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The Role of Inspiratory Muscle Exercises in Patients with Respiratory Distress: Increase in Respiratory Capacity

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Abstract— **The aim of this study is to investigate the effect of inspiratory muscle exercises in patients with respiratory distress. Methods: The sportive activities of respiratory muscles were done by the patients who have respiratory insufficiency were monitored with the parameters; Vital Capacity (VC), Forced Expiratory Volume in the 1st second/Forced Vital Capacity (FEV_1/FVC), Maximal Voluntary Ventilation (MVV), Forced Expiratory Flow 25-75 (FEF 25-75), hematocrit (htc), Arterial partial oxygen pressure (pO2), Left Ventricle Ejection Fraction (EF) in 20 patients. The data were analyzed with the Wilcoxon Signed Rank Test. Results: Parameters are increased except hematocrit with statistically and clinically in important amount except hematocrit. The initial values, final values, changing amounts by percentages and statistical p values of parameters are; VC% (76.92, 87.26, 10.34= 13.5%, p = 0.000), FEV_1/FVC% (65.01, 70.18, 5.17=8%, p= 0.000), MW% (39.87, 58.51, 18.64= 46.8%, p = 0.000), FEF 25-75% (32.03, 38.90, 6.87= 21.5%, p = 0.009), Htc% (41.7, 40, -1.7=4%, p= 0.023), pO_2 mmHg (77.82 , 78.12, 0.3= 0.38% , p = 0.984), EF% (63.1, 64, 0.9=1.4%, p = 0.206) respectively. Conclusion: Differences in all parameters except for p02 and EF have been found statistically and clinically significant in showing the effect of inspiratory muscle exercises on respiratory function. Future searches should be based on home exercises by life time.**

Key words: Respiratory exercise, respiratory distress, COPD,

I. INTRODUCTION

Patients with respiratory distress are growing in number in direct relation with air pollution and consumption of cigarettes. Along with chronic obstructive pulmonary disease (COPD); structural abnormalities like kyphoscoliosis, sequel of surgical interventions on the respiratory system, neoplasm, and neurological loss of muscle function may all be among the precipitating factors of respiratory distress and such patients gain little comfort by medical therapy. COPD is the fourth ranking group of disease that is responsible for jeopardizing the quality of life. Around 50% of the patients have limited physical activity, whereas 25% of them are bedridden [1]. The physical exercise programs shown to increase the functional capacity of the dyspneic patients increase the strength and durability of the extremities leading to a better quality of life [1-3].

As they are under physical and psychological stress, patients undergo more expenditure of energy and oxygen, thus aggravating dyspnea. When the patients eventually limit their daily activity, they become more bed-dependent day by day [4, 5]. Inspiratory muscle exercises done against a resistance has significantly improved both inspiratory muscle endurance and exercise performance. Appropriate sports programs were able to improve exercise capacity by 20-30 % to diminish the complaint of dyspnea. This improvement is thought to be dependent upon the increased intake of oxygen and its expenditure [3].

Emery et al. applied physical exercises on 64 patients with COPD. They have showed a significant improvement in the parameters of FVC, FEV1 and MVV, endurance of exercise, and an improvement in the psychological status of the patients(6). However, Dambron et al. could not demonstrate a statistically significant improvement in the parameters of PFT with respiratory exercises and progressive muscle relaxation techniques and absence of physical exercises [7]. It is proved that aerobics and exercises enable structural and biochemical differentiations in the muscle. Many of the performed studies have demonstrated that muscular exercises are safe and reliable [8-12]. Some researchers have also showed that sports programs increase exercise tolerability and the quality of life for patients with severe chronic pulmonary hypertension or systemic hypertension [13- 17].

It is very important to start physical exercise programs to improve the quality of life effectively during the initial stages of the pathological condition [4]. On the other hand, some researchers have proposed that the continuation of physical exercises for at least one year or more increase the effectiveness [1, 18, 19]. However, a Meta-analysis of 17 study showed that the result (change in exercise capacity) of an exercise program were not affected by these factors: the period and frequency of the exercise, quality of study, exercises application area (hospital or not), targeted muscles was lower-extremity or combined low-and upper-extremity, exercise experience, age, forced expiratory volume (in one second), and amount of resistance to movements of exercise [20, 21]**.** The aim of this study is to investigate the effect of inspiratory muscle exercises in patients with respiratory distress by using laboratory parameters.

II. MATERIALS AND METHODS

The investigation confirms the principles outlined in the Declaration of Helsinki. COPD patients attending H.N. Hospital have been chosen randomly and then included in the study after obtaining their informed consents. The investigation confirms the principles outlined in the Declaration of Helsinki, and the local ethical committee. The diagnosis was established upon medical history, physical examination, radiological findings and respiratory function tests. The patients with at least one value of FEV1, FEV1 / FVC, VC, FEF 25-75 being below 70% and showing less than 15% change upon bronchodilator therapy were included in the study if they had general stable condition of six weeks.

Pre-experimental pulmonary function tests (PFT), arterial blood gas analysis, cardiac ejection fraction (EF) and chest X-ray were evaluated with systemic physical examination. Afterwards, the importance, advantage and the way of application of the physical exercises were explained to the study group in a standardized manner. The PFT were done many (at least three) times as a training to prevent a wrong application of machine at the beginning by a "Minato" autospirometer and the arterial blood gas analysis was done by a "Acid-Base Laboratory- Radiometer (Copenhagen ABL4), and "Esaote Biomedica SIM 7000 CFM Challenge" was used for EF measurements.

The patients were asked to follow the exercise program for one hour every other day three times a week for three months. Respiratory muscles were grouped and targeted to work against a resistance with different exercises. During the deep inspiration with pursed lips followed by slow and forceful expiration, the exercise of the diaphragm and the abdominal muscles were provided. The grouped and targeted respiratory muscles were worked against a resistance by suitable movements and the exercise machines (Bench machine, Polaris-Butter fly, Lat machine anterior, Lat machine posterior, Bench press, Rowing machine,) shown in Table [22-25]. The sessions started with three types of exercises (each repeated ten times) and every other day another ten repetitions added to each type of them until each one is done 30 times. Every other third day, a new type of exercise was added to the program up to reaching a maximum of seven types of exercises for each patient. The exercises were performed under the supervision of a physician so that they were done in the right way continuously. All the parameters were measured at the end of each month and the final results were analyzed statistically with the "Wilcoxon Signed Rank Test".

III. RESULTS

The mean age of the population is 49 (29-77), with nine women (45%) and 11 men (55%). The distributions of population according to the age groups are given in Fig 1.

All the patients had been experiencing dyspnea for at least five years. Eight of them never smoked. Four quitted smoking at least one year ago and the other eight patients stopped smoking at least two years ago; two of them smoked for ten years while the other six smoked for longer than ten years.

The severity and prevalence of inspiratory insufficiencies of the patients were as follows: mild obstructive respiratory insufficiency in eight patients (40 %), moderate obstructive respiratory insufficiency in one patient (%5), moderate obstructive respiratory insufficiency and mild restrictive respiratory insufficiency in three patients (15%), moderate obstructive respiratory insufficiency and moderate restrictive respiratory insufficiency in two patients (10 %), mild restrictive respiratory insufficiency and obstructive respiratory insufficiency in three patients (15%), severe restrictive respiratory insufficiency in one patient (5%). At the end of the third month, statistically significant improvements were obtained in the all parameters except EF, pO2, and pCO2 (Table and Fig 2). In two patients (10 %), the clinical complaints of dyspnea improved mildly with a 25 % decrease in the use of medication, eighteen patients stated significant improvement in dyspneic complaints with 75 % decrease in the use of medication ($p<0.001$). All the FVC, FEV1, FEV1 / FVC, VC, MVV and FEF 25-75 values increased at the end of the one month, and the total increasing amount of each parameter at the end of the three months was significant statistically and clinically (within $p=0.0001$ and $p=0.0009$).

IV. DISCUSSION

Despite distribution of ages and heaviness of respiratory insufficiencies have wide ranges between 29 to 77 years and mild to severe conditions respectively, and the period of exercise was short as 3 moths, the results of the study suggest that there were important increases in respiratory capacities of each patient. The performed respiratory muscles exercises were simple and so easy to simulate and to repeat at the home conditions with different cheap apparatus. Comparing our results with the reported studies above suggests that the period of each exercise as one month could be effective.

The exercises of high resistance and low repetition lead to hypertrophy in muscles whereas the exercises with low tension and high resistance activity increase the durability and oxidative capacity of the muscles. In addition, the exercises with low resistance and high repetition are accepted as easy and safe for the older population [9, 18-21]. That is why repetitive exercises with low resistance and high repetition activity were used in the study.

Low resistance and high repetitive respiratory exercises have led to an improvement in the respiratory function of the patients with COPD. The dyspnea of each patient decreased significantly. Therefore, we conclude that wide range of patients according to age and severity of respiratory distress are not contraindications for application of this exercise program when the patients have at least the respiratory capacity of our population and they have general stable conditions in the last six weeks. Indeed, the effect of lifetime respiratory exercise on health and survey of COPD

should be a subject to therapeutic approaches and new investigations.

In addition, it is expected that this study will lead to selective life time respiratory home exercise programs according to the diagnosis, the status of performance, the affected organs and muscles, the repeated number of an exercise and the amount of a resistance.

According to these results, the patients that cannot be admitted to an operation because of poor PFT status can be treated with the respiratory exercises. The other groups of patients with respiratory distress may show clinical improvements with the respiratory exercises. We concluded that the exercise by a simple rowing machine and the exercise of slow and forceful expiration with the pursed lips following deep inspiration will cover most of the exercise of primary respiratory muscles, and simple exercises could be practiced at home by life time that remote control by internet or periodic examinations could be sufficient to collect objective data and medical follow up. Therefore, future searches should be based on simple, cheaper, suitable to the patient, and applicable types of (home) exercises by life time. Thus, such exercises may help the national health work force be much more effective since the modern information technology has brought up valuable tools to educate those patients.

V. CONCLUSION

The result of the search suggested in this article indicates that the respiratory exercise could be a promising method because of its simplicity, its cheapness, and its applicability at home and may present an example for the other patients with respiratory distress.

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Age diastribution of patients

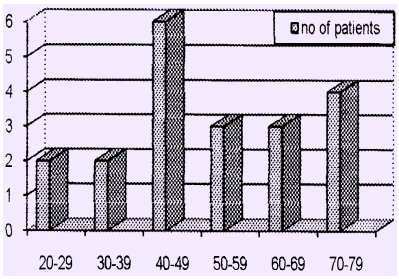

Figure 1. Number of patients and range of ages are represented on ordinate and axis respectively.

TABLE I.

Effect of Exercises on Respiratory Functions				
Parameter	**Initial value**	**Final value**	**Difference**	**p=**
VC%	76.92	87.26	10.34 (13.5%)	p= 0.0006
FEV1/ FVC %	65.01	70.18	5.17 (8%)	p= 0.0001
MW%	39.87	58.51	18.64 (46.8%)	p= 0.0001
FEF 25-75%	32.03	38.90	6.87 (21.5%)	p = 0.0009
Htc%	41.7	40	-1.7 (4%)	p= 0.0232
pO2 mmHg	77.82	78.12	0.3 (0.38%)	p = 0.9843
EF%	63.1	64	0.9 (1.4%)	p= 0.2069

The results are summarized as in the table with the evaluation of the statistical analysis according to the Wilcoxon Signed Rank Test. Difference in all parameters except for p02, EF have been found statistically significant in showing the effect of inspiratory muscle exercises on respiratory function.

Increasing respiratory capacities with period of exercises

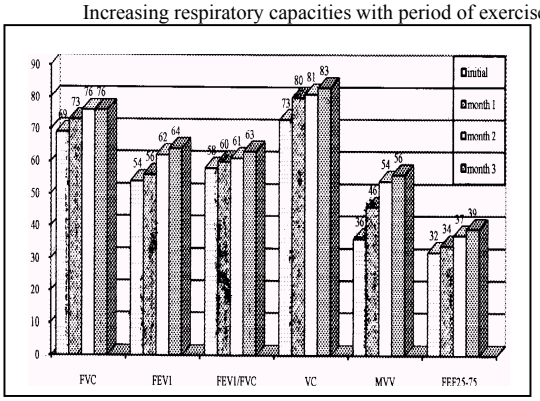

Figure 2. The Initial values and monthly changes in pulmonary function tests shown as percentages on the ordinate. Each parameter (FVC, FEV1 and others) of PFT is represented by consecutive four colon and each one represents the result of a month in order to the initial, end of the first, second and third months.