



Effect of Aerobic Exercise on Common Peroneal Nerve Conduction in Post Burn Children

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Abstract

Purpose: to determine the effect of aerobic exercise on common peroneal nerve conduction in post burn children.

Methods of Evaluation: (Measurement of motor common peroneal nerve conduction velocity).

Subjects: Forty children their age ranged from (12-18) years of both sexes suffered from severe burn covering 20% or more of the total body surface area were divided randomly into 2 groups of equal numbers. Group (A) received Oxandrolone 1mg/kg/day and 12 weeks Aerobic exercise program. Group (B) received Oxandrolone 1mg/kg/day only; all children were selected randomly from several teaching and general hospitals in Great Cairo with the children were enrolled in 12 weeks aerobic exercise program. Measurement of motor conduction velocity of was done prior and after 12 weeks. Results are expressed as mean \pm standard deviation (SD).

Results: Common peroneal motor conduction velocity were significantly improved after finishing exercise training than before start of training.

Conclusion: Aerobic exercise-induced enhancements in common peroneal motor nerve conduction indicates strong relation between aerobic exercise and nerve conduction.

Keywords: Aerobic exercise, Common peroneal nerve, Oxandrolone , nerve conduction study , severe burn.

Introduction

Childhood is a critical part of human development in social, cognitive and motor functioning. Unfortunately, one of the most common injuries affecting the childhood phase is burn in which severe consequences may develop and remain from childhood to adulthood.^{2,10,23}. Several problems may arise as a result of severe burn (TBSA more than $\geq 30\%$) which varies from weakness, scarring, and debilitating contractures to hypermetabolism which can persist up to 3

years post burn creating a catabolic state marked by elevated resting energy expenditure (REE), insulin resistance, tachycardia, negative muscle protein balance, decline in bone mass and growth retard.^{4,7,16}. Elevated REE may reach 180% of normal values during acute admission, and then it drops to 150% with full wound healing (2 months post injury). Further drop can be observed 12 months post injury to 115%. Endogenous catecholamines are vital mediators of the hypermetabolic response following major trauma³.

Endogenous catecholamines may cause high myocardial contractility, high myocardial oxygen consumption, local myocardial hypoxia and tachycardia. Catecholamine concentrations in plasma increase immediately 10 folds and remain elevated for 2 years post burn³². It has been suggested that the main cause of the peripheral neuropathies among burned patients is the hypermetabolic response of the burned patients, as the basal metabolic rate (B.M.R) of the burned patients is elevated by 2 to 2.5 times of normal value (Normal B.M.R. equals $40 \pm 10 \% C/m^2/hr$), which contributed to the increased content of catecholamines which stimulates the sympathetic tone in burned patients resulting in increased systemic vascular resistance, decreased cutaneous, muscular and endoneurial blood flow (Nerve blood flow) causing nerve function alterations^{15, 21, 33}.

Burn patients suffer from various problems due to disturbed function of the skin, severe metabolic stress with abnormal capillary permeability, protein rich fluid extra vascular or edema and injury to the vascular tree which affect the normal function of the peripheral nerves⁶. A burn injury can have devastating effects on the neuromuscular system. Patient's complaints regarding weakness or lack of sensation often are rationalized as generalized sequelae of the burn injury and healing process. However, these symptoms may be due to peripheral neuropathies and entrapment syndromes resulting from impaired nerve axons, or myelin sheath or both^{18, 33}.

Mononeuropathies and entrapment syndromes have been observed following thermal injury and most often affect nerves under the area of the burn, and they are usually seen in patient with burn greater than 20% of total body surface area (TBSA)^{19, 20}. The occurrence of entrapment syndromes or multiple mononeuropathies after thermal burns covered greater than 20% of TBSA is common and the number of nerves involved per patient ranged from 3 to 7 nerves. The source was believed to be due to multiple crush syndromes, in which multiple different neuropathic factors in

each patient summate to cause a multiple mononeuropathies or entrapment neuropathies^{26, 27, 29, 30}.

The sciatic nerve is subdivided into the common peroneal (fibular) and tibial nerves, common peroneal nerve fibers are formed from nerve fibers that the same fibers that break laterally in sciatic nerve to supply short head of the biceps femoris. The common peroneal nerve continues to run across the lateral head of gastrocnemius muscle. Then, it runs between the peroneus longus muscle and the fibula where it subdivides into two main branches, the deep peroneal and superficial peroneal nerves¹³. The superficial peroneal nerve runs between the peroneus longus and peroneus brevis (main ankle evertors) and provide neural supply to both muscles. The peroneus tertius and extensor digitorum longus also play a major role in ankle eversion. The nerve turns to a subcutaneous nerve when it reaches the midpoint of the lateral aspect of lower leg. It provides innervation to the skin of the lateral aspect of leg and the dorsum of foot and toes.^{1, 8}

The deep peroneal nerve provides neural supply to the anterior muscles of the leg (tibialis anterior, peroneus tertius, extensor hallucis longus and extensor digitorum longus). These muscles are responsible for foot dorsiflexion and toe extension. The deep peroneal nerve receives segmental innervation from the L4 through S1 nerve roots²². Nerve conduction velocity shortly known as "NCV" tests are used to determine the velocity of the electrical signals moving along a specific peripheral nerve. The use of NCV tests permit physicians to distinguish between an injury that aroused in the myelin sheaths and an injury in the nerve axons⁹. NCV is used as a standardized testing tool for CTS due to its objectivity in providing information on the status of the median nerve across the carpal tunnel. Comparing the latency and amplitude of a median nerve segment across the carpal tunnel to another nerve segment that does not go through the carpal tunnel is commonly used^{17, 24}. Rehabilitation of child burn depends on several factors which include age of

the child, depth of burn, extent of burn, degree of burn, presence of infection and psychological state of parents and child. The rehabilitation process is an ongoing process that takes some time to be accomplished as it requires engagement of the child in conjunction with the caregiver.¹²

Exercise is considered to have decisive effects on the pathological factors accompanied with neuropathy by enhancing microvascular dilation, declining oxidative stress, and improving neurotrophic factors⁵. Aerobic exercises are considered an integral component of pulmonary rehabilitation protocols as they enhance the patient's functional status and especially in patients with pulmonary malfunction. Aerobic exercise is an activity that requires activity of large muscle groups and overloads the cardiopulmonary system stressing them to work stronger than at rest for 15 to 20 minutes or longer while preserve during 60-80% of this period maximum heart rate³¹. Administration of oxandrolone (anabolic synthetic androgenic drug) 0.1 mg/kg/day for one year post burn may cause significant increase in lean body mass, improve long term recovery, attenuate muscle catabolism, decrease resting energy expenditure. The maximal effect of oxandrolone is observed in children aged 7-18 years while its therapeutic benefits may last up to 5 years post burn¹⁴.

Subjects

Forty children of both sexes ranging in age from to 12-18 years were randomly selected from several teaching and general hospital in Great Cairo from August 2015 to February 2016. Inclusion criteria included an age of 12- 18 years, thermal / flame burns covering $\geq 20\%$ of total body surface area and participation in the exercise program within 6 months post-burn. Children were excluded from the study if they had one or more of the following: leg (whole or segmental) amputation, limitation of range of motion (ROM) of lower limb joints, anoxic brain injury, and psychological or severe behaviour disorders¹⁴.

Children were randomly assigned into 2 groups of equal numbers (20 children in each group), Group (A) included 20 children who received Oxandrolone 1mg/kg/dl and 12 weeks aerobic exercise program, Group (B) included 20 children who received Oxandrolone 1mg/kg/day. Measurement of Common peroneal nerve motor conduction velocity was done prior and after 12 weeks for both groups.

Procedures

A. Evaluation:

Motor nerve conduction of the common peroneal nerve is measured via the Neuropack S1 MEB-9004 EMG device before the exercise program and after finishing the exercise program. For motor nerve conduction study, the active recording electrode is placed over the extensor digitorum brevis muscle approximately 1 cm distal to the bony prominence of the talus over the metatarsophalangeal joint. The reference electrode is placed over the lateral surface of the fifth digit. The ground electrode is placed over the dorsum of the ankle. The peroneal nerve can be stimulated at ankle level just lateral to extensor hallucis longus tendon, above and just behind head of fibula.

B. Treatment:

Each exercise training session also included aerobic conditioning exercises on a treadmill. Treadmill running exercises at a moderate pace began and ended with warming-up and cooling-down periods in the form of walking on the treadmill for about 3-5 minutes at speed 1- 1.5 kilometre/hour with zero inclination. This aerobic training was conducted 3 days per week. Each session lasted 20 to 40 minutes, and participants exercised at 70% to 85% of their previously determined individual $\dot{V}O_{2peak}$. Heart rate and oxygen saturation were monitored. All of the exercise sessions and exercise prescriptions were carefully supervised. Children randomly assigned to the exercise program were required to have participated in ≥ 33 workout sessions of the 36 total workout sessions to be considered compliant with the exercise program.

Statistical Analysis

Statistical analysis was conducted using SPSS for windows, version 18 (SPSS, Inc., Chicago, IL). The current test involved two independent variables. The first one was the (tested group); between subject factor which had two levels (study group and control group). The second one was the (training periods); within subject factor which had two levels (pre, post). In addition, this test involved one-tested dependent variables (NCV for common peroneal nerve). Accordingly, "paired t test" was used to compare between "pre" and "post" t-tests for the dependent variable for each group. "Unpaired t test" was conducted to compare NCV for common peroneal nerve between both groups in the "pre" and "post" tests with the alpha level 0.05.

RESULTS

1. Baseline and demographic data

Forty patients participated in the study. They were randomly assigned into two groups; study group and control group. Study group: consisted of 20 participants with mean \pm standard deviation age, weight, and height were 14.7 ± 1.83 years, 55.94 ± 12.26 kg, and 1.36 ± 0.22 respectively. Control study: consisted of 20 participants with mean \pm standard deviation age, weight, and height were 14.68 ± 1.83 years, 58.09 ± 12.37 kg, and 1.36 ± 0.22 respectively. Independent t-tests were conducted to compare between both groups for the demographic data (age, weight, and height). The independent t-test revealed that there were no statistically significant differences ($P > 0.05$) between subjects in both groups concerning age, weight, and height (Table 1).

Table (1): Descriptive statistics and independent t tests for the participants' demographic data for both groups.

	Study group ($X \pm SD$)	Control group ($X \pm SD$)	t-value	p-value	Level of significant
Age (years)	14.7 ± 1.83	14.68 ± 1.83	0.027	0.979	N.S
Weight (kg)	55.94 ± 12.26	58.09 ± 12.37	0.537	0.594	N.S
Height (m)	1.36 ± 0.22	1.36 ± 0.22	0.000	1.00	N.S

*Significant level is set at alpha level < 0.05

2. NCV for Common Peroneal Nerve

As indicated at table (2) and illustrated at figure (1) "Paired t test" revealed that there was a significant increase of NCV for common peroneal nerve (t-value = -31.297 , P-value = 0.000^*) at study group. In addition, "Paired t test" revealed that there was significant increase of NCV for common peroneal nerve (t-value = -5.139 , P-value = 0.000^*) at control group. Considering the effect of the tested group (first independent variable) on NCV for common peroneal nerve, "unpaired t test" revealed that the mean values of the "pre" treatment between both groups showed there was no significant differences (t-value = -0.093 , $P = 0.927$). while, the mean values of the "post" treatment between both groups showed there was significant increase of NCV for common peroneal

nerve in favor to study group (t-value = 23.912 , $p = 0.000^*$).

Table (2): Mean ±SD, t and P values of the NCV for common peroneal nerve pre and post test in both groups.

NCV for common peroneal nerve	Means ± SD	Means ± SD	% of improvement	t-value	P- value
	Pre test	Post test			
Study group	35.06±1.68	45.91±0.63	30.94	-31.297	0.000*
group Control	35.11±1.73	36.05±1.73	2.67	-5.139	0.000*
t-value	-0.093	23.912			
P- value	0.927	0.000*			

*Significant level is set at alpha level <0.05.

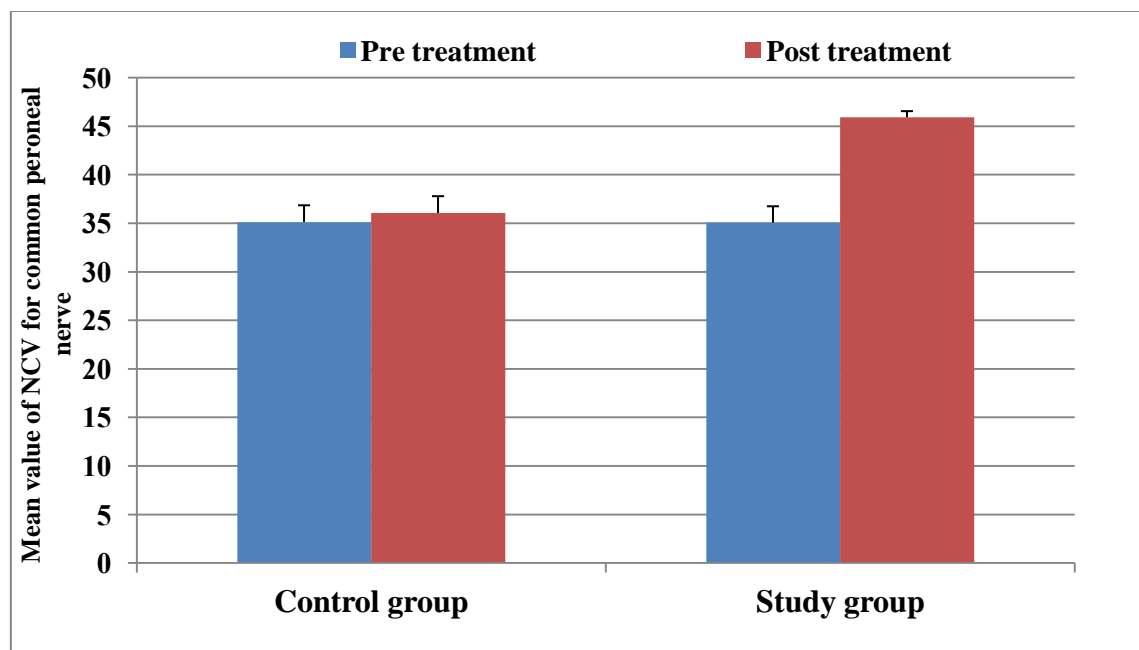


Figure. (1): Mean ±SD values of NCV for common peroneal nerve of pre test and post test in both groups.

Discussion

The present study was conducted to investigate effects of aerobic exercise on common peroneal nerve conduction in post burn children. The aerobic exercise program was especially designed for children who suffered from severe burns between the age of 12 and 18 years. The burn literature lacked massively enough evidence regarding this age group with much evidence need to develop adequate treatment approaches that may create successful outcomes for this challenging age group.

Assessment was done before and after 12 weeks, Nerve conduction study was used to measure common peroneal nerve motor conduction velocity which is considered a reliable and valid testing tool, Mallik and Weir, 2005 reported that

NCS is used as a standardized testing tool for peripheral neuropathy due to its objectivity in providing information on the status of the nerve across the whole body. Results of the current study pointed out that there was an improvement in common peroneal motor nerve conduction velocity which can be explained by improvement observed in drainage and removal of waste products which resulted in optimization of intraneural pressure. The clinical importance of optimizing intra neural pressure is related to improvement of neural blood flow which improve vitality and function of the nerve. Developing healthy nerve function using aerobic exercise may occur by enhancing axonal transport and stop deposition of mechano-sensitive elements which may result in pain and limited neural movement.

Aerobic exercise improve motor unit efficiency through enhancement of neural sprouting , increase percentage of slow twitch muscle fibres , increase number of mitochondria and increase number of oxidative enzymes leading to increased ATP storage and decreasing resting energy expenditure.

Results of the current study are supported by Dixit et al., 2014 who investigated effect of aerobic exercise on peripheral nerve functions in patients with type 2 diabetes. Measurement of common peroneal nerve conduction velocity was done before and after the start of aerobic exercise program using nerve conduction study, results showed that conduction velocity was significantly improved after finishing the aerobic exercise program which lasted for 8 weeks¹¹.

Mang, 2016 investigated the effects of aerobic exercise on motor learning and neural plasticity, he found out that high intensity aerobic exercise program improved motor learning and neural plasticity. This claim engaged with our explanation regarding neural sprouting and improvement of nerve function. Nathan et al., 2001 studied the effects of long term aerobic exercise on median nerve conduction and symptoms associated with carpal tunnel. They postulated that long term aerobic exercise program improved circulation and oxygen delivery which helps in reducing nerve ischemia (the leading cause of carpal tunnel syndrome) thus improving median nerve conduction velocity^{25, 28}.

Conclusion

The study concluded that aerobic exercise program improves common peroneal nerve conduction velocity in post burn children by improving circulation and releasing waste products which help in improving nerve conduction and creating a healthy environment for the common peroneal nerve to function properly.

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