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Effect of whole body vibration on leg muscle strength after healed burns: A randomized controlled trial

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ABSTRACT

Objective: To investigate the effects of eight weeks whole body vibration training program on leg muscle strength (force-producing capacity) in adults after healed burns.
Design: Randomized controlled trial.
Setting: Faculty of Physical Therapy, Cairo University.
Subjects: Thirty-one burned patients participated in the study and were randomized into whole body vibration group and control group. Non-burned healthy adults were assessed similarly to burned subjects and served as matched healthy controls.
Methods: The whole body vibration group performed an eight weeks vibration program three times a week on a vibration platform; the control group received home based physical therapy program without vibration training.
Main measures: Assessment of knee extensors and ankle planter flexor strength by isokinetic dynamometer at 150°/s were performed at the beginning of the study and at the end of the training period for both groups.
Results: Subjects with burns more than 36% TBSA produced significantly less torque in the quadriceps and calf muscle than non-burned healthy subjects. Patients in whole body vibration group showed a significant improvement in knee extensor and ankle planter flexor strength as compared with those in the control group. Knee extensor strength and percent improvement was 233.40 ± 5.74 (64.93 ± 3.03 change score) and 38.54% for the vibration group and 190.07 ± 3.99 (21.66 ± 4.41 change score) and 12.86% for the control group, ankle plantar flexor strength and percent improvement was 156.27 ± 5.95 (54.53 ± 6.16 change score) and 53.70% for the vibration group and 116.13 ± 3.24 (14.66 ± 2.71 change score) and 14.52% for the control group.
Conclusions: Participation in whole body vibration program resulted in a greater improvement in quadriceps and calf muscle strength in adults with healed thermal burn compared to base line values; a WBV program is an effective for strength gain in rehabilitation of burned patients.

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1. Introduction

Burns result in approximately two million injuries each year and leads to impairment or abnormality in psychological, psychosocial, physiologic or anatomic structure or function [1].

The immobilization period after burn is accompanied by numerous detrimental effect namely sever deconditioning such as sever weakness, impaired motor control decrease cognitive status, pain, risk of graft shearing and psychological factors [2].

Severe thermal injuries followed by a catabolic state leads to muscle wasting and weakness. Burn induces up regulation of acetylcholine receptors, altered mitochondrial function and apoptosis that begins about three to five days post burn and persists until 9–12 months which leads to atrophy of skeletal muscle cells [3].

Whole-body vibration (WBV), i.e. standing in different static positions or exercising on a vibrating platform, is being commercially promoted as an attractive and efficient alternative or complement to resistance training [4]. Specifically, long term WBV exercise suggested to have positive effects on knee extensors strength and power [5–8], and recommended as a therapeutic approach for sarcopenia and osteoporosis [9–11].

Whole body vibration platforms have become increasingly available and used at sports and rehabilitation institutes. There is an emerging profile of application of vibration as an exercise modality [12], mainly due to the documented effects of vibration on the neuromuscular and neuroendocrine systems [9].

Whole-body vibration (WBV) received a great deal of attention due to reports of enhanced physical performance [13,14]. The performance variables reported to be improved after acute WBV are muscle strength, power, rate of force development, and electromechanical delay [15–17]. Chronic vibration studies also have shown increases in similar neuromuscular variables such as muscle strength, power, and balance [18,19]. Improvement of these variables following WBV training result from neuromuscular adaptations resulting in enhanced neuromuscular activation [4,13].

The mechanical stimuli of vibration transmitted to the body and stimulate muscle spindles which activate the alpha motoneurons and initiates muscle contractions comparable to the ''tonic vibration reflex''. The effect of WBV on the neuromuscular properties of skeletal muscles and spinal mechanisms is demonstrated by a decreased electromechanical delay, increased rate of force development and the presynaptic inhibition of skeletal muscles [20], also there was significant increase in VO2 both during and following an acute WBV exercise session compared to the same exercise session without vibration [21] and WBV is effective for inducing a small degree of post activation potentiation [16,22].

Whole-body vibration enhances muscle power [23], improve muscular performance via neurogenic potentiation involving the spinal reflexes and muscle activation [15,18]. Practically, WBV application enhances anaerobic power [23,24]. Previous work demonstrates that WBV leads also to a rapid increase in intra-muscular temperature [25]. Intramuscular temperature in itself enhances muscle power [26].

Whole-body vibration has been suggested to elicit a high degree of muscle activation [13]. So our study hypothesized that the addition of WBV to home based exercise program for patients with healed burn will result in more gain in muscle strength compared to an identical home based exercise program performed in absence of vibration.

Therefore the aim of our study was to investigate whether the combination of WBV and home based exercise program during 8 weeks has any additional effect on knee extensors and ankle planter flexor compared to an identical exercise program without vibration on patients with healed thermal burn.

2. Materials and methods

Burned patients (men and women) were recruited from the burn unit in Umm Almasryeen Hospital after agreement to the participation in the study by instructing two physical therapists who were working in the burn unit to report all patients who fulfilled the inclusion criteria of the study and had no exclusion criteria. They were between 30 and 40 years age. The patients were categorized as having circumferential lower limb deep second to third degree thermal injury extends from the lower trunk to the foot. They received the same physical therapy program during the acute stage (mean time 28.26 ± 3.39 days) which includes positioning, range of motion, stretching exercise for lower limb muscles, daily walking, and isometric and isotonic exercise. *Inclusive criteria*: Burned patients, with percentages of burn ranged from 36 to 45% total body surface area, non-smokers, non-athletes. *Exclusion criteria*: prosthesis; any neurological, musculoskeletal, or other chronic disease; participation in an outside resistance training programs, recent fracture or bone injury; any medication that could affect strength adaptations and adversely affect the results of the study, previous brain injury or any disease affecting balance, vestibular or visual disorders and history of epilepsy.

Patients were randomly assigned to one of two groups; whole body vibration (WBV) group who received vibration training on vibration platform (Power Plate International, Irvine, CA, USA) plus home based physical therapy program (range of motion exercise, splinting, stretching exercise for lower limb muscles, daily walking, functional training for ambulation, resistance exercise and activities of daily living) and control group who received the same home based physical therapy program without vibration. All participants in this study follow exercise guidelines prescribed the exercise performed at home (three days/week) regarding the intensity, type and duration to control any variation between groups and instructions about there was no exercise done on the rest of the week. Random assignment of patients was conducted into two stages. Stage one involved instructing two physical therapists who were working in the faculty of physical therapy outpatient clinic to report all patients who fulfilled the inclusion criteria of the study (registration diagnosis, age, total body surface area burned) and had no exclusion criteria. The second stage involved randomly assigning the patients to either the whole body vibration group or the control group, random process that involved opening an opaque envelope