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Original Article

Effect of Aerobic Exercises on Persisted Post-Burn Anemia

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Abstract

Background: Persisted post-burn anemia is a serious condition, so multiple medical and adjunctive therapies are always being introduced to overcome it.

The aim of the work: This study aimed to explore the effect of aerobic exercises on persistent post-burn anemia.

Patients and methods: Forty patients with severe burns with burnt Total Body Surface Area [TBSA] varied from 20 to 35% were comprised in the study. They aged between 20 and 35. They were gathered from the hospitals of Cairo University and divided into two equal groups at random: **Group [A]** comprised 20 patients who received aerobic exercises and medical treatment [iron supplements, multivitamins, zinc, and folic acid]. **Group [B]** comprised 20 patients who had only received medical treatment. Before therapy, after six and after ten weeks of therapy, a Complete Blood Count [CBC] test was done to compare both groups in terms of Red Blood Cells [RBCs], Hemoglobin [Hgb], and Hematocrit [Hct].

Results: Both groups showed statistical improvement in red blood cells, hemoglobin and hematocrit levels after 6 weeks and after 10 weeks of therapy [P=0.001]; however, there was a statistically significant difference in favor of group A [P=0.001].

Conclusion: Aerobic exercises have a positive adjunctive effect on persistent post-burn anemia.

Keywords: **Anemia; Post-burn; Physical Therapy; Aerobic exercises.**

INTRODUCTION

Anemia is a frequent aftereffect of severe burns, initially brought on by sudden blood loss and later exacerbated by conditions associated with critical illness. Blood loss and the onset of the systemic inflammatory response [SIR] result in burn anemia. Manifestations of SIR are identified by a reduction in erythropoiesis regions, a poor response to endogenous and exogenous erythropoietin, a drop in blood iron, and erythrocyte death [1–3].

Anemia of critical illness is the term utilized to refer to persistent anemia that develops in patients with severe illness after a previous acute event has passed. Anemia in critical disease occurs due to the incapability to synthesize enough RBCs to fulfill demand, even though acute blood loss anemia is caused by the depletion of RBCs [2, 4, 5]. Research on the critical care of burn victims reveals that 77% of patients in the intensive care unit [ICU] are anemic when they are discharged from the hospital. Continuing to monitor these patients after their ICU stay, 63% of them still suffer from anemia 13 weeks post-discharge. Even at 26 weeks, anemia persists in 53% of these individuals [3, 6].

The physiology of medical treatment of anemia involves understanding RBCs' role in oxygen transport and systemic tissue oxygenation. Medical treatment for anemia addresses the underlying causes of anemia, enhancing erythropoiesis, and managing iron metabolism. The treatments include erythropoiesis-stimulating agents and iron supplementation for iron deficiency [7, 8]. The capacity to carry oxygen is boosted by exercise training, which increases red cell mass and total Hgb. Bone marrow is thought to be the primary source of the potential underlying mechanisms, which include hormone- and cytokine-accelerated erythropoiesis, improved hematopoietic microenvironment brought on by exercise training, and promoted erythropoiesis with hyperplasia of the hematopoietic bone marrow [9–12].

This study aimed to investigates the effect of aerobic exercise on persistent post-burn anemia.

PATIENTS AND METHODS

Participants: In this study, forty patients aged 20 to 35 years with severe burns [TBSA of burn ranged from 20 to 35%] took part. They were gathered from the hospitals of Cairo University. Those with persistent pre-burn anemia linked to systemic chronic conditions such as chronic renal disease or coronary artery disease were not allowed to participate. Additionally, those with autoimmune conditions such as vasculitis, rheumatoid arthritis, sarcoidosis, or inflammatory bowel disease [IBD] were not allowed to participate. Furthermore, those with undiagnosed cardiac arrhythmia, inadequately managed type 1 diabetes, poorly managed hypertension, poorly managed seizures, chronic bronchitis, improperly managed hyperthyroidism, lower-limb fractures, or Deep Venous Thrombosis [DVT] were excluded.

Ethical Approval: Before participating in this study, each patient was thoroughly advised of their rights before signing an informed consent form. The study gained ethical authorization from Cairo University's Faculty of Physical Therapy's Institutional Review Board before the study's implementation [P.T. REC/012/005217], and it had been registered on ClinicalTrials.gov [NCT06849479]. The current study's methodology complied with the Helsinki Guidelines for Human Research.

Study Design: It was a prospective, randomized, controlled trial study.

Randomization: Through the use of sealed opaque envelope procedures, participants were assigned at random to either Group A or B. Block randomization was implemented to ensure an equal number of participants in each group. After being randomly assigned, no subjects were dropped out. According to CONSORT 2010 [13], the participant flow is illustrated in **Figure 1.**

Assessment Procedures: Before starting the therapy, after six and ten weeks of the therapy, a CBC test was done for each patient. Either a professional nurse or the doctor took blood samples. From the injector, the obtained blood samples were moved separately into dry tubes containing anticoagulant and into tubes without it. The blood samples put into the tubes which do not contain anticoagulant, were kept for clotting. Following clotting, the serums in these samples were separated using a centrifuge set to 3000 rpm for 10 minutes. The separated samples were then stored at 80 degrees Celsius below zero. Each patient received a report containing counts of RBCs, Hgb, and Hct at each assessment time [14].

Therapeutic Procedures: The participants were presented to the treatment program between the 8th and 16th weeks post-burn. Patients in Group A received aerobic exercises and medical treatment, while patients in Group B received medical treatment only.

Medical treatment: Every patient received the same medical treatment; one daily capsule containing a 10 mg iron supplement, multiple vitamins [B1, B2, and B6 [0.6 mg for each], B12 = 1.2 mc, and C = 30 mg], and essential trace elements [Zinc = 5 mg, Copper = 0.44 mg, Folic acid = 200 mc, and Biotin = 12 mc] [15].

Aerobic exercises: For ten weeks, 30 minutes of aerobic exercise training was performed daily for three times weekly. The target heart rate was initially determined for every patient through the following formula: Target heart rate [THR] = [[maximum heart rate [MHR] − resting heart rate [RHR] × % Intensity]] + RHR. The MHR = 220- age [years]. Each session began with a warm-up that involved walking on a treadmill for five minutes at 20% of the THR, followed by an active phase that involved walking on a treadmill for twenty minutes at 50% to 70% of the THR. The last phase was cooling down, which involved five minutes of treadmill walking at 20% of the THR [15–18]. The exercise was conducted on an electric treadmill model LEOPARD 3030 with an AC motor.

Statistical Analysis: The mean ± SD was employed to express the data. The age and TBSA of the subjects in both groups were compared utilizing the unpaired t-test. The gender distributions in both groups were compared using the chi-square test. The Shapiro-Wilk test was applied to assess the data distribution's normality. The measured variables [Hgb, RBCs, and Hct] were compared within and between groups by multivariate analysis of variance [MANOVA]. Data analysis was conducted using the statistical package for the social sciences computer program [SPSS Inc., Chicago, Illinois, USA; version 20 for Windows]. Significant findings were defined as $P < 0.05$.

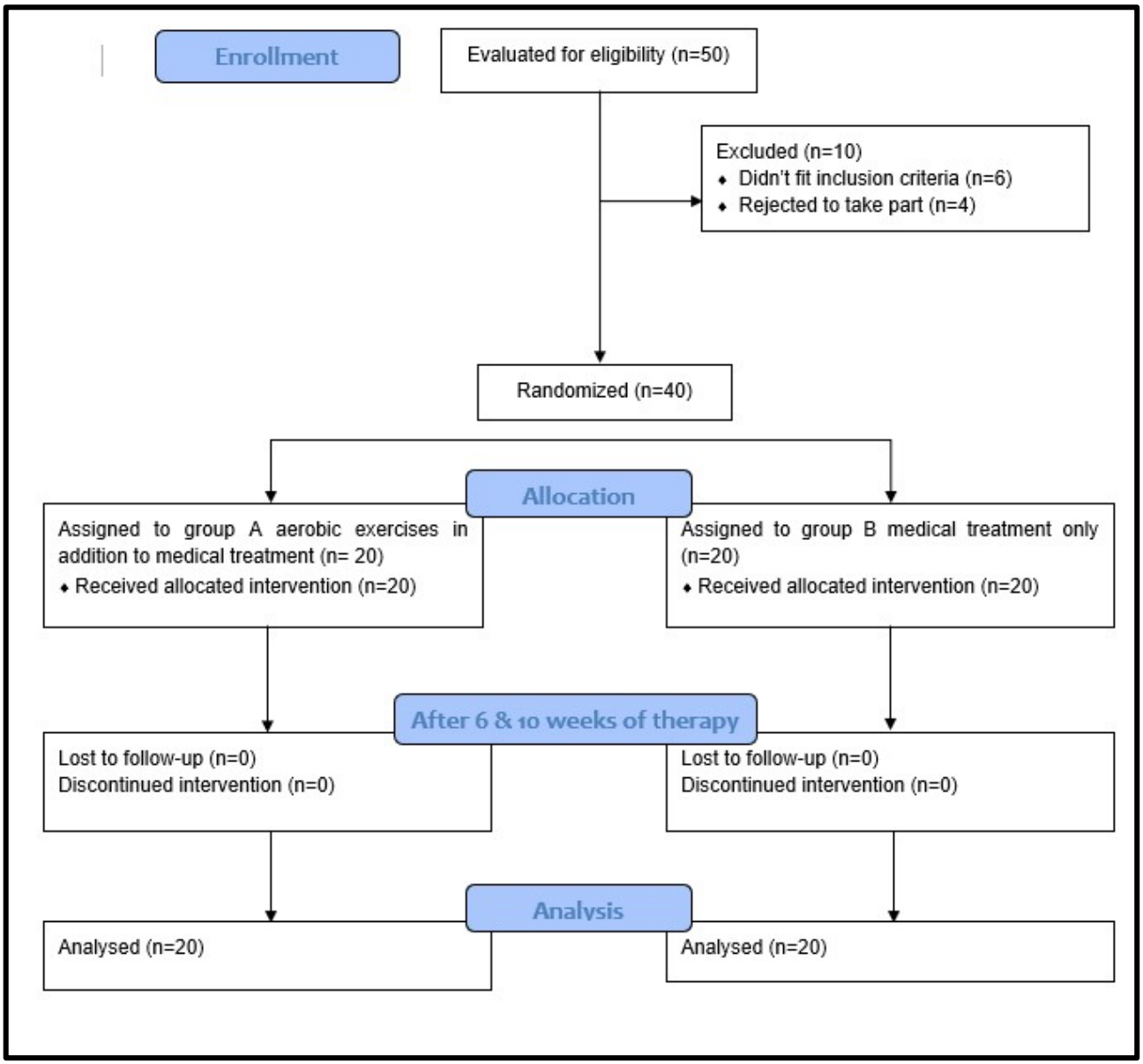

Figure [1]: Participants Flow in the study**.**

RESULTS

Table [1] demonstrates subjects' baseline data. There was no significant difference across groups in age, gender, or TBSA distribution.

Both groups showed statistically significant improvement in RBCs, hemoglobin and hematocrit after 6 weeks and 10 weeks of therapy P=0.001 **[Tables 2, 3, 4].**

RBCS results showed that, there was a statistically significant difference after 6 weeks and 10 weeks of therapy [p=0.001] in favor of group A [Table 2]. In addition, hemoglobin concentration showed that, there was a statistically significant difference after 6 weeks and 10 weeks of therapy [p=0.001], with the superiority of group A **[Table 3].**

Furthermore, hematocrit showed a statistically significant difference after 6 weeks and 10 weeks of therapy [p=0.001] in favor of group A **[Table 4].**

Table [1]: Demographic data of subjects of both groups

Demographic data	Group A [n=20]	Group B [n=20]	test	p-value
Age [years]	25.2±4	25.1±3.6	0.08	0.934
TBSA [%]	28.2±2.2	27.8±2	0.52	0.604
Sex	N [%]	N [%]	0.400	0.752
Males	9 [45]	11 [55]		
Females	11 [55]	9 [45]		

Data was expressed as mean ± SD or number [percentage], TBSA: Total body surface area

Table [2]: RBCs at different points of time [pre-therapy, after 6 and after 10 weeks] of both groups.

RBCs [cells x10^6/ml]	Group A	Group B	Mean difference [95% CI]	P-value[1]	η^2
Pre-therapy	3.45 ± 0.48	3.34 ± 0.41	0.11 [-0.16, 0.4]	0.400	0.019
After 6 weeks	4 ± 0.49	3.66 ± 0.43	0.34 [0.06, 0.64]	0.021*	0.133
After 10 weeks	4.49 ± 0.42	3.95 ± 0.48	0.54 [0.25, 0.83]	0.001*	0.275
% of change	30%	18%			
P-value	0.001*	0.001*			

Post-hoc test between measures						
	Group A			Group B		
p-value	Pre versus 6 weeks	Pre versus 10 weeks	6 weeks versus 10 weeks	Pre versus 6 weeks	Pre versus 10 weeks	6 weeks versus 10 weeks
	0.001	0.001	0.001	0.001	0.001	0.001

SD: standard deviation, CI: Confidence interval, p-value: significant level within group, % of change [from pre to after 10 weeks], p-value[1]: level of significance between groups, *: significant, η^2: partial eta square

Table [3]: Hemoglobin concentrations at different points of time [pre-therapy, after 6 and after 10 weeks] of both groups.

Hemoglobin [g/dl]	Group A Mean ±SD	Group B Mean ±SD	Mean difference [95% CI]	P-value[1]	η^2
Pre-therapy	8.5 ± 0.57	8.37 ± 0.46	0.13 [-0.20, 0.47]	0.416	0.017
After 6 weeks	9.1 ± 0.55	8.7 ± 0.48	0.4 [0.07, 0.73]	0.020*	0.134
After 10 weeks	9.7 ± 0.58	9 ± 0.5	0.7 [0.33, 1]	0.001*	0.290
% of change	14%	7.5%			
P-value	0.001*	0.001*			

Post-hoc test between measures						
	Group A			Group B		
p-value	Pre versus 6 weeks	Pre versus 10 weeks	6 weeks versus 10 weeks	Pre versus 6 weeks	Pre versus 10 weeks	6 weeks versus 10 weeks
	0.001	0.001	0.001	0.001	0.001	0.001

SD: standard deviation, CI: Confidence interval, p-value: significant level within group, % of change [from pre to after 10 weeks], p-value[1]: level of significance between groups, *: significant, η^2: partial eta square

Table [4]: Hematocrit percentages at different points of time [pre-therapy, after 6 and after 10 weeks] of both groups.

Hct [%]	Group A Mean ±SD	Group B Mean ±SD	Mean difference [95% CI]	P-value[1]	η^2
Pre-therapy	35.95 ± 4.58	34.1 ± 4.78	1.85 [-1.15, 4.85]	0.219	0.039
After 6 weeks	41.7 ± 4.44	37.9 ± 4.45	3.8 [-6.64, -0.96]	0.010*	0.161
After 10 weeks	45.85 ± 4.26	40.65 ± 3.92	5.2 [2.58, 7.82]	0.001*	0.298
% of change	27.5%	19%			
P-value	0.001*	0.001*			

Post-hoc test between measures						
	Group A			Group B		
p-value	Pre versus 6 weeks	Pre versus 10 weeks	6 weeks versus 10 weeks	Pre versus 6 weeks	Pre versus 10 weeks	6 weeks versus 10 weeks
	0.001	0.001	0.001	0.001	0.001	0.001

SD: standard deviation, CI: Confidence interval, p-value: significant level within group, % of change [from pre to after 10 weeks], p-value[1]: level of significance between groups, *: significant, η^2: partial eta square

DISCUSSION

One of the most common and challenging outcomes of a severe burn injury is anemia. Persisted burn anemia is accompanied by bone marrow failure and a chronic SIR following the acute phase. The most prevalent symptoms of anemia are tiredness and decreased activity tolerance, which are especially significant for burn patients [2, 4].

In the present study, adding aerobic exercises to medical therapy showed significant improvement over medical therapy alone in RBCs, Hgb, and Hct values. This improvement may be explained by the fact that exercise training can improve erythropoiesis, which raises plasma volume and RBC mass, which increases blood volume. Bone marrow stimulation results in enhanced erythropoiesis, which has therapeutic implications [9]. The current positive adjunctive effect of aerobic exercises agrees with the earlier studies results which investigated the effectiveness of aerobic exercise on selected hematological variables in different populations [19–21].

Malipatil *et al.* concluded that aerobic exercise training had a beneficial effect on college women on selected hematological variables, specifically RBC and Hemoglobin levels among college women. After an eight-week training program, the results indicated a notable improvement in these hematological variables, supporting the hypothesis that aerobic exercise positively influences RBC and hemoglobin levels [19]. Similarly, **Eunji, Han *et al.*** found that iron supplementation was more effective when combined with aerobic exercise in improving women's anemia. This suggests that integrating both interventions can enhance the overall treatment outcome for women suffering from anemia [20].

Additionally, **Sepriadi *et al.*** demonstrated that jogging exercises significantly improved Hemoglobin levels of students with disturbed ones. The average Hemoglobin level increased from 14.18 g/dL before the exercise to 15.66 g/dL after the treatment, concluding that engaging in aerobic exercises like jogging can lead to health benefits, particularly in improving Hemoglobin levels, which is essential for overall physical performance and well-being [21].

Conversely, the present study findings were mismatched with other studies which concluded that aerobic exercises did not lead to significant changes in the hematological factors [16, 22]. **Samavati *et al.*** found that the values of RBC, hemoglobin, and hematocrit in adolescent girls complaining of anemia due to menstruation showed significant increases after exercise in both studied groups but with no significant difference across them. Also, **Shapoorabadi *et al***. reported that while aerobic exercise led to increases in Hgb, HCT, and RBC mass, in women with rheumatoid arthritis, there was no obvious distinction between these increases and those in the control group, suggesting that the changes could not be solely attributed to aerobic exercise [22].

The discrepancy between our study results and the other mentioned studies' results might be due to the difference in study design, population, physical and psychological variance of the population, duration of the intervention, and the timing of the measurement. It is important to clarify that the current study might be limited by the variability in patients' compliance with medical treatment and/or exercise therapy and the physical and psychological variance between the cases.

Th current study could be considered the first to investigate the effect of aerobic exercises, as an additional way of control, on persisted post-burn anemia which considered one of the most challenging issues in burn care. The randomized controlled design of the current study with a calculated sample size and integration of objective ways of assessment could ensure the efficacy of our intervention and allow it to be recommended in the current practice.

Conclusion: Aerobic exercises have a positive adjunctive effect on persisted post-burn anemia.

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