Ventilatory Functions Response to Respiratory Muscle Training in Welders

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ABSTRACT

***Objective**: This study was conducted to determine the effects of resisted diaphragmatic breathing exercises and upper limbs exercises connected with breathing on the ventilatory functions in Welders. **Subjects material and methods:** Thirty subjects were enrolled in this study their age ranged from 20 to30 years and were classified randomly into two equal groups., group (1) received resisted diaphragmatic breathing exercises and group (2) received the upper limbs exercises connected with breathing. The workers in both groups were trained for 2-months where the ventilatory functions (FVC, FEV_1 and MVV) were measured before the study and after 2-months. **Results:** this study indicated that there was a greater significant improvement in measures of the ventilatory functions (FVC, FEV_1 and MVV) in group (1) received resisted diaphragmatic breathing exercises and group (2) received the upper limbs exercises connected with breathing. The differences between both groups were not significant.*

INTRODUCTION

It is estimated that more than one million workers worldwide perform some type of welding as part of their work duties. Epidemiological studies have shown that a large number of welders experience some type of respiratory illness. Respiratory effects seen in full-time welders have included bronchitis, asthma, and a possible increase in the incidence of lung cancer. The chemical properties of welding fumes can be quite complex. Most welding materials are alloy mixtures of metals characterized by different steels that may contain iron, manganese, chromium, and nickel[1].

Welding is the process of joining metals by different methods as electric arc or flame with a filler material that is called the consumable that is usually coated or wire that contributes metal to the joint. The process of melting the parent metals and the consumable produces concentrated particulate fumes and gases. These fumes contain number of elements including:- Fluorine (F), Manganese (Mn), Zinc (Zn), Lead (Pb), Arsenic (As), Calcium(Ca), Chromium(Cr) and Nickel(Ni). Also, fumes contain gases released including:- Ozone (O3), Cobalt (Co), Carbon dioxide (Co2) and Hafnium (Hf). So, a number of health problems are attributed to welding[9].

Most welders expressed concern regarding excessive smoke levels in the workplace and inadequate ventilation. Types of welding identified were mild steel, stainless steel, and aluminum. Ventilation upgrades in the workplace were required in most of the welding shops[6].

Occupational environment monitoring and biological-medical monitoring of persons professionally exposed to welding fumes have been performed. Chromium, manganese and polycyclic aromatic hydrocarbons in welding fumes represent an important health risk[13].

Welding fumes may cause acute respiratory effects including airway irritation, acute bronchitis, metal fume fever and less commonly hypersensitivity pneumonitis or occupational asthma. Welders are also known to have a higher risk for chronic respiratory disorders such as pneumoconiosis, chronic bronchitis and lung cancer[10].

In a study of the effects of welding fumes and their duration of exposure on lung function. Welding workers, with exposures longer than 9 years, showed a significant reduction in spirometry (forced expiratory volume in one second [FEV1], FEV1/forced vital capacity [FVC%], and peak expiratory flow [PEF]). Lung function in nonsmoking welding workers is impaired and stratification of results shows a dose-effect of years of welding on lung function. This effect primarily shows an obstructive pattern of airways disease[7].

Breathing exercises as a number of exercises whose goal is moving the thorax and thereby the lung movements that can give the choice for promoting the pulmonary circulation. Also, breathing exercises are important also for uptake of oxygen and the elimination of CO_2. So, teaching correct way of breathing for patients with respiratory difficulties, it can improve their general condition[14].

There are many types of breathing exercise as diaphragmatic breathing, pursed lip breathing, segmental breathing, low-frequency breathing, sustained maximal inspiration breathing and exercise connected with breathing[4].

During unsupported arm elevation oxygen uptake, carbon dioxide production, and minute ventilation, were significantly greater than during the control arm position. Approaches that train arm muscles and strategies that either support arm muscles or allow for frequent rests during upper arm activity may improve the endurance and the quality of life for COPD patients[3].

The main goal of this work was to compare the improvement of ventilatory functions in welders received resisted diaphragmatic breathing exercises and upper limbs exercises connected with breathing.

MATERIAL AND METHODS

Thirty male welders, age ranged between 20-30 years, have been selected randomly from Abu Al Yazid welding exhaust factory at 6th of October industrial area using metal arc welding. The workers were chosen to be exposed to welding fumes for at least 5 years, non smokers and without any previous pulmonary or cardiovascular disorders through clinical examination by medical specialists. Subjects were divided into two equal groups:-

Group (I): received resisted diaphragmatic breathing exercises

Group (II): upper limbs exercises connected with breathing.

INSTRUMENTATION

1- Jaeger flow screen computerized portable spirometer: Equipment used to evaluate ventilatory functions of the subjects of the present study. To measure forced vital capacity (FVC), forced expiratory volume in first second (FEV_1) and maximum voluntary ventilation (MVV), before, and post one and two months of the study.

2- Abdominal weights: It was used for resistive breathing exercise training .It is a sand weight connected with adhesive straps to be applied firmly, their weights were graduated from half kilogram till three kilogram according to patient's ability[6].

Training programs

Group (1) received resisted breathing exercises: This exercise was done for diaphragm through abdominal weights while worker was in crock-ying position. Weights were placed on abdominal muscles to achieve 15% of the subject's maximum pulmonary inspiration in the first week of applying this exercise, and then was asked to inspire and expire with the weight. The resistance was increased by 5% at each session till 60% at the end of the first month and we continued at the same level until the end of treatment. The exercise was applied 10 times per session.

Group (2) received upper limbs exercise connected with breathing) each worker performed the following steps within 40 minutes:

1) Warming up phase: - It was as preparation for the following exercise for 5 minutes in the form of forward lean sanding with swinging upper limbs for five minutes.
2) Breathing exercise via deep breathing with abduction for upper limbs, then expire air with adduction for upper limbs five times of exercise and one minute for rest and repeat again for thirty minute.
3) Cooling down phase: - Relaxation position to ensure maximum relaxation of all body and returning to his resting state. Relaxed back ward sitting for 5 minutes. That practical work was carried out in summer season three sessions per week for two months for both groups. Measurements of FVC,FEV_1 and MVV have been measured before the study and after two months at the end of the study.

RESULTS

Table (1): The difference between the pre and post values of FVC, FEV_1 and MVV of patients received resisted diaphragmatic breathing.

	Mean ± SD		t-value	Significance
	Pre	Post		
FVC (L.)	3.9±0.2	4.3±0.22	4.99	Sig.
FEV_1 (L/sec.)	2.63±0.2	3.51±0.22	8.82	Sig.
MVV (L. /min.)	107.1±4.5	119.5±5.26	10.91	Sig.

FVC (L): Forced vital capacity/liter.
FEV_1 (L/sec): Forced expiratory volume in the first second (liter/second).
MVV (L/min.): Maximum voluntary ventilation.
Sig.: Significant (P<0.05).
SD: standard deviation.

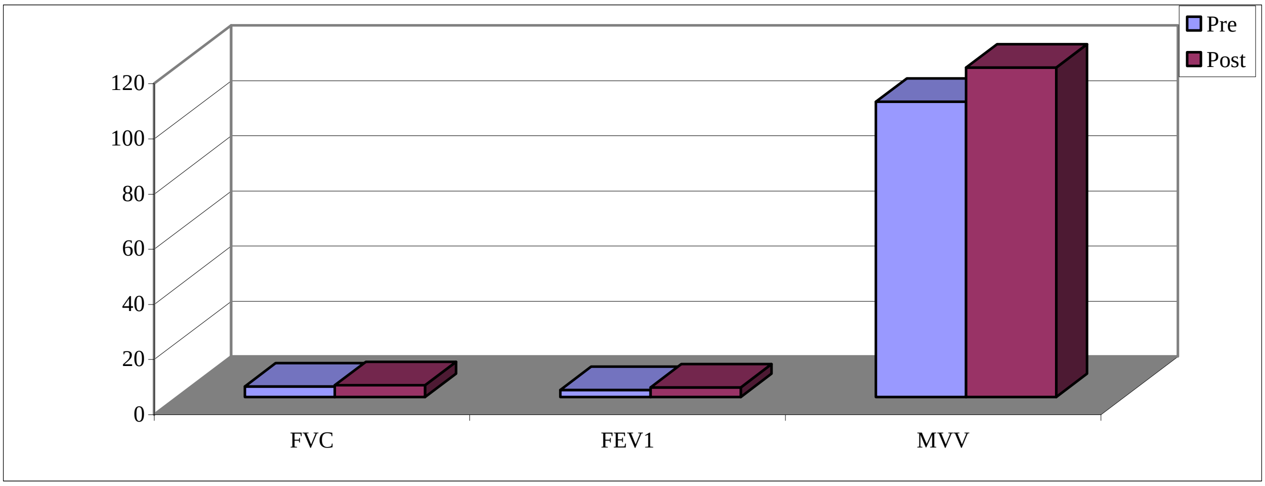

Fig. (1): The difference between the pre and post values of FVC, FEV_1 and MVV of patients received resisted diaphragmatic breathing.

Table (2): The difference between the pre and post values of FVC, FEV1 and MVV of patients received upper limbs exercise connected with breathing.

	Mean ± SD		t-value	Significance
	Pre	Post		
FVC (L.)	4.1±0.16	4.28±0.22	2.93	Sig.
FEV_1 (L/sec.)	3.09±0.32	3.35±0.3	8.92	Sig.
MVV (L. /min.)	110.4±7.37	117.8±7.12	8.49	Sig.

FVC (L): Forced vital capacity/liter.
FEV_1 (L/sec): Forced expiratory volume in the first second (liter/second).
MVV (L/min.): Maximum voluntary ventilation.
Sig.: Significant (P<0.05).
SD: standard deviation.

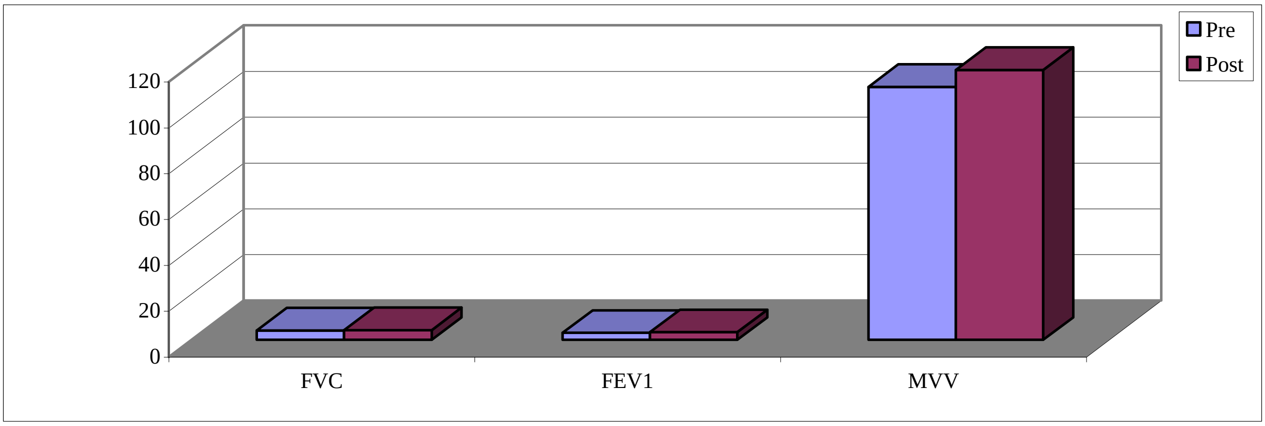

Fig. (2): The difference between the pre and post values of FVC, FEV1 and MVV of patients received upper limbs exercise connected with breathing.

Table (3): The difference between the effect of resisted diaphragmatic breathing and upper limbs exercise connected with breathing on FVC, FEV1 and MVV.

	Mean ± SD		t-value	Significance
	Group (1)	Group (2)		
FVC (L.)	4.3±0.22	4.28±0.22	0.57	Non sig.
FEV_1 (L/sec.)	3.51±0.22	3.35±0.3	0.83	Non sig.
MVV (L. /min.)	119.5±5.26	117.8±7.12	0.90	Non sig.

FVC (L): Forced vital capacity/liter.
FEV_1 (L/sec): Forced expiratory volume in the first second (liter/second).
MVV (L/min.): Maximum voluntary ventilation.
Sig.: Significant (P<0.05).
SD: standard deviation.

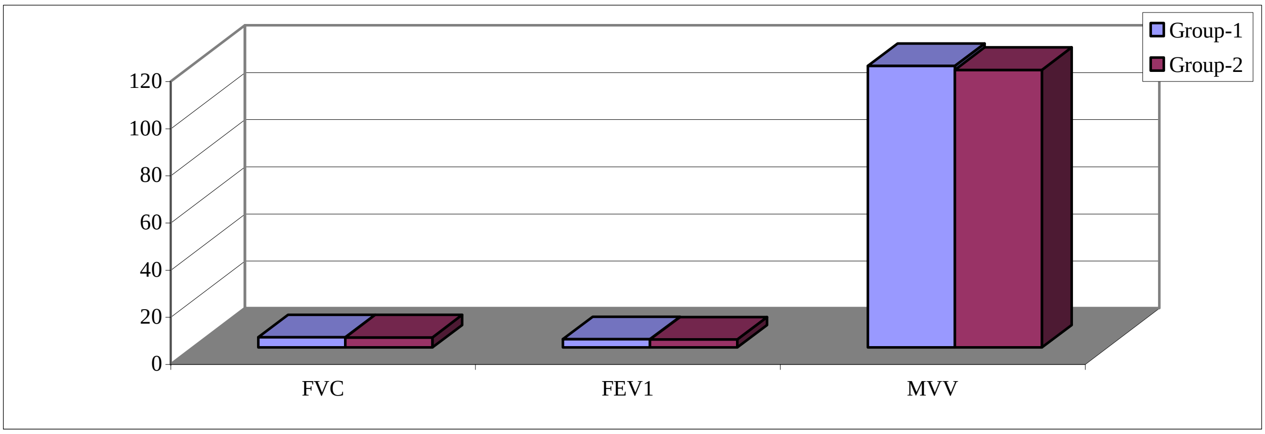

Fig. (3): The difference between the effect of resisted diaphragmatic breathing and upper limbs exercise connected with breathing on FVC, FEV1 and MVV.

DISCUSSION

Welding work is associated with exposure to various fumes and gases that are potentially harmful to the respiratory system. A number of health problems are attributed to welding fumes. Welding may cause acute upper respiratory symptoms, pulmonary fibrosis, and lung cancer[9].

In a study was done on the effects of exposure to welding fumes and their duration of exposure on lung function. Welding workers, with exposure longer than 9 years, showed a significant reduction in spirometery (forced expiratory volume in one second /forced vital capacity, and peak expiratory flow)[14].

This study was applied on thirty male welders, exposed to welding fumes for at least five years, non smokers and without any previous pulmonary or cardiovascular disorders. Subjects were divided into two equal groups, group (I) received resisted diaphragmatic breathing exercises and group (II) received upper limbs exercises connected with breathing. Measurements of FVC FEV_1 and MVV have been measured before the study and after two months at the end of the study.

The results indicated a significant increase in FVC, FEV_1 and MVV in both groups. Where, results of group (1) received resisted diaphragmatic breathing exercise showed a greater non significant difference than group (2) received upper limbs exercises connected with breathing.

These data agreed with a previous study reported that muscular exercise increase the rate and depth of respiration and so improve FVC, the consumption of O_2 and the rate of diffusion even when there is no significant change in the rterial partial pressure of O_2 or CO_2. Diffusion capacity is improved by increase in the number of functioning capillaries[5].

A significant improvement in the FEV_1 with a mean percent of change 17 % occurs after one month of physical training in the form of postural drainage with the use of mechanical vibrator, arm exercise in the form of arm swings, swimming movements and arm circles followed by breathing exercise in a form of diaphragmatic breathing and localized breathing exercises (6 days /week) applied on workers in jute and hemp industry[2].

Maximum voluntary ventilation (MVV) is important because it reflects the severity of airway obstruction as well as the patient's respiratory reserves, inspiratory muscles strength and endurance[8].

Training of respiratory muscles can significantly increase MVV, prolonged intense constant intensity exercise, reduce blood lactate concentration and improve lactate uptake by these trained muscles as fuel for their own activity[12].

The result is supported by a study that was conducted to measure the effect of breathing exercise (postural exercise connected with breathing) on pulmonary function in insecticides spray workers. He proved that the increase in VC and MVV followed breathing exercises was due to improvement in muscle strength and endurance , maintain of positive pressure in the airways by removal of excessive secretions , keeping them open and improving the efficiency of ventilation[11].

Volume and pattern of ventilation are initiated by neural output from the respiratory center in the brain stem. This output is influenced by input from carotid PaO_2 and central $PaCO_2$, [H+] chemoreceptors; proprioceptors in muscles, tendons, and joints; and impulses from the cerebral cortex nerves to the intercostals and diaphragmatic muscles. Therefore repeated periodic respiratory exercises help in maintaining the strength, endurance of respiratory muscles and as a result good ventilation. Normal gas exchange occurs if inspired gas is transmitted through structurally sound, un- obstructed air ways to patient, adequately perfused alveoli[8].

It was concluded that breathing exercises specially resisted diaphragmatic breathing exercise can improve the ventilatory functions in welders. So this type of exercise must be provided to welders to improve their ventilatory functions.

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الملخص العربي

استجابة وظائف التهوية الرئوية لتدريبات عضلات التنفس لعمال اللحام

أجريت هذه الدراسة لمعرفة استجابة وظائف التهوية الرئوية لتمرينات التنفس لعمال اللحام على ثلاثين عامل تتراوح أعمارهم بين عشرين إلى ثلاثين عاما تم تقسيم عمال اللحام إلى مجموعتين. حيث استخدمت المجموعة الأولى جهاز الحافز التنفسي وأدت المجموعة الثانية تمرينات للأطراف العلوية مرتبطة بالتنفس. وتم تسجيل قياسات التهوية الرئوية عند بدء الدراسة وبعد شهرين من التدريب لكل عامل . أظهرت النتائج أن هذا البرنامج نتج عنه تحسن ملحوظ في وظائف التهوية الرئوية بعد شهرين من التدريب . وأوضحت هذه الدراسة أهمية تمرينات التنفس خاصة جهاز الحافز التنفسي في تحسين التهوية الرئوية لعمال اللحام .