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Efficacy of Transcutaneous Electric Diaphragmatic Stimulation on Lung Functions in Post Mastectomy Women

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Abstract:
Objective: This study was conducted to investigate the efficacy of transcutaneous electric diaphragmatic stimulation on lung functions in post mastectomy women.
Material and methods: thirty post mastectomy women for longer than three months were participated in this study in the period between March and May 2022. They were selected randomly from Deraya University Physical Therapy Center in Minya. Their ages ranged from 45-60 years. They were divided into two groups, the control Group (Group A) they received chest physiotherapy (diaphragmatic breathing &pursed lip breathing) and the study group (Group B) they received transcutaneous electric diaphragmatic stimulation in addition to chest physiotherapy (diaphragmatic breathing &pursed lip breathing). Spirometry was used to assess lung function (forced expiratory volume FEV & forced expiratory volume / forced vital capacity FEV/FVC) in both groups (A&B) before and after treatment.
Results: the finding of this study indicated significant improvement of FEV and FEV/FVC after treatment in both groups values (P value= < 0.00001). there was significant difference between both groups after treatment regarding the FEV (95%CI where p value < 0.00001), and FEV/FVC (95%CI where p value=0.001) with favored result in study group.
Conclusion: It can be concluded that transcutaneous electric diaphragmatic stimulation is an effective adjuvant therapy in improving lung function through increase FEV& FEV/FVC.

Key words: lung function, diaphragmatic stimulation, mastectomy.

1.Introduction:

As early as 1600 BC, the Ancient Egyptians were aware of breast cancer. In the past 50 years, it has developed into a serious health issue that could impact up to one in eight women throughout their lives. Mastectomy is a common surgical procedure for women with breast cancer who are interested in preventing the spread of the disease. Regrettably, a significant risk of local recurrence can still exist even after a successful operation (for example, in the lymph nodes or chest wall) (1).

Radiation therapy, chemotherapy, hormone therapy, as well as immunotherapy are only some of the options for treating breast cancer. Despite this, surgical intervention remains the gold standard (2).

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Despite rising survival rates, the illness and associated treatment still leave survivors suffering from side effects such lymphedema, restricted shoulder motion, shoulder pain, muscular weakness, reduced upper extremity function, exhaustion, depression, and issues with the heart and lungs. Post-mastectomy syndrome (PMS) is the term used to describe all of these side effects (3).

Post-mastectomy radiation (PMRT) contributes to increased patient survival and a reduction in locoregional recurrence. However, there are a number of potential adverse effects of this drug that could affect the patient's survival or quality of life. One of these problems is lung disruption. When it comes to radiation therapy for thoracic malignancies, the lung is a crucial dose-limiting organ because of its close proximity to the target volume. Radiation-induced pneumonitis with lung fibrosis are two pulmonary complications of PMRT (4).

Delivering tangential fields for post-mastectomy radiotherapy (PMRT), a small section of the underlying lung is sometimes included within the radiation portals, which may increase the risk of radiation-induced lung toxicity (RILT). The two most common clinical presentations of radiation-induced lung toxicity (RILT) are acute radiation-induced pneumonitis (RIP) as well as late radiation-induced fibrosis (RIF). RIP normally presents itself anywhere from 4-12 weeks after the end of PMRT, and while it can occasionally induce coughing and shortness of breath, it is often mild and barely noticeable. Although most cases of RIP improve on their own or with the help of steroids, there is always the risk that it will progress into RIF as a late toxicity. Factors that significantly affect RIP and RIF include the total lung volume irradiated, the mean lung dose, the fractionation schedule, and any concurrent therapies. However, the pulmonary functional reserve is also influenced by the following factors: 1) Involvement or non-involvement of the supraclavicular (SC) region. 2) Radiation therapy methods 3) Smoking practices, 4) Concurrent tamoxifen use. RILT has a detrimental effect on quality of life even though it might not raise mortality risk (5).

Patients with breast cancer whose pulmonary functional reserve is reduced may experience less favorable long-term therapy outcomes (6).

While there is some evidence that pulmonary function tests (PFTs) improve after PMRT for breast cancer, this evidence is rare. Only a few studies have shown that PFTs significantly decreased in breast cancer patients who had PMRT, including SC area, and adjuvant chemotherapy (7).

Previous research has shown that individuals who have undergone a major mastectomy for breast cancer have an immediate need for physical rehabilitation plus psychological care (8,9,10).

Cardiovascular and respiratory problems are common among breast cancer survivors, making them a priority for prevention and treatment efforts (11,12). Adequate physical therapy not only leads to a notable enhancement of health and physical condition, but also of quality of life. Transcutaneous electrical diaphragmatic stimulation (TEDS), particularly in patients with neuromuscular disorders as well as ventilator weaning, promotes muscle strength and prevents muscle atrophy by retraining and recruiting the maximum number of uninjured muscle fibres capable of producing targeted muscle contraction. In the last case, it is also suggested to improve contractile dysfunction in addition to causing breathing to occur (13).

TEDS has been used to improve the strength of breathing muscles in individuals who have weak respiratory muscles. A previous study found that patients with chronic obstructive pulmonary disease (COPD) had better lung capacity but also oxygen saturation after only one TEDS session (14).

When you want to increase your lung capacity, you need to make sure your breathing muscles stay coordinated. While inhaling, these muscles cause the rib cage to expand and the diaphragm to lower, allowing the lungs to take in a larger volume of air. To allow air to leave the lungs during expiration, these muscles must relax (15).

During respiration, tissues exchange oxygen as well as carbon dioxide with the air. Respiratory muscle movements and neurological mechanisms regulate it. One of the respiratory muscles, the diaphragm, is essential to the respiratory pump. Additionally, it affects how the respiratory system regulates breathing and affects human posture. Diaphragmatic respiration is respiration performed through diaphragmatic contraction. The diaphragmatic breathing method has been used in Pilates, yoga, as well as other activities that strengthen the core. So far, there have been many studies done on it. Diaphragmatic breathing, in particular, can be used to improve lung and trunk stability. It is anticipated that improving respiratory function through various forms of exercise will result in stronger and more resilient respiratory muscles (16).

2.Patients and Methods:

2.1. Study participants and recruitment criteria:

Between March and May 2022, thirty women who had a mastectomy more than three months ago took part in this study. They came from the Deraya University Physical Therapy Center in Minya and were chosen at random. They were between 45 and 60 years old. All patients were treated with post mastectomy radiotherapy and adjuvant chemotherapy. Patients with heart disease, lung disease, a history of other abdominal surgeries, a history of smoking, or maybe a history of skin disease were not allowed to take part in this study. This was randomized, controlled, pre-test and post-test design study. Before the initiation this study was approved by the Ethics Committee No: P.T. REC/012/003634. Faculty of Physical Therapy, Cairo University, Egypt. Before the patients participated in our study, they gave their written consent. Patients who met the selection criteria were split into two groups of the same size, Group A (control group): There were 15 patients in this group, they received chest physiotherapy (diaphragmatic breathing &pursed lip breathing) three to four times per day for 6 weeks. Group B (study group): There were 15 patients in this group, they received transcutaneous electric diaphragmatic stimulation with frequency of 30 hertz (cycle per second); phase width (pulse duration) of 0.4 ms and the current was adjusted to provide a comfortable level of stimulation while still producing diaphragmatic muscle contraction, sessions will last 20 minutes each, three times a week, for a total of six weeks. in addition to chest physiotherapy (diaphragmatic breathing & pursed lip breathing). Numbered envelopes were used by independent research assistant to distribute patients at random into the two groups. Patients were blinded in which group they have been placed in.

2.2. Measurement procedures:

Both groups were evaluated using a spirometer prior to therapy and again at the end of the 6-week treatment period.

Procedure of Spirometer:

To measure FVC and FEV1, the patient was told to inhale as deep as they could and then exhale as forcefully and quickly as they could, continuing until no more air was left. The FEV1 and FVC maneuver produced the PEF. For VC, the patient inhaled as deeply as they could before blowing continuously for as long as they could till they ran out of air. For VC, nose clips were crucial since poor flow might cause air to seep out. To perform the IVC maneuver, the patient inhaled strongly and rapidly following full exhalation as the FVC/VC was being completed (depending on the device used). Encouragement made a significant difference, as a result, don't be shy about using a loud voice near the end of the maneuver to push the subject to exhale until there is no more air coming out and the volume time trace reaches a plateau, resulting in 50 ml being breathed in 2 seconds (17).

2.3. Therapeutic procedures:

• Transcutaneous electrical diaphragmatic stimulation procedures:

Group B patients received transcutaneous electrical diaphragmatic stimulation as following:

-the Dualpex 961 model Phrenics (Quark®; Piracicaba, São Paulo, Brazil) with respiratory rate of 15 rpm, phase width (pulse duration) of 0.4 ms, rise time of 0.7 seconds, and frequency of 30 hertz (cycles per second) Sessions lasted 20 minutes, three times a week for six weeks, and the current intensity was kept at a minimum sufficient to generate diaphragm muscle contraction while also providing the subjects with a nice sensation (18).

- Four silicone-carbon electrodes measuring 3 by 5 cm will be applied to clean skin for this purpose, together with gel & micropore tape space, which is located near to the xiphoid region, and at the seventh intercostal space, which is located on the mid-axillary line, two electrodes will be placed, one on each side of the thorax. The subjects were told to time their breathing to the electrical current's pulsating. The individuals stayed in the semi-Fowler position (30o), with their arms by their sides and their lower extremities extended (16).

•Breathing exercises procedure

Both groups (A&B) patients received Breathing exercises as following:

Breathing exercises help you breathe more easily, obtain more oxygen, and improve your breathing muscles.

-Pursed-lip breathing:

The patient was told to relax his neck and shoulder muscles, inhale via his nose for 2 seconds while keeping his mouth shut, and exhale through pursed lips for 4 seconds. Simply exhale for twice as long as he inhales if this is too long for him. While exercising, breathe through pursed lips. If he was having trouble breathing, try lowering his breathing rate and concentrating on exhaling through pursed lips.

-Diaphragmatic breathing:

On being told to lay on his back with his knees bent, the patient. He can support his knees by placing a pillow under them. The patient put one hand on the area beneath his ribs on his belly and the other hand on his chest and took three long breaths into his nose. His lower ribs and tummy should rise, but his chest should not. The patient was told to contract his abdominal muscles and breathe out via slightly pursed lips for six counts.

3. Statistical analysis:

Statistical analysis was conducted using SPSS for windows, version 25 (SPSS, Inc., Chicago, IL). The current test involved two dependent variables (forced expiratory volume FEV & forced expiratory volume / forced vital capacity FEV/FVC). Prior to final analysis, data were screened for normality assumption. Parametric teste (paired sample testes and independent sample t-tests, for within group and between groups comparison, respectively) was used for inferential analysis of forced expiratory volume & FEV/FVC. Intestinal alpha level was 0.05 for all tests.

4. RESULT:

Statistical analysis showed no statistically significant differences (P>0.05) between subjects in both groups concerning outcome variables at baseline (pre-intervention) regarding age, weight, FEV, and FEV/FVC variables as represented in **(Table 1).** Moreover, posttest comparison between both groups showed a statistically significant difference regarding the FEV (95%CI where p value < 0.00001), and FEV/FVC (95%CI where p value=0.001) with favored result in study group as represented in **(Table 2).**

Within group comparison in both groups showed significant improvement of FEV and FEV/FVC after treatment in comparison to pretreatment values (P value < 0.00001).

5. Discussion:

Despite the small sample size and short follow-up time, this study may have significant consequences for how we think about radiation's effect on lung function in the future. Although asymptomatic individuals can have abnormal PFTs, it is recommended that PFTs be incorporated into the follow-up of women who have undergone radiotherapy as well as chemotherapy in order to identify pulmonary impairment at an early stage (19).

Current study reported that posttest comparison between both groups showed a statistically significant difference regarding the FEV (95%CI where p value < 0.00001), and FEV/FVC (95%CI where p value=0.001) with favored result in study group as represented in (Table 2). Within group comparison in both groups showed significant improvement of FEV and FEV/FVC after treatment in comparison to pretreatment values (P value < 0.00001).

The findings of this study were in line with Yong (20) as they compared feedback breathing exercise (FBE) to diaphragm breathing exercise (DBE) to discover which method would have a more significant impact on respiratory performance. Before and after performing any breathing exercises, there were statistically significant changes in both functional vital capacity (FVC) and slow vital capacity (SVC) (p0.05) according to the findings. During the breathing exercise with the feedback respiratory device, the people demonstrated thoracic respiration by lifting their shoulders or moving their chests during excessive inhalation and exhalation, indicating that they were using the breathing accessory muscles rather than the diaphragm.

Because they used the diaphragm, the DBE group displayed exhalation resistance with pursed lips and diaphragmatic respiration. This group also displayed a larger increase in FVC. It has been suggested that the findings of this study can be used as a starting point for the development of new types of breathing exercises.

Table (1): Comparison between both groups at baseline and after 4 weeks of treatment, independent sample t-test

	Baseline				6 weeks	
	Age (mean±SD)	Weight (mean±SD)	FEV (mean±SD) Pretreatment	FEV/FVC (mean±SD) Pretreatment	FEV (mean±SD) Posttreatment	FEV/FVC (mean±SD) Posttreatment
Study Group (n= 15)	51.2±6.181	85±4.062	3.37±0.088	76.27±1.486	4.23±0.085	80.6±1.595
Control Group (n=15)	51.25±8.098	88.75±3.5	3.38±0.1019	76.93±1.534	3.82±0.099	78.73±1.1629
T-value	0.0190	2.7087	-0.499	-1.209	12.147	3.663
P-value	0.985	0.0114	0.621	0.237	< 0.00001	0.001

Table (2): Comparison between pre and post treatment results within each group, study and control, paired sample t-test:

		FEV (mean±SD)		FEV/FVC (mean±SD)	
		Baseline	6 weeks	Baseline	6 weeks
Study Group (n=15)		3.37±0.088	4.23±0.085	76.27±1.486	80.6±1.595
	T-value	50.138		6.873864	
	P-value	< 0.00001		< 0.00001	
Control Group (n=15)		3.38±0.1019	3.82±0.099	76.93±1.534	78.73±1.1629
	T-value	27.99		8.293315	
	P-value	< 0.00001		< 0.00001	

According to Guerri (21) Specifically, respiratory muscle wasting is a predictor of vulnerability and hospitalization in patients with chronic COPD, suggesting that respiratory muscle training be incorporated into physical therapy for this condition. Applying TEDS to the diaphragm muscle is one strategy for stimulating fast fibers that are depleted in COPD patients.

The results of this study were consistent with those of Cancelliero (16) which showed that in a subset of COPD patients with higher hypoxemia, TEDS improved SpO2, lowered HR, and increased lung volumes. These findings might be clinically applicable to the use of TEDS with COPD patients. To assess the long-term impact of TEDS, additional research including individuals with COPD and respiratory muscle weakening is required.

The results of this study agreed with those of Tomar (22) who conducted research to assess the impact of breathing exercises on postpartum moms who had normal vaginal deliveries and to compare the impact of breathing exercises with a control group. According to the study's findings, breathing exercises for postpartum moms significantly changed their lung functions (FVC, FEV1, PEFR, FEF25-75%, and FEV1/FVC).

Another study by Santos [18] found that the tidal volume had increased after two weeks of daily thirty-minute sessions with fourteen elderly and TEDS participants.

According to research by Forti (23) maintaining the strength of the inhaling muscles did not differ between conventional chest physiotherapy (CCP) and conventional physiotherapy combined with transcutaneous electrical diaphragmatic stimulation (CCP+TEDS). Additionally, it was shown that after 15 and 30 postoperative days, the group treated with CCP had significantly reduced expiratory muscle strength compared to the group treated with CCP+TEDS. This demonstrates that CCP+TEDS is a crucial preventative strategy for patients recovering from bariatric surgery.

Conclusion:

It can be concluded that transcutaneous electric diaphragmatic Stimulation is an effective adjuvant therapy in improving lung function through increase VC& FEV/FVC.

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