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Multidimensional Impact of Treadmill Walking Exercise in Adults with Major Thermal Burn Injury

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ABSTRACT

Objective: This study aimed to evaluate the impacts of 8 weeks aerobic exercise using treadmill on immunity, physical function, fatigue, and hospital time in adults with major thermal burn injury. **Methods:** Thirty patients with age range from 20-40 years had thermal burn injury, covering 25-45% of the body, were enrolled in this randomized clinical trial. Therapeutic intervention was started after one week from burn onset for 8 weeks or until wound closure. Patients were randomized to either group A (aerobic exercise group in addition to traditional physical therapy program) or group B (control) received traditional physical therapy program. Fatigue scale, white blood cells count (WBCs), physical function assessments were performed at the beginning and the end of study. **Results:** showed significant improvement in the study group compared to control group regarding the WBCs, physical function, and fatigue. **Conclusion:** Adding aerobic exercises to burn rehabilitation program has a great value in improving immunity, fatigue sensation and decrease hospitalization time.

Keywords: Aerobic exercise; Burn injury; Fatigue; Hospitalization time; Immune system; Physical function; Treadmill walking.

INTRODUCTION

Burns are one of the most common devastating forms of trauma. Patients with serious thermal injury require immediate specialized care in order to minimize morbidity and mortality. Significant thermal injuries induce a state of immunosuppression that predisposes burn patients to infectious complications[9].

Severe burns induce marked physiologic derangement in addition to skin injury. These include hyper metabolism with erosion of lean body mass, generalized weakness and altered immune function with increased infectious complication, peripheral insulin resistance, and poor wound healing[8,17].

Loss of the barrier function of the skin, together with the immune compromised state associated with burns, means that burn patients are susceptible to localized and systemic sepsis and multi-organ dysfunction, with 75% of deaths from burns resulting from sepsis from burn wound infection or other infection complications and/or inhalation injury[1,6].

Many strategies have been used to improve immune function. Unfortunately, many of these interventions have been disappointing, impractical, and costly to develop. Research involving behavioral preventative or restorative therapies has been lacking. Moderate exercise training has been shown to elicit beneficial outcomes in both the prevention and rehabilitation of many diseases. It has been hypothesized that moderate levels of exercise improves, whereas strenuous exercise or overtraining suppresses, various immune function measures[2,33].

Without doubt aerobic exercise and training influence natural immunity. An important question is, however to what degree are these cellular changes of clinical significance, especially with respect

exercise on disease lethality vary with the type and time that it is performed[27].

Because of lack of studies examined the effect of exercise on wound healing in a laboratory experiment and quality of life with a controlled exercise intervention. This preliminary study evaluated the influence of exercise on immunity by white blood cells counting WBCs, wound healing acceleration by hospitalization time, physical function and fatigue response using quality of life scale, in a randomized controlled investigation. It was hypothesized that adding 2-month program of aerobic exercise program to traditional exercise program, in comparison to traditional exercise program, would be associated with: (a) increased immunity, (b) significantly faster healing of burn wound, (c) an enhanced physical function and fatigue sensation.

SUBJECTS AND METHODS

Research design and setting

This study was a randomized controlled trial, single blinded including 30 patients with dermal partial thickness burn injury randomly assigned to an aerobic exercise training program or to a control group. Both groups received traditional physical therapy program.

Randomization and blinding

Patients are randomly assigned to one of the two following conditions: aerobic exercise training (n=15) or control group (n=15). Randomization is performed by using numbered opaque envelopes containing treatment allocations[29].

Participants

All participants were informed about the nature and the purpose of the study; patients were examined by a physician before the study to determine inclusive and exclusive criteria. Demographic data was obtained from patient's file including age, cause of burn, and total body surface area TBSA%. Patient were male, aged 20-40 years, had second degree (dermal) thermal burn injury (hospitalization period), with total burned area ranged from 25-45%, and body mass index less than 30%. Patients were excluded if they had psychological disorders, cardiopulmonary diseases, diabetes hypertension, obesity, severe anemia associated or inhalation injury, immediately post skin grafting, limitation of R.O.M of joints of lower limb that may prevent adequate participation in exercise activities or affecting the results.

Patients participated in this study after one week of burn injury after signing an institutionally approved informed consent form prior to data collection. They were recruited from the burn unit of OM EL -MASREEN hospital. All patients were on the same protocol of medical and nursing care and traditional physiotherapy program of the hospital, which includes: positioning, splinting stretching exercise, R.O.M. exercise, breathing exercise and ADL exercise.

Data collection tool

- Anthropometry measures and patient demographic data:

Body weight, height, and BMI were obtained using standard weight and height scales. Data were collected for all participants at baseline only before intervention.

- Automated Hematology Analyzer:

Sysmex Corporation KX-21N was used to measure (WBCs)

- Quality of life scale QOL (fatigue assessment procedure): Lowa Fatigue

Scale (LFS):

It was used to measure the degree of fatigue in burn patient and QOL. It is a self-report questionnaire developed by the Department of Family Medicine, It consisted of many questions about the quality of life and its affection by fatigue. The 11 item scale contains four subscales: cognitive, fatigue, energy and productivity. Patients with a higher fatigue score are much more likely to have lower health status, greater depression and more somatic symptoms[15]. Lowa fatigue scale LFS is translated into Arabic by two translators a translator office and its validity and reliability were tested before its use.

- Hospitalization time:

Hospitalization time from the date of admission till the date of discharge was calculated[22].

- Physical Function

This variable was assessed through a physical performance task; 6-minute walk test (6MWT) distance in which participants were instructed to walk as far as possible in a 6-minute time on an established course. Performance was measured in the total distance covered[7].

Procedures

Patients who agreed to participate in this study signed a written consent, then the actual study maneuver started by baseline data assessment in the two groups (pre) using the designed study tool. Treatment procedure was applied; both groups received the same equivalent medical, nursing care and traditional physical therapy program previously designed to acute burned patient (hospitalization phase); combined exercise program for Group A which consisted of aerobic exercise in addition to traditional physical therapy program. All the patients in the exercise group followed an 8 weeks training program consisting of sessions with a duration ranging from 45 min (in the first few weeks of the program) to 60 min (by the end of the program) each session started and ended with a low-intensity 5-10 min warm up and cool-down period .The duration and intensity of the aerobic training was gradually increased during the 6 week period so that the subject start with at least 10 min of aerobic exercises at 50% of age predicted maximum heart rate (HR max), (calculated as 220minus age minus rest heart rate) and progress to at least 30 min exercise at ≥ 70% HR max by the end of the 8weeks program.

Bruce protocol:

The starting speed of the Bruce protocol was 1.7 miles per hour (mph) and 10% angle of elevation, and progressed to increased treadmill speed and grades every 3 minutes until exhaustion[5].

Ethical Consideration

This study was approved by the Institutional Review Board of the faculty of physical therapy, Cairo University. An official approval was obtained from Director of OM El-Massrien hospital and the heads of the departments. All patients were informed about the purpose, tools, procedures, and duration of the study and signed a written consent. They were given full explanations about the benefits of the study maneuver, as well as their rights to refuse or withdraw at any time without giving reasons and without consequences on their care.

Statistical Analysis

Data entry and statistical analysis were done using SPSS 16.0 statistical software package. Descriptive statistics including mean, standard deviation and percentage of difference of post treatment data as compared to pre one, were calculated for each group. Interferential statistics for Quantitative continuous data were compared using The paired sample student t-test within group variables and the independent sample t-test was used to compare between group variables, where $P<0.05$ is significant. Qualitative categorical variables were compared using chi-square test. In order to identify the independent predictors of lowa fatigue scale multiple linear regression analysis was used after testing for normal distribution, normality. Statistical significance was considered at P-value <0.05[28].

RESULTS

Results of patient demographic data

The demographic characteristics of the participants at baseline (pre) are shown in table 1. There were no significant differences between the two groups relevant to independent variable (Age, TBSA%, Height, Weight, and BMI).

Table (1): Demographic characteristics of patients in the two groups of the study.

Groups	Group A		Group B				
Variables	Mean	±SD	Mean	±SD	t-value	P-value	Significance
Age (yrs)	30.86	±5.31	29.86	±4.99	0.53	0.6	NS

TBSA%	30.6	±3.8	31.9	±4.3	.88	0.39	NS
Weight (Kg)	81.8	±5.41	80.53	±5.8	0.61	0.54	NS
Height (cm)	168.4	±4.68	166.06	±6.47	1.13	0.26	NS
BMI (Kg/m2)	28.84	±1.58	29.26	±2.53	0.54	0.59	NS

SD: standard deviation P: probability NS: non-significant.

Results of WBCs and fatigue

Table 2 demonstrates that there were no statistical differences in WBCs and QOL scale in the two groups before the intervention. After implementation of the intervention, Patients in study group had a significant difference of WBCs between pre and post treatment .The improvement % was 43.7 %.

Fatigue sensation assessment post treatment period for study group A revealed that a significance difference between pre and post treatment of QOL scale. The percentage of improvement was 25.12 %.

While patients in the control group had a considerable increase between pre and post treatment WBCs mean values, with improvement of 16.35 %.

Results Fatigue sensation assessment post treatment period for group B revealed a significant difference in pre and post treatment fatigue scale. The percentage of improvement was 9.44%.

Comparison of WBCs between 2 group revealed that there was no significant difference in pretreatment values, but there was a significant difference in the post treatment values (P<0.05).

Comparison of QOL scale between 2 group revealed that; there was no significant difference in pretreatment values, but there was a significant difference in the post treatment values (P<0.05).

Table (2): Results for groups A and B in relation to WBCs and LFS.

Variable	Group A(study)		Group B (control)	
	$\bar{x}$ ±SD		$\bar{x}$ ±SD	
	WBCs	Fatigue	WBCs	Fatigue
Pre	5.72±0.95	40.6±3.97	5.38±0.85	41.6±3.5
Post	8.22±1.17	30.4±3.85	6.26±0.82	37.66±4.11
percent of improvement	43.7 %	25.12 %	16.35 %	9.44 %
t-value	10.34	18.41	11.92	9.37
P-value	0.0001	0.0001	0.0001	0.0001
Significance	s↑	s↓	s↑	s↓

SD: standard deviation P: probability S: significance NS: non-significant $\bar{x}$: mean.

Table (3): comparison between the mean values of WBCs and Fatigue scale (pre and post treatment) in both groups of the study (A and B).

Variable	WBCs				Fatigue			
	pre		post		Pre		Post	
$\bar{x}$ ±SD	GA	GB	GA	GB	GA	GB	GA	GB
	5.72±0.95	5.38±0.85	8.22±1.17	6.26±0.82	40.6±3.97	41.6±3.5	30.4±3.85	37.66±4.11
Mean difference	0.34		1.96		1.0		7.26	
t-value	1.02		5.26		0.73		4.99	

P –value	0.31	0.0001	0.47	0.0001
Significance	NS	S	NS	S

SD: standard deviation P: probability S: significance NS: non-significant G: group ¯x: mean

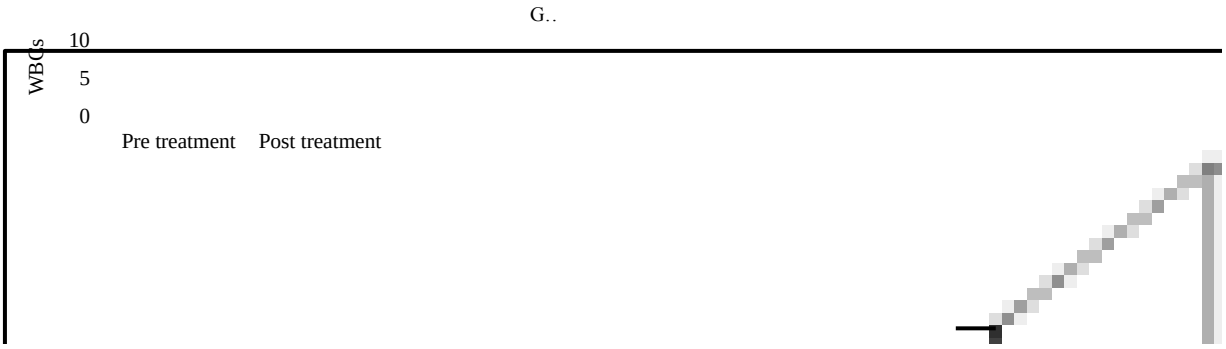

Fig. (1): Mean values of WBCs pre and post treatment of groups (A, B).

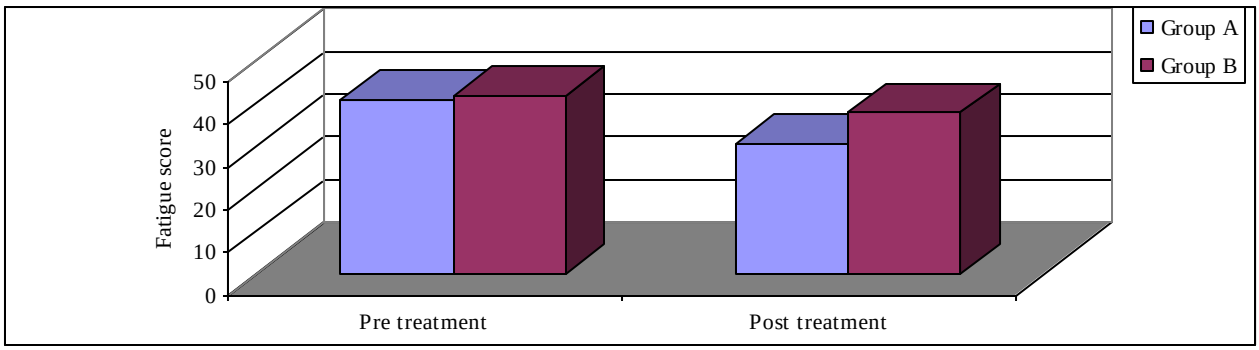

Fig. (2): Mean values of fatigue pre and post treatment of groups (A, B).

Results of physical function (6 minute walk test) hospitalization time in each group after treatment:

Table (4) demonstrate hospitalization time for group A,B. There was a significant difference in hospitalization time between control and study groups as reflected by unpaired t-test as the P-value was (0.0001).

Table (4): comparison of hospitalization time and 6 MWT between both groups of the study.

	HT(days)		6 MWT(meter)			
	GA	GB	pre		Post	
			GA	GB	GA	GB
Mean	27.06	41.2	354.5	356.4	431.1	402.0
±SD	±5.93	±8.68	± 49.4	± 46.1	± 35.5	± 39.8
t-value	5.2		0.11		2.11	
P-value	0.0001		0.9141		0.0436	

S	S	NS	S

HT: hospitalization time SD: standard deviation P: probability S: significance NS: non-significant

G: group $\bar{x}$: mean

Correlation between immunity (WBCs) and Fatigue sensation:

Correlation between the immunity (WBCs) and fatigue revealed that there was a significant inverse intermediate correlation between sense of fatigue and number of white blood cells (r = - 0.66, P = 0.0001).

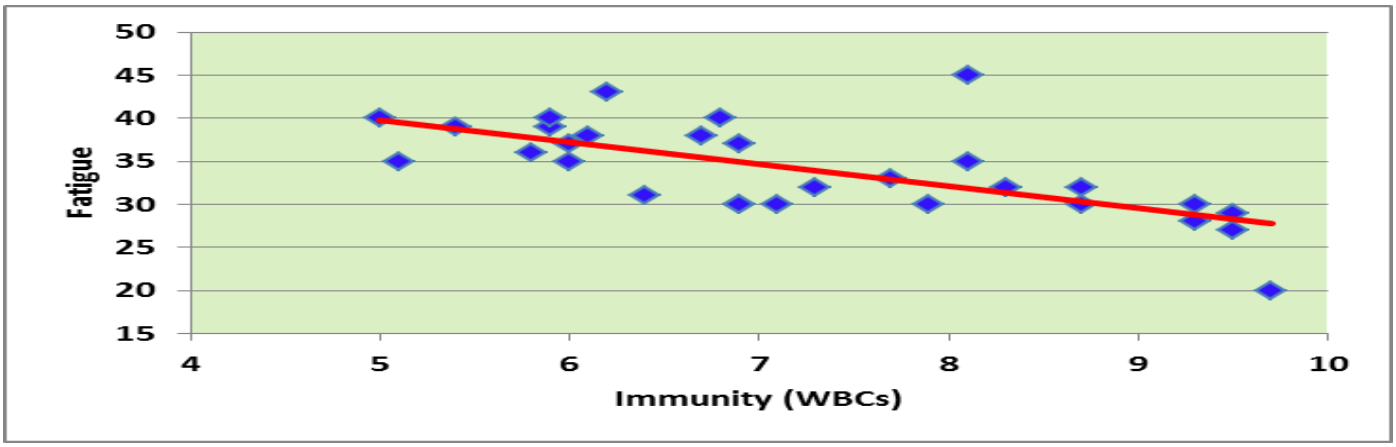

Fig. (3): Correlation between immunity (WBCs) and fatigue.

DISCUSSION

Burn injuries are an increasingly recognized public health problem. Burns have always been considered as one of the most destructive injuries, causing not only deaths but also major economic and psychological impacts[23].

Burn wound infections are one of the most important and potentially serious complications that occur in the acute period following injury. The damaged tissue represents a medium for infection. Burn wounds will almost inevitably be colonized by microorganisms within 24-48 hours and this may remain as a local wound or regional infection[11]. The most important patient characteristics that influence morbidity and mortality from burn wound infection and sepsis[10].

The cells that circulate in the bloodstream are generally divided into three types: white blood cells (leukocytes), red blood cells (erythrocytes), and platelets (thrombocytes). Abnormally high or low counts may indicate the presence of many forms of disease, and hence blood counts are amongst the most commonly performed blood tests in medicine, as they can provide an overview of a patient's general health[4,25]. So, Complete blood picture test that include white blood cells count were used to measure the immunity.

There is growing evidence that moderate level of exercise training improves immune function and decrease the risk of infection[21,24].

The results of the present study reaveled a significant increase in WBCs after the exercise program in group A are supported by Arida et al., and Johnson et al.,[3,18] who stated that circulating leukocytes levels increase during times of stress (i.e., when an organism is exposed to a physical/psychological stressor or suffers from various pathological conditions). It has been proposed that elevated leukocytes level serves a protective role by facilitating immunological

responses during times of increased risk of pathogenic challenge and/or tissue damage.

Results of the current study agreed with Johnson et al.,[18] who stated that Moderate aerobic exercise induced a hemodynamic (Circulatory) effect and endocrinal (hormonal) effect; significant rises in absolute numbers of neutrophils and monocytes in sportsmen and stimulates the release of beta-endorphin and other endogenous opioid peptides that are believed to be responsible for changes in mood, perception of pain, immunity and also performance.

Moderate treadmill training down-regulated the steady state levels of cells of the monocytes/macrophages lineage. We found that production of monocytes and macrophages was increased after training[20].

Also, the result of this study agreed with that of Tak and Mary[32], who concluded that heat shock proteins (HSP) were first characterized as intracellular proteins, which function to limit protein aggregation and facilitate protein refolding. They exhibit potent immune modulatory effects on innate and acquired immunity. During times of cellular stress, intracellular HSP levels increase to provide cellular protection.

Also, the result of this study agreed with that of Feng and Tianjian & Field et al., and Fleshner et al.,[11,12,13] who reported that natural immunity is highly influenced by muscular exercise highly consistent changes are found in the production of Interleukin-6 as well as in the number and function of natural killer cells (NK) and neutrophils. Aerobic exercise influences natural immunity, T- and B-cell functions, and cytokine responses, through circulatory (hemodynamic) changes and by endocrine hormones secreted in response to physical stress. The magnitude of the effects on the immune system reflects the intensity, duration and chronicity of the exercise[19,20].

On the other hand, the results of the present study disagreed with others who stated the effects of exercise on isolated components of the immune system may not reflect a change in the overall immune status. Likewise, because variations in the intensity, duration, or specific type of activity can have significant effects on the response of the immune system, the nature of the exercise being studied needs to be clearly defined. In general, the magnitude of the effects tends to increase as the intensity and increase duration of exercise[25].

According to the findings of the current study and concerning decrease sense of fatigue and improved physical function are agreed with Buyomi et al.,[5] who studied the effects of a 20-week aerobic exercise program on fatigue measures in fatigued and non-fatigued people with Hodgkin disease.

Simone et al.,[31] stated that impaired immune system weakens the body's ability to fend off infection and malignancy, but the immune system can also produce symptoms such as fever, weight loss, musculoskeletal pain and fatigue.

Exercise can also improve your mental wellness. Regular aerobic exercise can help relieve mild to moderate degrees of depression and anxiety. People who exercise also have less loneliness and anger, and are better able to control their own destiny. It is not clear whether exercise boosts the immune system directly or works through a link with the brain and nervous system[5,16,20].

Women with breast cancer who were receiving the first 3 cycles of chemotherapy had lower fatigue scores with each chemotherapy cycle in 63% of exercisers, compared with 9% of non- exercise. No adverse effects from the aerobic were recorded[30].

Results In this study concerning the relation between level of fatigue and immunity. The results showed decrease in fatigue values when immunity level increased.

Finally from the previous results and its discussion according to reports of other investigators in the related field to the present study, it could be proved that combination of both aerobic exercise on treadmill and traditional exercise using free weights is more effective in improving immunity, decreasing fatigue and, decreasing hospitalization time in post burn patients than traditional rehabilitation program. So, post burn rehabilitation program must include aerobic exercises to improve immunity.

Conclusion

The study concluded that the selected exercise program that was used in the form of aerobic

exercise using treadmill and traditional physical therapy exercises improve immunity and physical function and decrease fatigue as well as time of hospitalization, it is cost-effective for patients and hospitals.

Acknowledgment

I express my thanks to all patients and medical team participated or helped in this study for their confidence and collaboration in this study.

Conflict of Interest

Author declares no conflict of interest. There is no financial or personal relationship with other people or organizations that could inappropriately influence this research.

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الملخص العربي

التأثير المتعدد لتمرينات المشي على السير المتحرك في المرضى البالغين ذو الحروق الكبيرة

أجري هذه البحث لدراسة تأثير تمرينات المشي على السير المتحرك لمدة ثمانية أسبوعا على مرضى الحروق البالغين و قد كان عددهم ثلاثين مريض بالغ لديهم حروق كبيرة تتراوح نسبتها بين 25-45% وتتراوح أعمارهم ما بين 20 – 40 سنة . وتم تقسيمهم إلى مجموعتين مجموعة تتلقى التمرينات العلاجية وأخرى ضابطة . وقد أوضحت النتائج تحسن ذات دلالة إحصائية في المناعة ومستوى الإجهاد و تقليل مدة الإقامة بالمستشفى والوظيفة الحيوية . بينما لم يكن هناك تغير ذات دلالات إحصائية في المجموعة الضابطة. وقد استنتج أن التدخل بتمرينات المشي على السير المتحرك لمدة ثمانية أسبوعا له دور فعال و مفيد في زيادة المناعة لدى مرضى الحروق وتقليل حدة الإجهاد وتقليل مدة الإقامة بالمستشفى