Growth Hormone & IGF Research 27 (2016) 1–6

Contents lists available at ScienceDirect

Growth Hormone & IGF Research

journal homepage: www.elsevier.com/locate/ghir

Effects of sustained release growth hormone treatment during the rehabilitation of adult severe burn survivors

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ARTICLE INFO

Article history:
Received 6 September 2015
Received in revised form 17 December 2015
Accepted 31 December 2015
Available online 5 January 2016

Keywords:
Burns
Metabolism
Growth hormone
Rehabilitation

ABSTRACT

Objectives: The catabolic phase following burn injuries increases caloric imbalance and results in substantial weight loss because of hypermetabolism; energy expenditures as high as twice the normal limit have been documented during the first 3 weeks. Furthermore, the wound size and healing duration seem to be related to the length of stay in the intensive care unit, which results in the loss of muscle mass, the so-called sarcopenia; weakness; and physical frailty. Possible therapeutic strategies include exercises, use of anabolic steroids, or replacement with human growth hormone (hGH). To determine the clinical effects of hGH on sarcopenia after burn injuries, we compared patients who received subcutaneous hGH injections during rehabilitation with control patients who received placebo treatment.

Methods: A total of 33 patients with third degree burn injuries covering a total body surface area of >20% were randomly divided into a test group (n = 18), which received 2-mg injections of sustained release hGH (SR-hGH) weekly for 3 months during rehabilitation, and a control group (n = 15), which followed the same rehabilitation protocol with placebo injections. Muscular strength, cardiopulmonary function, body composition, and body weight were measured at baseline and 1 and 3 months after SR-hGH or placebo administration.

Results: The mean age of patients was 37.67 ± 7.64 years in the SR-hGH group and 37.22 ± 8.19 years in the control group, while the interval between injury and SR-hGH or placebo injection was 123.7 ± 53.6 and 126.6 ± 43.5 days, respectively. The oxygen consumption at the lactate threshold, maximum oxygen consumption, lean body mass, knee extensor peak torque, and insulin-like growth factor 1 (IGF-1) and adiponectin levels were significantly higher in the SR-hGH group than in the control group at 3 months. There were no differences in the body weight, systolic and diastolic blood pressure (BP), bone mineral content, percentage body fat, and burn scar characteristics between groups.

Conclusion: Our results suggest that SR-hGH treatment during the rehabilitation of adult burn survivors positively affects physical fitness levels, muscle power, and metabolic processes, although further confirmation through research of metabolic pathways in burn survivors is required.

1. Introduction

Burns are a serious and debilitating type of injury that result in a hypermetabolic and catabolic response. Advances in acute burn care, such as early fluid resuscitation, early burn wound excision and closure, antibiotic usage, and appropriate nutrition, have significantly decreased mortality after severe burn injuries, thus increasing the number of burn patients entering rehabilitation [9]. The hypermetabolic response continues for up to 2 years after a burn injury, resulting in delayed rehabilitation and resumption of social activities [11].

More than 200,000 burn injuries are reported every year in Korea [7]. These injuries require long-term care, including wound management, skin grafting, and skin care. After acute care, several sequelae necessitating management can occur, such as joint contracture, hypertrophic scars, pruritus, poor esthetics caused by burn scars, and post-traumatic stress disorder. In addition, patients often undergo physical difficulties and emotional trauma [5]. Burn injuries lead to various metabolic responses such as increased levels of catabolic hormones, decreased levels of anabolic hormones, a marked increase in the metabolic rate, a sustained increase in the body temperature, a marked increase in glucose demands, rapid skeletal muscle breakdown, and unresponsiveness of catabolic processes to nutrient intake [4].

In patients with severe burn injuries, decreased muscle mass and energy expenditure changes persist even at 1 year after injury. Consequently, these patients experience difficulties in rehabilitation and social interactions, which can affect their overall well being. The

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http://dx.doi.org/10.1016/j.ghir.2015.12.009
1096-6374/

catabolic phase following burn injuries increases caloric imbalance and results in substantial weight loss because of a hypermetabolic state during the first 3 weeks after injury, which results in energy expenditures as high as twice the normal limit. Furthermore, the wound size and healing duration appear to be related to the length of stay in the intensive care unit (ICU), resulting in the loss of muscle mass, the so-called sarcopenia; weakness; and physical frailty [9]. Possible therapeutic strategies include exercises, use of anabolic steroids, or replacement with human growth hormone (hGH) [18].

From the above perspectives, we hypothesized that the addition of sustained release hGH (SR-hGH) to the standard rehabilitation regimen of adult severe burn survivors improves the lean body mass and increases the maximum muscle power, and that SR-hGH use prevents the burn scar from undergoing hypertrophic and other changes. To test these hypotheses, we conducted a randomized case–control study to compare the effects of SR-hGH treatment with those of conventional treatment during the rehabilitation phase of adult severe burn survivors.

2. Subjects and methods

2.1. Study design and population

This double-blind, placebo-controlled, randomized case–control study included 33 patients with severe burn injuries who were randomly assigned to receive placebo (control group; n = 15) or SR-hGH treatment (SR-hGH group; n = 18) during the rehabilitation phase (Fig 1). Because this was a prospective study, all participants were reviewed and approved by the Hallym University Hangang Sacred Heart Hospital Institutional Review Board. The subjects were informed about the risks and benefits of the proposed research and provided informed consent before study initiation. The inclusion criteria for this study were as follows: (1) severe burn injuries (third degree burns covering a total body surface area of >20%), (2) complete healing of the skin graft site within 4 weeks, and (3) provision of written informed consent. Patients with any mental disabilities, incapability to achieve the neutral position in the supine posture because of factors such as bony deformities or severe spasticity, and overt diabetes mellitus were excluded.

The SR-hGH hormone group underwent individualized stretching and strengthening exercises supplemented with SR-hGH injections for 3 months, while the control group underwent the same exercise protocol with placebo injections (Fig. 1). Medical staff not involved in the study randomized the patients using a random number table and prepared the medication for each patient. The study staff and patients were blinded to treatment allocation, and all analyses were performed with blinding of the treatment, subject, and time.

In order to determine the effects of SR-hGH treatment, we measured energy expenditure, hormone levels, and muscle strength and mass for all patients. The two groups were compared before and 1 and 3 months after SR-hGH or placebo administration (Fig. 2). The patients were familiarized with exercise and functional testing procedures at least 2 weeks before the actual tests.

2.2. Injection method and side effects of SR-hGH treatment

The SR-hGH group received 2-mg injections of sustained release recombinant hGH (Declage®, LG life science, Seoul, Korea) weekly for 3 months by the rehabilitation physician, while the control group received normal saline injections. We have selected the dose of 2 mg on the basis of previous studies. GH-deficient adults were reported to require an initial daily GH dose of 1 IU [13], while Kim et al. administered 2 mg (6 IU) of SR-rhGH once a week [14]. All patients were assessed for side effects after SR-hGH administration through examinations for blood pressure, edema, joint pain, and headache every 2 weeks. All assessments were made by the rehabilitation physician.

2.3. Evaluated parameters

2.3.1. Maximal oxygen consumption and exercise intensity

A treadmill test was performed using an exercise testing system (Marquette T2000 Treadmill; GE, USA) along with blood pressure measurements and electrocardiographic monitoring. Prior to careful measurements, the subjects were familiarized two or three times with the exercise test and procedures to exclude any possible variables. Using a submaximal exercise and stress test, pulmonary gas exchange indices were measured with a fast-response, breath-by-breath gas analyzer (Quark b2; COSMED, Rome, Italy) that can check oxygen consumption and the lactate threshold (anaerobic threshold). Before exercise testing, we attempted to maintain the patients' heart rates at minimum levels by physical activity restrictions in order to minimize anticipatory stress. The exercise test was discontinued when the difference in the heart rate checked at 5–6 min was not more than 5 beats per minute. If it was more than 5 beats per minute, the test duration was extended by one more minute. However, the total test duration did not exceed 10 min for any patient. Exercise prescriptions were individualized and recommended on the basis of the heart rate, with the exercise strength maintained at 50%–60% of the individual's maximal exercise capacity, in accordance with the Modified Bruce Protocol. All patients were instructed to feel their radial arteries and check their

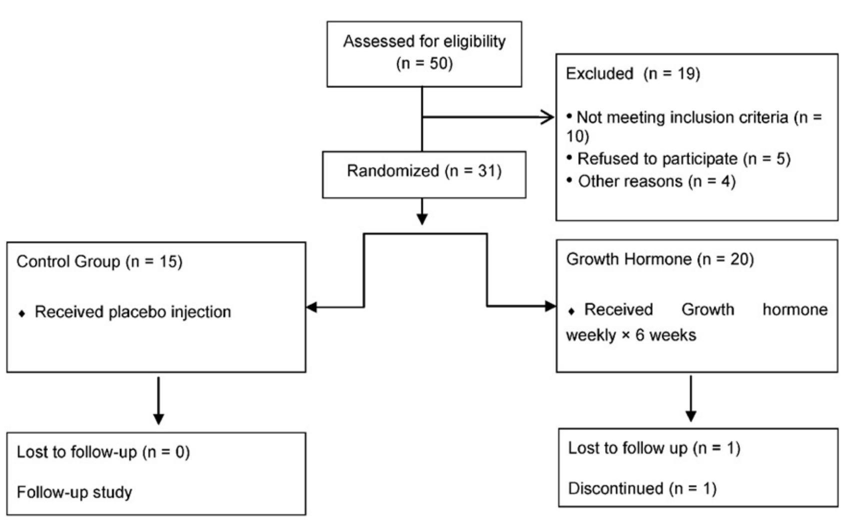

Fig. 1. Diagram for subject enrollment, allocation, and follow-up.