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Effects of community-based exercise in children with severe burns: A randomized trial

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ABSTRACT

Objective: To counteract long-lasting muscle break down, muscle weakness, and poor physical fitness resulting from severe burns, we recommend a 12-week in-hospital exercise training rehabilitation program. Unfortunately, this in-hospital training program requires time away from home, family, school or work. This study was undertaken to evaluate an alternative exercise rehabilitation strategy involving a 12-week community-based exercise training rehabilitation program (COMBEX) carried out at or near the patient and caretaker's home.

Study design and participants: Pediatric patients (7–18 years) with ≥30% of total body surface area (TBSA) burns were randomized to participate in COMBEX ($N = 12$) or an outpatient exercise program (EX) at the hospital ($N = 22$). Both programs were started after hospital discharge and consisted of 12 weeks of progressive resistive and aerobic exercise. COMBEX was performed in community fitness centers near the patients' home. Endpoints were assessed at discharge (pre-exercise) and after the 12-week program. Primary endpoints were lean body mass (dual energy X-ray absorptiometry), muscle strength (isokinetic dynamometry), and peak aerobic capacity (indirect calorimetry).

Results: Demographics, length of hospitalization, and TBSA burned were comparable between groups ($P > 0.05$). Both groups exhibited a significant ($P \leq 0.01$ for all) increase (mean ± SEM) in lean muscle mass (EX: 6.9 ± 1.7%; COMBEX: 6.5 ± 1.1%), muscle strength (EX: 67.1 ± 7.0%; COMBEX: 49.9 ± 6.8%), and peak aerobic capacity (EX: 35.5 ± 4.0%; COMBEX: 46.9 ± 7.7%). Furthermore, the magnitude of these increases were not different between groups ($P > 0.12$).

Conclusions: Both EX and COMBEX are efficacious in improving lean mass, strength, and cardiopulmonary capacity in severely burned children.

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Abbreviations: COMBEX, community-based exercise program; TBSA, total body surface area; EX, exercise program.

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1. Introduction

Burns covering significant portions of the total body surface area (TBSA) induce a physiological response characterized by a persistent and extensive catabolic state [1,2]. Burn-induced catabolism lasts for up to 1 year and is exacerbated by physical inactivity [2]. This catabolic state decreases muscle mass, leading to weakness [2]. Due to these burn-induced responses, aerobic and resistive exercise activities have been recommended to counteract these outcomes.

We have previously shown that, in pediatric outpatients, a 12-week regimen of progressive resistive and aerobic exercise performed at the hospital attenuates muscle loss and weakness [3–5]. However, a drawback to this type of exercise program (EX) is that it requires significant financial resources and is a considerable time commitment, requiring patients and sometimes caregivers to be in the hospital rather than at school, work, or home. In cases in which the patient and family do not have the resources or need to be home due to family, work, or other issues, it is highly desirable to identify an approach aimed at improving muscle mass, strength, and cardiopulmonary fitness. Therefore, such activities or EXs, if carried out in or near the patient's home or community, would offer an alternative to in-hospital rehabilitation for burn victims. There are no studies currently published in patients with severe burns in reference to a community-based exercise program; however, there are numerous studies in other populations that have reported beneficial effects of such programs [6–10].

The objective of this study was to compare in children the efficacy of a 12-week community-based exercise program (COMBEX) relative to an ''in-hospital'' EX program in improving lean mass, muscle strength, and aerobic capacity. There are no studies currently published in patients with severe burns in reference to a community-based exercise program; however, there are numerous studies in other populations that have reported beneficial effects of such programs. Obtaining evidence that progressive resistive exercise and aerobic exercise offered through COMBEX provides superior or equivalent benefits to those offered by EX (the current standard of care [SOC]) could lead to a much needed rehabilitation treatment alternative that allows for continued exercise rehabilitation without the obstacles that exist with ''in-hospital'', outpatient EXs.

2. Methods

This prospective, randomized study, with an intended allocation of 1:1, was conducted according to a study protocol approved by the Institutional Review Board (IRB) at the University of Texas Medical Branch (Galveston, Texas). Legal guardians agreed to their child's study participation by signing an informed consent form approved by the IRB. Children older than 7 years of age agreed to study participation by signing an IRB-approved assent. After consent/assent was obtained by the clinical research staff, children were randomized to EX ($N = 23$) or COMBEX ($N = 22$) in sequentially numbered, alternating containers (EX versus COMBEX). A total of 34 children aged ≥ 7 to < 18 years and with burns covering $\geq 30\%$ of their TBSA completed this study. Children in both groups received standard burn care and comparable treatments from emergency admission until acute care and hospital discharge. Three primary variables were assessed in this study: lean mass, muscle strength, and cardiopulmonary fitness (VO_2 peak). Assessments were made at hospital discharge and at completion of the 12-week COMBEX and EX.

2.1. Lean body mass

Dual energy X-ray absorptiometry (Hologic Inc., Bedford, MA) was performed while patients were supine. Total lean mass was expressed in kilograms of body weight and corrected for height. The methodology used is detailed in previous studies by our group [3,11].

2.2. Muscle strength

Peak torque was measured using an isokinetic dynamometer (Biodex System 3, Shirley, NY). Peak torque is the highest muscular force output and is similar to a one repetition maximum effort in an isokinetic contraction (Biodex Advantage Software Operations Manual. Shirley, NY, 2001). Dominant leg extensors were tested at 150 degrees per second while patients were seated and secured in this position with a strap fastened over the midthigh and pelvis. The dominant leg was determined by asking the patient which leg was used when kicking a ball, as well as having the patient simulate the act of kicking a ball. Patients were told what to expect throughout testing and were then allowed to complete one practice session of 10 repetitions at a speed of 150 degrees per second. After the practice session, the patient underwent testing by performing 10 repetitions at 150 degrees per second at a maximal volitional effort. Verbal encouragement was given throughout the test in an attempt to elicit a maximal volitional effort. Similar wording was used for encouragement in all patients.

2.3. Cardiopulmonary fitness

Patients underwent maximal exercise testing according to a modified Bruce protocol [12]. The test consisted of changing the incline and/or speed every 3 min, with the incline being started at an angle of zero and the speed being started at 1.7 mi/h [12]. Exercise intensity was progressively increased (i.e., a graded exercise test) and lasted until the patient could not maintain the required workload (volitional fatigue). A Respiratory Quotient exceeding 1.10 and a Borg's Rated Perceived Exertion level (RPE; CR-10) of 9–10 also served as indicators that a maximal or peak value had been attained [3,5]. Heart rate and VO_2 peak (mL O_2 consumed/kg body weight/minute) were measured and analyzed as described elsewhere [12]. We used VO_2 peak and peak heart rate to guide the intensity of training of aerobic exercise in the COMBEX and EX programs.

2.4. Exercise program (EX) group

After discharge, patients were housed at a hotel or home within or near the hospital. Housing accommodations were