high incidence, mortality rate, and detrimental impact on the quality of life. Carcinoma of the breast continues to be the most common cancer in women over the age of 40 years, and represents one of every seven new cancer cases diagnosed

[1]. The women who had axillary lymph nodes dissection (ALND) (secondary to breast cancer) as well as curative effect of radiation and chemotherapy are at risk to develop lymphedema and they have a prevalence of 25–30% [2].

Lymphedema is an accumulation of protein rich interstitial fluid because of impaired lymphatic function [3]. Lymphedema can begin insidiously post mastectomy or several years later, and swelling may range from being mild and barely noticeable especially in the early stage to seriously disabling enlargement [4]. In post mastectomy patients, chronic lymphedema has the potential to become a permanent progressive condition. Allowed to be progressing the condition can become extremely treatment resistant and in most cases cannot be completely relieved with either medical or surgical means [5].

Short-term complications such as increased fullness of soft tissues, heaviness of the affected extremity, discomfort, and pain

\* Corresponding author. Mobile: +20 1001475828.

E-mail address: mkhalaf1871@yahoo.com (M.M. Khalaf).

<sup>1</sup> Assistant Professor in Department of Physical Therapy for Surgery, Faculty of Physical Therapy, Cairo University, Giza, Egypt. Peer review under responsibility of Ain Shams University.



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make patients susceptible to long-term complications of restricted shoulder mobility and decreased functional ability. The lymphedema in turn may be subsequent to fibrosis of the tissues because of deposition of protein rich fluids in interstitial tissues [4,6].

Treatment of lymphedema is difficult and multidisciplinary in nature, and even in the best outcome costly and time consuming. Therapy available for lymphedema may be divided into three general categories, pharmacological, surgical and rehabilitation. The later is a multidisciplinary and comprehensive treatment approach incorporating specialized massage, skin care, bandaging, exercises, and pneumatic pump and complex decongestive therapy (CDT) [7].

Range of motion (ROM) restrictions of the ipsilateral arm are almost universal and are the result of tissue manipulation and positioning during surgery. Even if successful, resolution of surgery-induced ROM restrictions occurs. Lymphedema, by itself, can cause ROM limitations of the shoulder, elbow, and wrist. As the expanding subcutaneous tissues reach maximum capacity, tissue spaces that are necessary for free movement of the joints become full of fluid, and joint mobility can be severely reduced. The sheer weight of the arm further limits movement, can negatively alter posture, and can reduce the functional abilities necessary for independent activities of daily living [8,9].

Low level laser therapy (LLLT) is reported to have beneficial effects on cells and tissues. These remarkable effects are reported for treatment of a wide range of conditions (e.g. musculoskeletal disorder, wound healing problem, scar and pain). Laser was reported to have an efficacy for treatment of lymphedema [10,11]. Laser has been used for treatment of post mastectomy lymphedema as it encourages lymphangiogenesis and stimulation of lymphatic drainage as well as stimulation of macrophage cells and stimulation of the immune system [12]. The current study had been conducted to determine the effect of Helium Neon laser therapy (which is a type of LLLT) in the treatment of lymphedema and shoulder mobility.

## 2. Subjects and methods

Thirty female volunteer patients from the National Cancer Institute who had modified radical mastectomy and had lymphedema of the upper limb secondary to breast cancer surgery were included in the study. Their ages ranged from 45 to 55 years. They were examined carefully by the physician before the study procedures. All patients were free from any other pathological conditions or histories of other health abnormalities except arm lymphedema. The patients were excluded if they had recurrent malignancy, active infection, clinical evidence of obstructive venous diseases, bilateral upper limb lymphedema, neurological and orthopedic problems, or diabetes.

The patients were randomly assigned into two main groups (A and B). Group A: (study group) included 15 patients who received laser therapy (Helium Neon laser therapy) in addition to decongestive lymphatic therapy. Group B: (Control group) included 15 patients who received placebo laser therapy in addition to decongestive lymphatic therapy. Treatment sessions were conducted three times per week for 6 months.

### 2.1. Ethical consideration

The study protocol was explained in detail for each patient before the initial assessment and signed informed consent

was obtained from each patient before enrollment in the study.

### 2.2. Measurements

Primary clinical and laboratory investigations were done to draw a complete picture of the health of all patients and to decide if the patient is able to undergo the experiment. The patient's name, age, weight and height, were written in the evaluation sheet of every patient. The measurement procedures were conducted before treatment application and at the end of the study after 6 months.

### 2.3. Lymphedema volume measurement procedure

The patients were placed in the supine lying position on a plinth with arm resting comfortably at the sides with forearm in pronation. This position enables easy access to ulnar styloid process for measurement. The limb was divided into intervals of 10 cm from the ulnar styloid process and with total of four segments. The distal and proximal circumferences for each segment were measured. The distance between the distal and proximal circumferences was measured. The measurement was calculated by using the following formula.

$$V = L/12\pi(C_1^2 + C_1C_2 + C_2^2)$$

where  $v$  = volume,  $C_1$  and  $C_2$  are the measured circumferences at the either end of the chosen segment of length ( $L$ ),  $\pi$  a constant of 3.12 [13].

### 2.4. Shoulder mobility measurement procedure

A standard goniometer was used to measure active ROM for shoulder flexion, abduction, and external rotation. For measurement the patient was placed supine with the thorax firmly strapped to the table to prevent body shift, which would tend to compensate for movement of the shoulder [14]. For shoulder, abduction and external rotation, the range of motion measurement started from neutral zero position to the limit of pain. The patient is asked actively to move the limb in the desired direction as she can till the appearance of pain and the degree of joint movement was recorded [15].

### 2.5. Laser treatment procedure

The laser unit was set at the following treatment parameters (frequency: 5000 Hz, duration: 15 min, pulse duration: 50 ns, power intensity: 5 mW, wave length: 632.8 nm and dosage: 1.5 J/cm<sup>2</sup>). The patients were placed in a comfortable supine position. A plastic guide with a grid of 17 treatment points centered at 2 cm interval, was placed in axilla to guide application and determine the points of application for laser therapy. During the laser treatment head was held in contact with and at right angles to the skin, after that the therapist presses on the emission enabling key to allow irradiation beam passages through laser aperture. Each point had been irradiated for one minute with a total duration of 17 min [6].

## 2.6. Decongestive lymphatic therapy

Decongestive lymphatic therapy comprises a number of inter-related treatment modalities that are most effective when utilized in an interdependent fashion.

- Proper skin care will optimize the supple texture of the skin and with the other components of this therapy and minimize the risk of infection through cutaneous portals of entry.
- Manual lymphatic therapy is a specialized form of massage that has been demonstrated to stimulate and direct lymphatic flow, thereby decreasing the edema and fibrous changes of the involved extremity.
- Application of multilayered low-stretch bandages (with appropriate padding) is utilized to enhance the effect of muscular activity upon the clearance of lymphatic fluid from the limb.
- Exercises include active range of motion, and they are maximally effective when performed while the edematous limb is bandaged. Isometric exercise is of dubious benefit and may, in fact, promote worsening of the edema [16].

## 3. Data analysis

The equivalence of both groups was checked by conducting independent *t*-test on lymphedema volume and shoulder mobility. Paired *t*-test was calculated on the pretest to posttest change within each group. Finally to assess whether any difference existed in the posttest scores, an independent *t*-test was calculated on the posttest change for both groups. The level of significance  $p < 0.05$  was used.

## 4. Results

The descriptive characteristics of both groups are shown in Table 1. There were no statistical differences between both groups regarding the age and lymphedema period.

### 4.1. Comparison between pre and post treatment within the same group

#### 4.1.1. Results of lymphedema volume

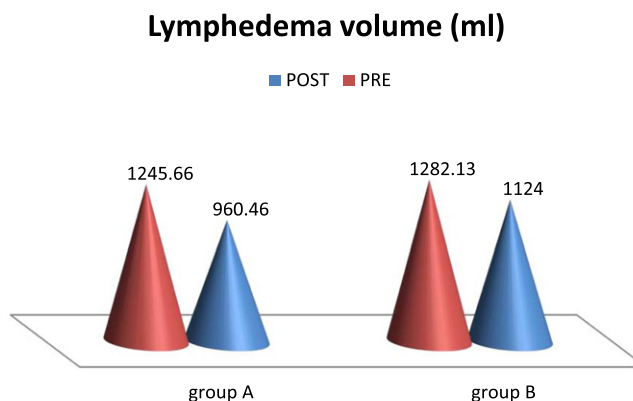
The mean value of lymphedema volume pretreatment in the group A was  $1245.66 \pm 101.3$  ml. and the value after treatment was  $960.46 \pm 76.00$  ml. The paired *t*-test demonstrated a statistically significant difference between pre and post treatment for lymphedema volume in this group ( $t = 13.28$ ,  $p = 0.00$ ).

**Table 1** Descriptive statistics in both groups.

| Comparison      | Age (years)     |            | Lymphedema period (months) |            |
|-----------------|-----------------|------------|----------------------------|------------|
|                 | A               | B          | A                          | B          |
| Mean            | 49.13           | 48.66      | 19.80                      | 18.66      |
| SD              | $\pm 2.58$      | $\pm 2.31$ | $\pm 4.31$                 | $\pm 2.84$ |
| <i>t</i> -Value | 0.520           |            | 0.850                      |            |
| <i>p</i> -Value | 0.607           |            | 0.403                      |            |
| Significance    | Not significant |            | Not significant            |            |

**Table 2** Comparison of lymphedema volume (ml) pre and post treatment in both groups.

| Groups          | A            |             | B           |              |
|-----------------|--------------|-------------|-------------|--------------|
|                 | Pre          | Post        | Pre         | Post         |
| Mean            | 1245.66      | 960.46      | 1282.13     | 1124.00      |
| SD              | $\pm 101.36$ | $\pm 76.00$ | $\pm 97.43$ | $\pm 121.99$ |
| <i>t</i> -Value | 13.28        |             | 7.83        |              |
| <i>p</i> -Value | 0.00         |             | 0.00        |              |
| Significance    | Significant  |             | Significant |              |



**Figure 1** Comparison of lymphedema volume (ml) pre and post treatment in both groups.

The mean value of lymphedema volume pretreatment in the group B was  $1282.13 \pm 97.43$  ml. and the value after treatment was  $1124.00 \pm 121.99$  ml. The paired *t*-test demonstrated a statistically significant difference between pretest and posttest for lymphedema volume in this group ( $t = 7.83$ ,  $p = 0.00$ ), Table 2, Fig. 1.

#### 4.1.2. Results of shoulder mobility

The paired *t*-test showed a significant increase in range of motion in both groups regarding shoulder flexion, abduction and external rotation in comparing pre and post treatment range of motion scores with ( $p < 0.05$ ), Tables 3 and 4.

### 4.2. Comparison between both groups at the end of treatment

#### 4.2.1. Results of lymphedema volume

Independent *t*-test showed a significant decrease in lymphedema volume after 6 months of treatment in group A in relation to group B ( $p = 0.00$ ), Table 5 and Fig. 2.

#### 4.2.2. Results of shoulder mobility

Independent *t*-test showed a significant increase in shoulder mobility (flexion, abduction and external rotation) after 6 months of treatment in group A in relation to group B ( $p = 0.00$ ) as shown in Table 6.

## 5. Discussion

This study demonstrated that, laser therapy was significantly more effective in reducing limb volume and increasing shoulder mobility associated with post mastectomy lymphedema.

**Table 3** Comparison between shoulder mobility (in degrees) pre and post treatment in group A.

| Shoulder ROM          | Flexion     |        | Abduction   |        | External rotation |        |
|-----------------------|-------------|--------|-------------|--------|-------------------|--------|
|                       | Pre         | Post   | Pre         | Post   | Pre               | Post   |
| Mean                  | 151.40      | 173.20 | 162.28      | 172.40 | 70.38             | 81.90  |
| SD                    | ± 4.01      | ± 4.06 | ± 6.50      | ± 7.00 | ± 4.18            | ± 4.31 |
| <i>t</i> -Value       | -25.63      |        | -12.49      |        | -38.25            |        |
| <i>p</i> -Value       | 0.00        |        | 0.00        |        | 0.00              |        |
| Level of significance | Significant |        | Significant |        | Significant       |        |

**Table 4** Comparison between shoulder mobility (in degrees) pre and post treatment in group B.

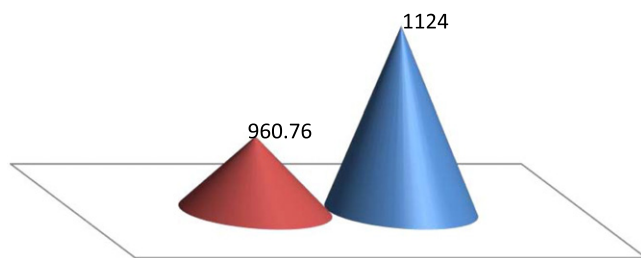
| Shoulder ROM          | Flexion     |        | Abduction   |        | External rotation |        |
|-----------------------|-------------|--------|-------------|--------|-------------------|--------|
|                       | Pre         | Post   | Pre         | Post   | Pre               | Post   |
| Mean                  | 150.16      | 163.93 | 158.36      | 163.40 | 70.38             | 75.60  |
| SD                    | ± 5.70      | ± 7.15 | ± 5.92      | ± 5.32 | ± 4.23            | ± 4.10 |
| <i>t</i> -Value       | -8.31       |        | -6.64       |        | -15.69            |        |
| <i>p</i> -Value       | 0.00        |        | 0.00        |        | 0.00              |        |
| Level of significance | Significant |        | Significant |        | Significant       |        |

**Table 5** Comparison of lymphedema volume (ml) after end of treatment.

| Groups                | A           | B        |
|-----------------------|-------------|----------|
| Mean                  | 960.46      | 1124.00  |
| SD                    | ± 76.00     | ± 121.99 |
| <i>t</i> -Value       | 4.156       |          |
| <i>p</i> -Value       | 0.00        |          |
| Level of significance | Significant |          |

### Lymphedema volume (ml)

■ Group B ■ Group A

**Figure 2** Comparison of lymphedema volume between both groups after end of treatment.

Our results agree with Piller and Thelander [11], who studied the effect of laser therapy in post mastectomy arms lymphedema (duration >4 years). This trial found that the arms responded well to the laser therapy. There was a reduction in the amount of edema and volume of the extracellular fluid as measured by bioimpedence. The tissues become softer as measured by tonometry and the patients perceived an improvement in symptoms of pain, tightness, heaviness, and cramps as well as mobility of the limb. The arm had lost 19.7% of its edema volume during the first 16 sessions, in addition to 7% loss over 6 months.

Similarly, Thelander [17], examined the effect of low level laser therapy (LLLT) (wavelength of 632.8 nm, output intensity of 9 mW, and energy density of 2.4 J/cm<sup>2</sup>) on lymphedema. The laser therapy targets the areas of blockage of fibrosis starting over the chest wall and axilla and moving distally in the arm. Results confirmed that the patients treated with laser therapy had a significant reduction of the lymphedema and drop in the rate of infections. Also they reported a significant reduction of lymphedema of the face and neck following surgery and associated radiotherapy for cancer of thyroid.

The effect of LLLT may be due to, restoration of lymphatic drainage through the axillary regions due to stimulation of new lymphatic pathways and restoration of draining through reduction of fibrosis and scarring of tissues as there was evidence of tissue softening after treatment with LLLT [6].

Nussbaum [18] demonstrated that LLLT increased endothelial prostacyclin secretion and degradation of fibrin net-

**Table 6** Comparison of shoulder mobility (in degrees) after end of treatment between both groups.

| Shoulder ROM          | Flexion     |        | Abduction   |        | External rotation |        |
|-----------------------|-------------|--------|-------------|--------|-------------------|--------|
|                       | A           | B      | A           | B      | A                 | B      |
| Mean                  | 173.20      | 163.93 | 172.40      | 163.40 | 81.90             | 75.60  |
| SD                    | ± 4.06      | ± 7.15 | ± 7.00      | ± 5.32 | ± 4.31            | ± 4.10 |
| <i>t</i> -Value       | 4.10        |        | 4.46        |        | 4.19              |        |
| <i>p</i> -Value       | 0.00        |        | 0.00        |        | 0.00              |        |
| Level of significance | Significant |        | Significant |        | Significant       |        |

works with enhancement of hematoma absorption. In addition, LLLT increases the production of vascular endothelial growth factors (VEGF) by smooth muscle cell fibroblasts and stimulation of endothelial cell growth thus enhancing vascular and lymphatic repair and promotion of collateral growth of lymphatic vessels.

Improved circulation due to LLLT irradiation is considered to be one of the possible mechanisms of clinical effectiveness of LLLT for the treatment of pain and edema reduction. The reduction in tissue fluid accumulation occurs through changes in the blood flow directly via effect on blood vessels (enhancing vascular and lymphatic repair and promotion of collateral growth of lymphatic vessels) or by neural or hormonal regulations of vessels in the limb. The LLLT is capable of inducing potent arteriolar vasodilatation and a consequent increase of blood flow [19]. The increased blood flow occurs in two phases; the first increase occurred shortly after the laser irradiation and the second additional increase occurred approximately 20 min after the irradiation. The sympathetic vasomotor nerve plays a key role in the control mechanisms for arteriolar constriction. It is known that LLLT attenuates neural conduction in the dorsal root of sensory nerves. Thus, it is reasonable to hypothesize that the attenuation of the vasomotor nerve activity by laser would be involved in the LLLT induced arteriolar vasodilatation [20].

In conclusion, we found that, a combination of laser therapy and decongestive lymphatic therapy had a significant effect on lymphedema reduction and increasing shoulder mobility. For this, a program of laser therapy and decongestive lymphatic therapy should form a core for most patients with lymphedema aiming to reduce limb volume and improve shoulder mobility.

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