Efficacy of Aerobic and Deep Breathing Exercises on Pulmonary Function and Functional Capacity in Burned Male Patients

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ABSTRACT

The purpose of the present study was to investigate the efficacy of aerobic and deep breathing exercises on pulmonary function and functional capacity in burned male patients. Subjects: Forty-five burned patients participated in this study after one month from their discharge from hospital. They had second degree burn of TBSA ranged from 20 to 40% combined with inhalation injury. Their age ranged from 20- to 40 years old. They were divided randomly into three groups of equal number. Group (A): patients received an aerobic exercise with deep breathing exercise plus physical therapy chest routine, group (B): patients received only an aerobic exercise plus physical therapy chest routine, and group (C): patients received the routine chest physical therapy program. Measurement: pulmonary function (forced vital capacity "FVC", forced expiratory volume after one second " FEV_1", maximum voluntary ventilation "MVV"), maximum oxygen consumption "VO_{2max}", treadmill time, and dyspnea were measured pre-treatment and after eight weeks post treatment. Procedure: The patients treated three times/w for eight weeks for aerobic exercise and two times/d for five days /week for eight weeks for the deep breathing exercise using incentive spirometer. Results: the results of this study revealed that, there were significant improvement in all groups but the percentage of improvement in group "A" was more than "B" and "C". Conclusion: Combination of aerobic exercises and deep breathing exercises produces more improvement in the burned patient's parameters than aerobic exercises alone.

INTRODUCTION

Burn injuries are tragic event that have immediate and long-term effects on patient's psychological adjustment, function, and appearance[1]. Advances in the critical care of burns have greatly increased the survival rate of burn victims, allowing a high percentage of persons with massive injuries to live beyond their acute hospitalizations[2].

Injury of respiratory system is due to smoke, airway burns and burns of the chest wall. The burn related pathology appears to be more sever if the thermal damage is combined with inhalation injury[3]. Smoke inhalation is a major cause of mortality and morbidity. The survivors of fire accidents show symptoms very similar to asthma, such as productive cough and dyspnea, within minutes or hours of exposure and these symptoms can persist for >1 year[3]. Several studies conducted on the effects of smoke inhalation injury and they concluded that airway obstruction commonly occurs after smoke inhalation[2].

One of functional limitation due to burn injury is a decrease in the patient's pulmonary function (forced vital capacity "FVC", forced expiratory volume after one second "FEV_1", and maximum voluntary ventilation "MVV", which correlates with the patient's exercise capacity)[4].

Most researches on lung function have been done in the immediate post-burn period and concentrated on the acute airway problems[5]. It was demonstrated a decrease in patient's pulmonary function and functional capacity after burn injury[2]. It was reported that, there was reduction in pulmonary function in seven adult patients evaluated using spirometry and they indicated that FEV_1 measurements showed chronic pulmonary sequela due to burn injury[3,5]. On the other hand persistent muscle weakness has been reported after second to third degree burns[6]. It was noticed that, burned chest lead to respiratory muscles weakness. This weakness may contribute to dyspnea, continuous reduction of pulmonary function and limitation of exercise capacity of these patients[2,7].

This reduction in pulmonary function in addition to decreases in functional capacity, indicates a need to find rehabilitative interventions that improve physical function and performance. Therefore, pulmonary rehabilitation is a multidisciplinary program for patient with respiratory disease. Potential benefits include reduced symptoms, improved exercise tolerance and quality of life[8].

Exercise has been used successfully to improve pulmonary function and exercise tolerance in other populations exhibiting reduction in pulmonary function such as chronic obstructive pulmonary disease (COPD)[9]. Furthermore aerobic exercise considered as an important component of pulmonary rehabilitation program and it improves the patient's functional status and if the intensity of training is adequate, it produce a physiological training effect in patient with pulmonary dysfunctions[10,11].

It was suggested that, incentive spirometer considers one method for respiratory muscle strength[12]. Training of the respiratory muscles has been studied in several different populations including patients with chronic obstructive pulmonary disease, and in both acute and chronic tetraplegia. Interventions attempting to strengthen muscles of breathing have included abdominal weight, incentive spirometry, positive pressure training and facemasks.

Unfortiontly the previous literatures indicated the presence of lack of data on the effect of an aerobic exercise and deep breathing exercise maneuver on burned patient's pulmonary function, maximum oxygen consumption and functional capacity.

The results of the present study might help the physicians, physical therapist in planning a protocol of treatment which might enhance the pulmonary function and functional capacity in burned patients.

Therefore the aim of the present study was to investigate the effect of aerobic exercises and deep breathing exercises in burned mal patients.

MATERIAL AND METHODS

Subjects

Forty-five burned male patients were participated in this study. They were selected from Omm El Mysrieen Hospital (Department of Burn and Plastic Surgery).The study was done at the cardiopulmonary unit in the faculty of physical therapy, Cairo University. The burned patient's age ranged from 20 to 40 years old.They had 2nd degree burn of total body surface area ranged from 20- 40% of chronic phase and with anterior chest burn not less than 6% of the TBSA.All patients had inhalation injury and they were participated in the study one month after discharging from hospital. None of the patients had any evidence of any previous lung problems or reactive airway disease[2].Patients who reported a previous smoking history, and who had

circumferential chest burn were excluded from the study.These patients were divided randomly into three groups of equal number as follow:

Group (A)

(Aerobic+IS); Fifteen burned male patients received an aerobic exercise-training program on treadmill in conjunction with deep breathing exercise by using incentive spirometer plus the routine chest physical therapy (chest stretch exercise and breathing exercise).

Group (B)

(Aerobic); Fifteen burned male patients received only an aerobic exercise-training program on treadmill plus the routine physical therapy.

Group (C)

(Control); Fifteen burned male patients received the routine chest physical therapy only, in form of breathing exercise and chest stretching exercise. All patients signed informed consent forms before the study.

The design of the current study was Pre-treatment, Post-treatment design.

Instrumentation

1-Measuring equipment and tool

a-Ergospirometry system

It is Zan-680 Ergospiro "Ergospirometry System", which is manufactured by ZAN Me Bgerate Gmbh, Germany. It is a recording device for synchronous registration of breathing flow, respiration volumes as well as inspired and expired gases. It was used to measure: (a) The pulmonary function: (forced vital capacity "FVC" forced expiratory volume after 1 sec "FEV_1",and maximum voluntary ventilation. "MVV"), (b) Maximum oxygen consumption (VO_{2max}), and (c) Treadmill time.

b-Modified Borg Scale for Breathlessness

It comprises a 10-point scale (0-10), with descriptors at most of the values for example: moderate (3), sever (5), and maximal (10) table (2). This score is easy to employ and reproducible. It is used to measure dyspnea associated with exercise.

2-Theraputic equipment

a-Treadmill

RAM model 770 CF electronic treadmill was used for providing an aerobic exercise for group A&B of patients.

b-Incentive spirometer device (IS)

It is a flow type device. It consisted of three champers, and it was be used to provide sustained deep breathing exercise for group "A" only.

Procedure of the study

(A) Measurement procedure

Each patient was evaluated by measurement of pulmonary function (PF), VO_{2max}, treadmill time and level of dyspnea.All measurements were done pre treatment and after 8-w post treatment.

a) Measurement of pulmonary function

- Procedure to measure forced vital capacity "FVC" and forced expiratory volume at 1 second "FEV_1"

Each patient was instructed to inspire slowly and deeply, and then he expired with power as quick and as much as possible. Each patient was performed at least three trials and the best performance was used for analysis[5].

- Procedure to measure Maximum voluntary ventilation "MVV"

Each patient was instructed to breathe as rapidly and fully as possible for 12-15 sec. The total volume was obtained through multiplying this volume by the appropriate number (5 if tested for 12 sec, 4 if tested for 15 sec)[13].

b) Measurement of maximum oxygen consumption and treadmill time

A treadmill exercise test was done by using the modified Bruce protocol as shown in table (1). The speed and angle of elevation started at 1.7 miles/ h and 0% respectively. Then the speed and level of inclination was increased every three min[4]. Patients were constantly encouraged to complete three min stages and the test terminated once the peak volitional effort achieved[4,7].

Table (1) Modified Bruce protocol for treadmill exercise testing14

Duration of interval minutes	Treadmill speed m/h	Grade of elevation%
3	1.7	0
3	1.7	5
3	1.7	10
3	2.5	12
3	3.4	14
3	4.2	16
3	5	18
3	5.5	20
3	6	22

c) Measurement of dyspnea

Measurement of dyspnea was done during exercise testing on treadmill with using Modified Borg Scale for Breathlessness as shown in table (2)

Table (2): Modified Borg scale for breathlessness15

0	Nothing at all
0.5	Very very slight
1	Very slight
2	Slight
3	Moderate
4	Somewhat sever
5	Sever
6	-
7	Very sever
8	-
9	Very very sever (almost maximal)
10	Maximal

(B) Treatment procedures

(1) Treatment procedures of group A

(a) Aerobic exercise

It was organized in the form of treadmill exercise. It was done three times/week, for eight weeks, each session lasted from 20 to 40 min and the participant exercised at 70-85% of his previously determined individual VO_{2max}[4]. The aerobic exercise began and ended with warming-up and cooling-down periods of three to five minutes. Warming up period: it was in the form of walking on the treadmill for about three to five minutes at speed 1.5 km/h with zero inclination[16]. Cooling down period: it was in the form of walking on treadmill for three to five minutes at a speed 1km/h with zero inclination and gradually decreasing the speed until reach to zero[16].

(b) Deep breathing exercise

Deep breathing exercise was done by using incentive spirometer.Patient asked to breath slowly after a deep exhalation, and then patient was instructed to hold breath from three to five seconds.The exercise was performed twice daily for 15 min and five time/week for eight weeks. The exercise was splitted into five minutes/ session if the subject was unable to train for 15 min without interruption[17].

(2) Treatment procedures of group B

The treatment procedure of group B consisted of an aerobic exercise on treadmill only.The treatment procedure of aerobic exercise was similar to group A.

(3) Treatment procedures of group C

The treatment procedure of group C consisted of routine chest physical therapy program

Data analysis

In this study, the mean, standard deviation, maximum, minimum values and the percentage of improvement were calculated for all groups of patients. Paired t- test was utilized to identify the changes in each group over time for pulmonary function tests (FVC, FEV_1, MVV), VO_{2max}, treadmill time and dyspnea score. One- way analysis of variance was done to compare the variables between the three groups. Correlation was done between maximum voluntary ventilation and Vo_{2max} post treatment. All hypotheses were tested at 0.05 level of significance.

RESULTS

The results showed that, there were no significance differences between the patient's age, height, weight, and %TBSA pre treatment in all groups with P value >0.05.

I- Analysis of Results for Pulmonary Function

The result represented that there were significant differences between the pre and post-treatment pulmonary function for the three groups of patients with the percentage of improvement in group A more than group B and C respectively.

The percentage of improvement of FVC for group A, B and C were: 30.9%, 12.7%, and 2.4% respectively and the percentage of improvement of FEV1for group A, B and C were: 71.9%, 16.4% and 5.7% respectively. In addition the percentage of improvement of MVV for group A, B and C were; 70.41%, 15.2%, and 1.3% respectively.

II- Analysis of Results for Functional Capacity and Treadmill Time

It revealed that there were significant differences between the pre and post-treatment VO2max and treadmill time for the three groups of patients with the percentage of improvement in group A more than group B and C.

The perecentage of improvement of VO2max for group A, B and C were; 56.4%, 10.9%, and 1.01% respectively. In addition the perecentage of improvement of treadmill time for group A, B and C were;60.5%, 22.8%, and 1.6% respectively.

III- Analysis of Results for Dyspnea

The results of the current study revealed that, there was a significant difference between the pre and post-treatment dyspnea score for the three groups of patients with the percentage of improvement in group A more than group B and C respectively.

The perecentage of improvement of of dyspnea score for group A, B and C were; 62.12%, 27.2%, and 6.9% respectively.

IV- Comparative Analysis of Data among all Groups

A- Comparative Analysis of Pulmonary Function

The comparative analysis of variance for pre-treatment mean values of FVC, FEV1, MVV showed no statistical significance differences (P> 0.05) among all groups.

As shown in table (3) and fig (1,2,3) the comparative analysis of variance for post-treatment means values of FVC, FEV1, MVV showed statistical significance differences (P< 0.01) among all groups. Post hock analysis of variance showed that, the post-treatment means values for group A demonstrated highly significance difference in comparison to post treatment mean values for group B and C respectively.

Table (3): Comparative analysis of variance for pulmonary function at Post treatment among three groups.

Variable	Group A $\overline{X}$ ± S.D	Group B $\overline{X}$ ± S.D	Group C $\overline{X}$ ± S.D	F-ratio	P-Value
FVC(L)	4.36±0.41	3.73±0.63	3.48±0.5	11.25	0.001
FEV_1(L)	3.61±0.31	2.41±0.4	2.22±0.3	72.66	0.001
MVV (L/min)	107.55±8.8	71.4±11.6	64.3±9.44	80.4	0.001

X = Mean FEV_1=Forced Expiratory Volume in one second L= Liter
FVC =Forced Vital Capacity L/min = Liter per minutes SD = Standard Deviation
MVV= Maximum voluntary ventilation. Level of significant (P<. 0.01), non significant

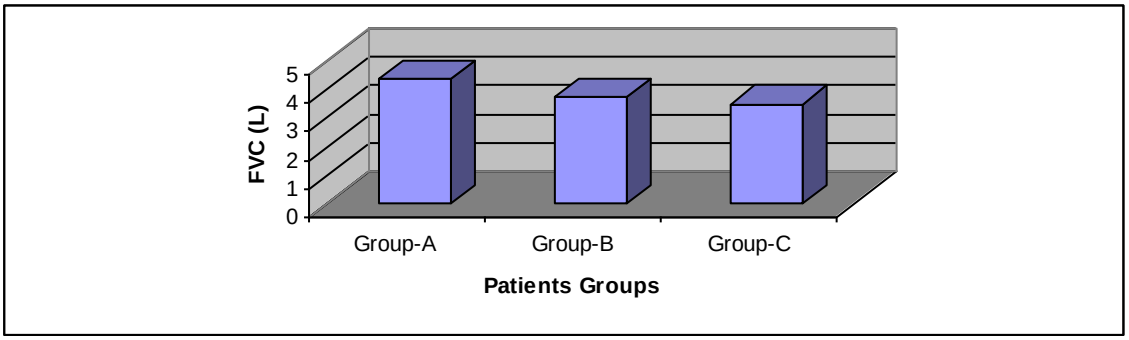

Fig. (1): Post-treatment mean value of FVC for patients among the three groups (A, B&C).

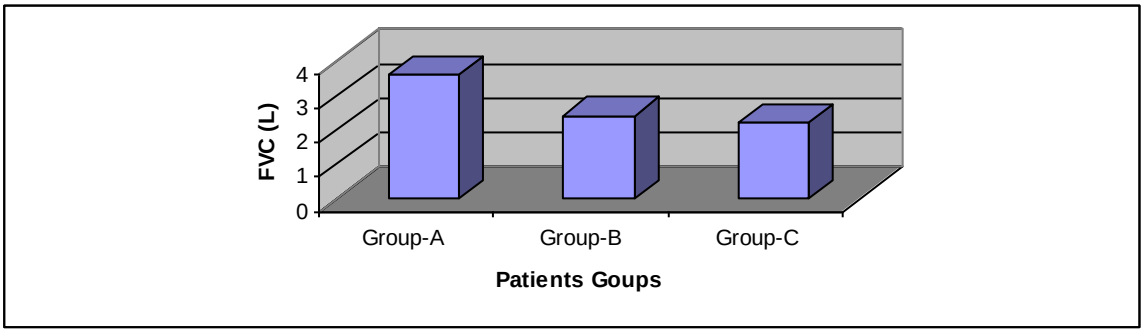

Fig. (2): Post-treatment mean value of FEV 1 for patients among the three groups (A, B&C).

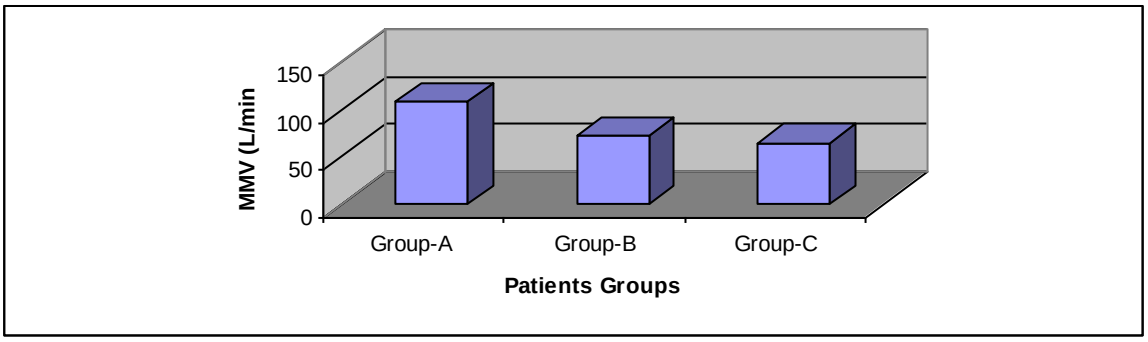

Fig. (3): Post-treatment mean value of MVV for patients among the three groups (A, B&C).

B-Comparative Analysis of VO2max & Treadmill Time

The comparative analysis of variance for pre-treatment mean values of VO2max and treadmill time showed no statistical significance differences (P> 0.05) among all groups of patients.

As shown in table (4) and fig (4,5) the comparative analysis of variance for post-treatment mean values of VO_{2max} and treadmill time revealed statistical significance differences (P< 0.01) among all groups of patients. Post hock analysis of variance showed that, the post-treatment means values of VO_{2max} and treadmill time for group A demonstrated significance difference in comparison to post treatment mean values for group B and C respectively.

Table (4): Comparative analysis of variance for functional capacity (VO_{2max},& time) at post-treatment among the three groups.

Variable	Group A	Group B	Group C	F-ratio	P-value
	$\overline{X}$ ± S.D	$\overline{X}$ ± S.D	$\overline{X}$ ± S.D		
VO_{2max}(L/m/Kg)	34±3.76	24.77±2.03	22.84±2.39	66.67	0.001
Time (minute)	17.56±1.65	13.78±1.23	11.5±2.01	50.47	0.001

X = Mean SD = Standard Deviation VO_{2max}=Maximum oxygen consumption
Level of significant (P<0.01), significant L/m/kg = Liter per minute per kilogram

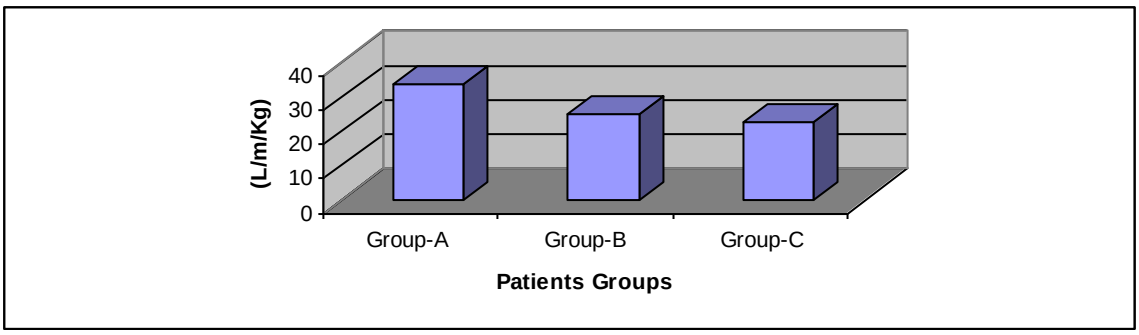

Fig. (4): Post-treatment mean value of VO_{2max},for patients among the three groups (A,B&C).

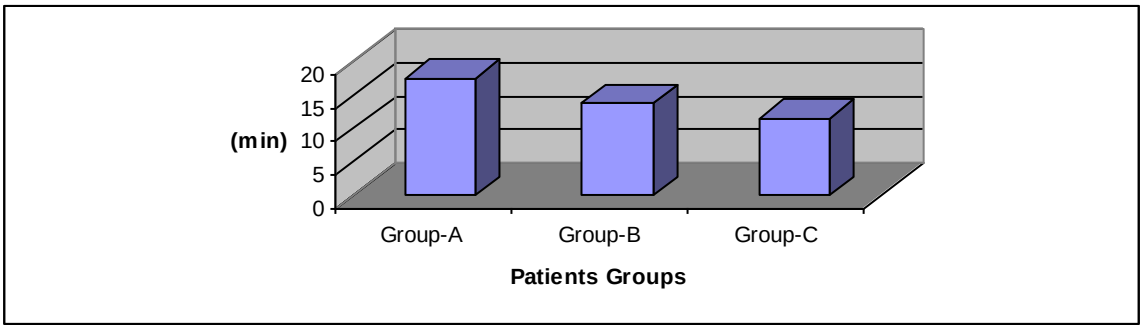

Fig. (5): Post-treatment mean value of treadmill time, for patients among the three groups (A, B&C).

C- Comparative Analysis of Dyspnea Score

The comparative analysis of variance for pre-treatment mean values of dyspnea score represented no statistical significance differences (P> 0.05) among all groups of patients.

As shown in table (5) and fig (6) the comparative analysis of variance for post-treatment mean values of dyspnea score represented statistical significance differences (P< 0.01) among all groups of patients.Post hock analysis of variance showed that, the post-treatment means values of dyspnea score for group A demonstrated significance difference in comparison to post treatment mean values for group B and C respectively.

Table (5): Comparative analysis of variance for dyspnea score at post-treatment among the three groups..

Variables	Group A	Group B	Group C	F ratio	P-value
	$\overline{X}$ ± S.D	$\overline{X}$ ± S.D	$\overline{X}$ ± S.D		
Dyspnea score	2.5±1.34	5±1	6.2±1.08	40.15	0.001

X = Mean SD = Standard Deviation Level of significant (P<0.01), significant

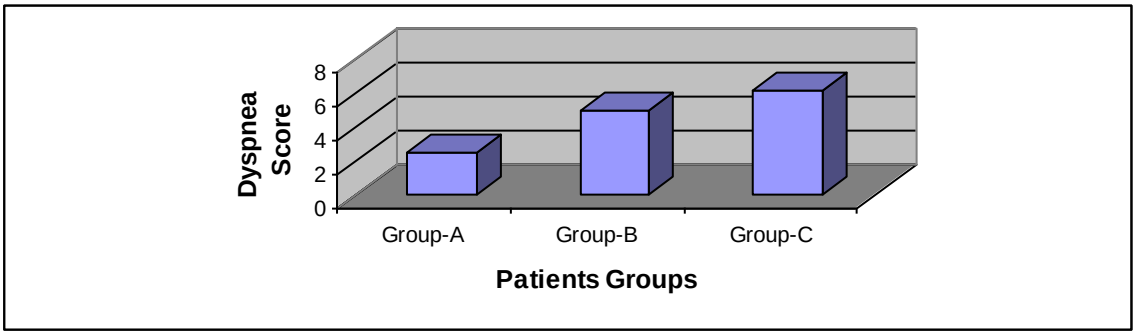

Fig. (6): Post-treatment mean value of dyspnea score for patients among the three groups (A,B&C).

V- Correlation between the MVV and VO_{2max}

As shown in table (6); there is a significant positive correlation between MVV and VO_{2max} for group A, B, and C with P<0.01.

Table (6): Correlation between VO_{2max}, and MVV for groups(A, B and C).

Variables			VO_{2max},		
			Group A	Group B	Group C
MVV	Group A	r	0.81	-	-
		P-Value	0.001	-	-
	Group B	r	-	0.76	-
		P-Value	-	0.001	-
	Group C	r	-	-	0.61
		P-Value	-	-	0.001

DISCUSSION

This study was conducted to evaluate the therapeutic efficiency of aerobic exercise on treadmill and deep breathing exercise using the incentive spirometer on the burned male patient's pulmonary function, exercise capacity, treadmill time and dyspnea. Also to determine if the combination of aerobic and deep breathing exercises has additional effects on the burned patient's measured parameters.

All factors that might influence the results were controlled "age, weight, height and TBSA" as the pre-treatment results showed that; there were no significant difference among the three groups of patients "group A (aerobic &IS), group B (aerobic) and group C (control)".

The results of this study showed that there were no significant differences among all groups of patients at the pre-treatment pulmonary function test with P> 0.05. In addition, they were below the predicted values for these patients in relation to their age, weight and height. As well as, the results of the current study indicated that there were no significance differences among all groups of patients at the pre-treatment functional capacity (VO_{2max}), treadmill time and dyspnea with P>0.05.

The results of this study are in agreement with those who reported deterioration in pulmonary function and functional capacity in burned patients; Park et al., 2003[3], investigated the value of spirometry in 28 adult patient with combined burn and inhalation injury and they were able to identify sever obstructive defect evidenced by sever reduction in pulmonary function. Suman et al., 2001[7] reported in seven burned patients evaluated using spirometry compromised pulmonary function measured approximately 8.4 years after sustaining an inhalation injury associated with burn and they documented that, all the spirometric measurements had been shown to be worse.

As well as it was, reported reduction in pulmonary function, which typified by an initial obstructive pattern of disease lasting up to 2 years and then restrictive pattern that lasts into convalescence[2]. Furthermore Mlcak et al., 1995[18], represented abnormal cardiopulmonary functions in patients who survive after thermal injury. The result of the present study also supported by the results achieved via several researchs, whom documented deterioration in both pulmonary function and functional capacity evidenced by reduction in FVC, FEV_1, MVV and VO_{2max}.[4]

The results of this study pointed out that, there were improvements in the patient's pulmonary function "FVC, FEV_1, MVV"

represented by significant differences between the pre-treatment and post-treatment pulmonary function after 8-w with the percentage of improvement in group A "Aerobic & IS" was more than in group B "Aerobic" and group C "Control" respectively.On the other hand improvement was noticed in the treadmill time in the three groups, which parallels the increase in VO_{2max} "functional capacity". The percentage of improvement in group A was more than group B and C respectively. Furthermore, the results revealed that there was an improvement of dyspnea "reduction" with a higher percentage in group A than in group B and C respectively.

The finding of the current study has an agreement with reported gains in pulmonary function, functional capacity and dyspnea in patient with respiratory dysfunction as COPD or cystic fibrosis, who trained using various exercise protocols. It was reported a significant improvement in patient peak exercise O_2 consumption who suffered from obstructive disease with the application of aerobic exercise of 30-40 min[11]. Similar finding was reported by a researcher, who mentioned that after aerobic exercise applied 3 times/week at intensity of 75% to 85% of maximal heart rate, peak O_2 consumption increased by 15-20%[19]. Furthermore, the results of this study have an agreement with Ortega et al., 2002 [20], who documented that aerobic exercise results in improvement in exercise capacity, treadmill time and dyspnea of patients with varying degree of obstruction. The results of the study also supported by Tomohiro et al., 2003[21] that reported that moderate intensity of aerobic exercise have a significant improvement in VO_{2max} in patients who suffered from coronary heat disease.

In addition, it was, reported in adult patients improvements in pulmonary function measured with spirometry with the application of aerobic exercise[22]. It was achieved significant increase in patient's exercise capacity, FVC, and FEV_1 with the application of pulmonary rehabilitation program consisted of 10 min warm up, 25 min aerobic exercise and 10 min cool down[23]. It was suggested that aerobic exercise provide a sufficient stimulus to improve cardio-respiratory function[24]. Similar finding was reported by many investigators, whom showed improvement in lung function and exercise capacity of patients with obstructive disease[25,26]. In addition several authors, succeeded to conclude that children with thermal injury also benefit from exercise training, which was evidenced by increase in PF and exercise capacity[4].And recently Janos et al., 2005[27], concluded that lower extremity training for 8-w caused improvement in exercise capacity and dyspnea reduction measured with Modified Borg Scale.

As revealed in the present study the percentage of improvement in group "A" was more than in group "B" and "C". This might be explained by the additional effects of deep breathing exercise using incentive spirometer, which is supported by many studies: as Ho et al., 2000[28], showed improvement in pulmonary function with the using of incentive spirometer in patient with chronic pulmonary disease. Lotters et al., 2002[29], supported that strengthening of the inspiratory muscles might improve exercise capacity and reduce symptoms of breathlessness. As well Sutbeyaz et al., 2005[30], concluded that combination of both aerobic exercises and respiratory muscle exercise showed greater improvement in PF and exercise capacity compared to the aerobic exercise alone. On the other hand, many investigators, failed to support that combination of both exercises had additive effect on patients compared to aerobic exercise alone[31,32].

The results of this study suggested that MVV has a positive correlation with patient's exercise capacity VO_{2max}. On the other hand the increase in treadmill time and VO_{2max} revealed an improvement in the patient's cardiovascular endurance[4].

Conclusion

It was concluded study that combination of both aerobic exercise on treadmill and deep breathing exercise using IS is more effective to improve the burned male patient's PF, functional capacity and dyspnea when added to the traditional exercises program.

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الملخص العربى

فاعلية التمرينات الهوائية وتمرينات التنفس العميق على الوظيفة الرئوية والسعة الوظيفية لمرضى الحروق من الرجال

كان الهدف من هذه الدراسة هو تقييم الكفاءة العلاجية للتمرينات الهوائية بإستخدام جهاز المشى الكهربى و تمرينات التنفس العميق بإستخدام المقياس الرئوى الحافز على الوظيفة الرئوية و السعة الوظيفية وأيضا عسر التنفس فى مرضى الحروق من الرجال . وأيضا لبحث أهمية اضافة تمرينات التنفس العميق الى التمرينات الهوائيةو التى قد تؤدى الى تحسن أفضل فى قياسات المريض وشمل هذا البحث على 45 مريضاً من الرجال بعد مرور شهر منذ خروجهم من المستشفى و هؤلاء المرضى يعانون من حرق من الدرجة الثانية بنسبة 20-40% مصحوب بضرر إستنشاقى. وقد تم تقسيم المرضى إلى ثلاث مجموعات متساوية:المجموعة الأولى: تم علاجهم بإستخدام التمرينات الهوائية و تمرينات التنفس العميق بالإضافة إلى العلاج الطبيعى التقليدى، المجموعة الثانية :تم علاجهم بإستخدام التمرينات الهوائية بالإضافة إلى العلاج الطبيعى التقليدى،المجموعةالثالثة: تم علاجهم بإستخدام العلاج الطبيعى التقليدى و الذى يتكون من تمرينات التنفس اليدوية بالإضافة إلى تمرينات الشد لمنطقة الصدر. تم العلاج بواقع ثلاثة جلسات أسبوعياً لمدة ثمانية أسابيع و بالنسبة لجهاز المقياس الرئوى الحافز فبواقع جلستان يومياً خمسة مرات أسبوعياً لمدة ثمانية أسابيع. أخذت القياسات لكل من الوظيفة الرئوية، السعة الوظيفية و المدة التى أستغرقها المريض على المشاية ، وعسر التنفس قبل وبعد العلاج بثمانية أسابيع . وقد أظهرت النتائج تحسن فى جميع المجموعات ولكن التحسن كان ملحوظاً فى المجموعة الأولى والتى تلقت العلاج بالتمرينات الهوائية بجانب تمرينات التنفس العميق أكثر من المجموعة الثانية والثالثة على التوالي .