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Effects of different duration exercise programs in children with severe burns

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ABSTRACT

Introduction: Burns lead to persistent and detrimental muscle breakdown and weakness. Standard treatment at our institution includes a voluntary 12-week rehabilitative exercise program to limit and reverse the effects of increased muscle catabolism. In the present work, we investigated if different durations of exercise, 6 or 12 weeks, produce comparable improvements in muscle strength, body composition, and cardiopulmonary fitness.

Methods: We prospectively enrolled and randomized patients with ≥30% total body surface area (TBSA) burned to receive 6 or 12 weeks of exercise rehabilitation. Patients were evaluated for muscle strength, oxygen consumption capacity, and lean body mass at discharge (n=42) and after exercise. After 6 weeks (n=18) or 12 weeks (n=24) of exercise training, leg muscle strength was assessed as peak torque per body weight using a Biodex isokinetic dynamometer. Oxygen consumption capacity, measured as peak VO_2, was studied using a standard treadmill-based test, and lean body mass was determined using dual-energy X-ray absorptiometry.

Results: Significant improvements in muscle strength, peak VO_2, and lean body mass were seen after 6 weeks of exercise training ($p < 0.001$), with only significant improvements in peak VO_2 being seen after 6 weeks more of training.

Conclusion: These data suggest that a 6-week rehabilitative exercise program is sufficient for improving muscle strength, body composition, and cardiopulmonary fitness in pediatric burn patients. However, continuation of at- or near-home cardiopulmonary training following the 6 weeks of at-hospital rehabilitation may be useful.

1. Introduction

Burns exceeding 30% of the total body surface area (TBSA) result in a profound hypermetabolic response that includes many organ systems and persists for an extended time [1–4]. The hypermetabolic response augments proteolysis to cause loss of lean body mass, which is exacerbated by prolonged physical inactivity [5]. The resulting morbidity inhibits

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patients' return to normal societal activities and reduces quality of life [6]. One strategy that has proven effective in combating decreased lean body mass, reduced muscle strength, and reduced cardiopulmonary fitness is physical exercise [7–9]. At our institution, current standard of care comprises a voluntary rehabilitation program entailing occupational and physical therapy with an added component of respiratory therapy. This program is usually implemented for 12 weeks following discharge from the hospital and involves the use of standard gym equipment and various strength and cardiopulmonary exercises [9]. Patients were discharged from the hospital when 95% of wounds were healed. However, the 12-week exercise program typically requires patients to remain in an unfamiliar environment, away from family and normal daily activities. The effects of the injury and subsequent rehabilitation cause a significant socioeconomic burden on the families. While the facilities at Shriners Hospitals for Children®—Galveston are uniquely adapted to accommodate all patients and families that are affected by severe burns, the location relative to the majority of our patients' homes is typically quite far and unfortunately burdensome. In an effort to decrease the duration of time away from family and home, we explored options to reduce the length rehabilitative exercise program without compromising patient care or safety. To this end, we designed a study to determine if a 6-week exercise program would provide similar benefits as the current 12-week exercise program.

2. Methods

2.1. Subjects

Children 6–18 years of age were prospectively enrolled in this study between 2003 and 2014. Written informed consent was obtained, and all procedures were approved by the Institutional Review Board at the University of Texas Medical Branch. Patients were included if the TBSA burned was equal to or greater than 30% and if they were admitted to Shriners Hospitals for Children® Galveston for acute burn care. Burn size was measured using modified Lund and Browder charts [10]. All patients received identical standard-of-care treatment. Exclusion criteria included leg amputation, anoxic brain injury, psychological disorders, quadriplegia, or severe behavior and/or cognitive disorders. Additionally, subjects were only included in this exercise study if they were previously randomized to the 'control' drug group of a core randomization scheme, indicating that they would not receive any type of research study drug. Furthermore, as patient volume at our institution decreased or a higher number of randomized protocols increased, there was a smaller population of subjects to approach for the current study. This accounts for an extended study period for our 42 subjects.

Muscle strength, reflected by peak torque, peak oxygen consumption (peak VO_2), and lean body mass were measured at hospital discharge and at 6 weeks or 12 weeks after starting the rehabilitative exercise program.

2.2. Patient groups

Patients consenting/assenting to the rehabilitative exercise program were randomly placed into a 6- or 12-week exercise-training group (Fig. 1) using a randomization scheme that was generated prior to the start of the study. The scheme was generated using the randomization function of Microsoft Excel (Redmond, WA). Values were obtained at discharge, after 6 weeks of exercise, and after 12 weeks of exercise (if in the 12-week exercise program). Of the 42 patients consented, 18 participated in 6 weeks of training, while 24 received 12 weeks of training. Patients enrolled in the 12-week rehabilitative exercise program also had measurements collected at the 6-week time point. Analysis of demographics and measured variables were minimally different between the 6-week exercise group and 12-week exercise group at the 6-week time point and were subsequently grouped together for final analysis (Figs. 2–5).

Discharge values of patients were obtained upon discharge from the hospital, typically occurring when a patient's wounds are 95% healed. The discharge values from the 6- and 12-week rehabilitative exercise programs were grouped together during the final analysis (Figs. 2–5). While there was a single variable we found to be significantly different between the two discharge groups (Table 1, % TBSA burned), our statistical model accounted for this difference in the final analysis. All other demographic and experimental outcomes were not statistically different between the 6- and 12-week exercise groups. Demographics data are presented in Table 1.

2.3. Standard of care

All patients received identical treatment from admission until discharge (95% healed) and the end of the rehabilitative exercise program [11]. Briefly, fluid resuscitation was performed using the Galveston formula (5000 ml/m^2 TBSA burned +2000 ml/m^2 TBSA lactated Ringer's solution given during the first 24 h). Burn wounds were excised and covered with

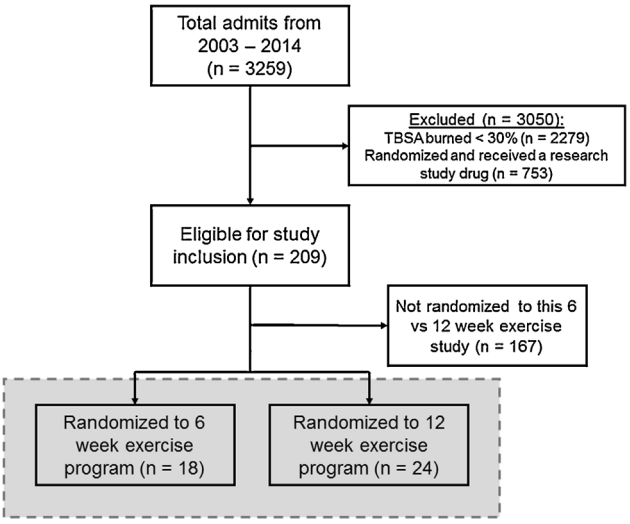

Fig. 1 – CONSORT diagram showing the randomization process. Gray shaded area shows finalized patient groups.

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