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The effect of lower body burns on physical function

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ARTICLE INFO

Article history:
Accepted 29 May 2015

Keywords:
Burn
Exercise
Lower body
Joint

ABSTRACT

Objective: To attenuate burn-induced catabolism, patients are often enrolled in a resistance exercise program as part of their physical rehabilitation. This study assessed how lower body burn locations affected strength and cardiopulmonary function.

Methods: Children enrolled in an exercise study between 2003 and 2013, were 7–18 years of age, and burned ≥30% of their total body surface area were included. Analysis of variance was used to model the relationship of lower body strength (PTW) and cardiopulmonary function (VO_{2peak}) due to burns which traverse the subject's lower body joints.

Results: There was a significant relationship between PTW and burns at the hip and toe joints, showing a 26 N m/kg ($p = 0.010$) and 33 N m/kg ($p = 0.013$) decrease in peak torque, respectively. Burns at the hip joint corresponded to a significant decrease in VO_{2peak} by 4.9 ml kg^{-1} min^{-1} ($p = 0.010$) in peak cardiopulmonary function.

Conclusion: Physical function and performance are detrimentally affected by burns that traverse specific lower body joints. The most significant relationship on exercise performance was that of hip joint burns as it affected both strength and cardiopulmonary measurements. Ultimately, burns at hip and toe joints need to be considered when interpreting exercise test results involving the lower body.

1. Introduction

The annual number of burns in the United States receiving medical treatment is approximated at 450,000, of which 40,000 are admitted for acute care. Males comprise nearly 70% of burn patients. The majority of the patients are Caucasian (59%) with African–Americans (20%) and Hispanics (14%) following thereafter. About three-quarters of the patients are injured in the home place with far fewer being work, car, or recreational/sports related. Burns are predominantly flame/fire (43%) and scald (34%), while contact (9%), electrical (4%), chemical (3%), and other (7%) comprise the rest of the patient population. The chance of survival for a burn patient is about 97% [1], leaving an increasingly large number of patients in need of rehabilitation. Burns are most commonly accompanied by stark muscle loss, scarring, and contractures [2], which often benefit from rehabilitation activities including a resistance and cardiopulmonary exercise program [3–5].

Burns result in the highest metabolic rate of any critical injury [6]. Associated with this hypermetabolic state is muscle weakness and cardiopulmonary deconditioning [2,7], made worse by prolonged inactivity [8,9]. To attenuate muscle weakness and deconditioning, as well as burn-induced

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http://dx.doi.org/10.1016/j.burns.2015.05.020

catabolism, patients are often enrolled in a resistance and aerobic exercise program as part of their physical rehabilitation [3]. Such a program implemented after acute discharge in severely burned children increases muscle strength and cardiopulmonary endurance [3–5].

Diego et al. [10] surveyed licensed physical and occupational therapists who are part of the American Burn Association Physical Therapy/Occupational Therapy Special Interest Group to assess the standard of care for outpatient rehabilitation programs. Of the respondents, 82% claimed their institution offered outpatient therapy after discharge, although 81% of the therapists stated that no cardiopulmonary endurance exercise programs were in place. Additionally, the prescribed and follow-up assessments were found to be diverse among the surveyed institutions. At the time of acute discharge, standard of care at our institution includes recommendations by occupational therapy and physical therapy, which are to be performed at home. Additionally, for patients greater than 7 years of age, standard of care also includes offering patients enrollment into a 12-week supervised resistance and cardiopulmonary exercise program to be completed at our institution.

Comments occasionally made in manuscript reviews and grant proposals note concern about burn location and its effect on exercise performance. These comments have included, concerns that patients with severe burns will have varying burn areas and that the effect of these varying burn locations on physical function and performance is unknown. Thus, the current study was undertaken to assess how burns over lower body joints affected strength and cardiopulmonary endurance. To our knowledge, there have been no previous reports of the effects of burn location on physical function or more specifically, compensatory strategies for lower body movements when multiple lower body parts are impacted by a severe burn.

2. Materials and methods

2.1. Burned subjects

Children who were randomized and consented to take part in a program consisting of resistance and aerobic exercise between 2003 and 2013 were included in this study. The children were 7–18 years of age and had a 30% or greater total body surface area (TBSA) burn as assessed by the Lund and Browder method [11] during excisional surgery in the acute phase of injury. Patients were excluded from this analysis if they had 1 or more of the following: leg amputation, anoxic brain injury, psychological disorders, quadriplegia, severe behavior or cognitive disorders, or consented to an institutional review board (IRB) approved study in which they were randomized to receive the active form of a research drug. IRB approval was obtained for this study, as well as informed consent/assent from parents/child subjects for each study participant.

As shown in Fig. 1, there were 260 patients who agreed to participate in a randomized study to receive a research drug between 2003 and 2013. Of the 260 enrolled patients, 84 were identified as control patients (taking the non-active from of the research drug). Because this study reviewed measurements taken only at or shortly after discharge, 47 patients who had PTW measurements were analyzed. However, only 36 of those patients had VO_{2peak} measurements and could be included in the subsequent analysis. This was due to the presence of facial burns, as they could not use the mouthpiece to measure VO_{2peak}.

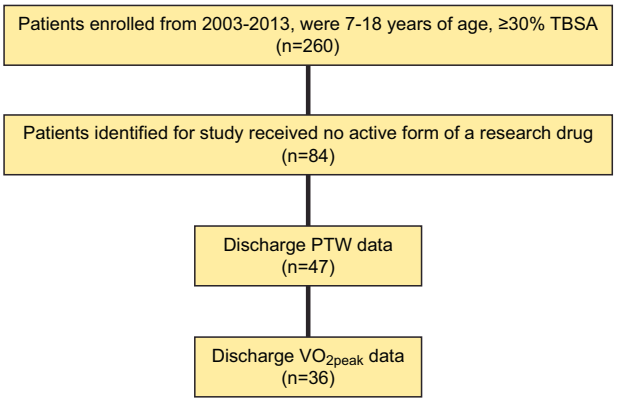

Fig. 1 – Consort diagram showing the number of patients enrolled in the study and those whose measurements were analyzed.

2.2. Subjects and clinical care

All subjects were admitted to Shriners Hospitals for Children in Galveston and treated in a similar manner by the same team of burn surgeons. Standard treatment included early excision of full thickness burn wounds, treatment with systemic antibiotics, and continuous enteral feeding. Early excision involves patients undergoing total burn wound excision and grafting within 48 h of admission for any full thickness burns. Patients returned to the operating room as donor sites healed and allowed for reharvesting of the unburned skin (usually 7–10 days). Additional surgical procedures for excision and grafting were undertaken until all wounds were covered and healed.

All patients received similar standard of medical treatment from the time of hospital admission until time of discharge. In addition, both groups were discharged with similar standard of medical and rehabilitation care. After discharge, patients who consented to participate in exercise were tested at Shriners Hospitals for Children in Galveston within a week of discharge. Only measurements gathered after discharge from the acute unit, and prior to initiation of an exercise program were used for this study. Measurements were completed in an individualized and supervised manner during leg strength and cardiopulmonary endurance treadmill testing. It should be noted that both measurements rely mainly on lower body function and stability.

2.3. Assessment of burn location

A Lund and Browder [11] burn diagram was completed for each acutely admitted patient using similar methods of assessment