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High-voltage electric stimulation of the donor site of skin grafts accelerates the healing process. A randomized blinded clinical trial

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ABSTRACT

Introduction: Severe burns benefit from skin grafting, and grafting surgery is of great importance in the treatment of these injuries. As a result, there is formation of an additional wound at the donor site, which is painful and susceptible to infection. However, the therapeutic approach to these problems at donor sites for skin grafting is insufficiently explored in the literature.

Aim: To evaluate electrical stimulation of the donor sites of burn patients treated by grafting surgery.

Methods: This work evaluated 30 donor sites of cutaneous graft burn patients treated with high-voltage electrical stimulation. Subjects were randomized into two groups: electrical stimulation (GES), treated with electrostimulation (50 min, 100 Hz, twin pulses 15 us, monophasic), and the sham group (GS), treated by the same procedures but without current. Pain was assessed by visual analog scale daily before and after the electrical stimulation. The time elapsed until complete epithelization was evaluated (time of primary dressing detached spontaneously). Skin temperature was measured by thermography. The characteristics of donor sites were qualitatively evaluated using images and the plug-in CaPAS® (Carotid Plaque Analysis Software).

Results: The results showed a significant decrease in pain, which was absent on the third day in the GES and the sixth day in the GS. The time the primary dressing detached spontaneously in days decreased ($p < 0.05$) (4.7 ± 0.2) compared to the GS group (7.0 ± 1.3). Donor site healing characteristics such as vascularization, pigmentation, height, the quantity of crust formed,

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irregularities, and the quality of healing was better in the GES; moreover, homogeneity and inertia of the images confirmed higher healing quality.
Conclusion: As a result of the study, the technology shows promise and merits a larger study with objective assessments and different physical variables.

1. Introduction

The donor sites many times result in complications (e.g., pain, hypertrophic scarring, etc.) and become a problem for patients. It is a common procedure to treat burned patients [1–4].

In extensive and deep burns, there is no possibility of wound healing by spontaneous epithelialization, and early grafting is indicated. Skin grafting is a widely used technique for the reconstruction of injuries and can mean the difference between life and death for patients with major burns [5].

High-voltage electrical stimulation has been used to treat various disorders [6], with positive results in the treatment of different skin ulcers [7–12]. A study evaluated 40 patients diagnosed with diabetic foot ulcers divided into treated and placebo groups. After 12 weeks, 65% of the wounds in the treated group closed compared with 35% in the placebo group [7]. Houghton et al. [8], in a randomized controlled blind clinical trial, evaluated 34 adults with medullary injury with pressure ulcers divided into treated and control groups. After 12 weeks, the high-voltage group obtained an 80% decrease in surface area, while the control group obtained a 36% reduction in the area of the ulcer.

There are studies that used a continuous electrical current in the healing of grafts [13] and second-degree burns of rats [14]. However, no studies using a high-voltage current for the treatment of skin graft donor sites could be found. Thus, this study hypothesized that a high-voltage current would accelerate the healing process of the donor site of skin grafts and would reduce pain.

Considering the above, the objective of the study was to evaluate the ability of a high-voltage current to accelerate donor site wound healing. Additionally, we sought to determine if it had any effects on pain and quality of healing.

2. Material and methods

2.1. Search local, ethical aspects, and patient selection

This study was a randomized controlled and blinded clinical trial. The first researcher was responsible for the recruitment, evaluation, and analysis of data, and a second researcher was responsible for the randomization, concealed allocation, and intervention. The researcher responsible for the evaluation and analysis of the data was unaware of the allocation of volunteers. The patients were divided into electrical stimulation (GES) and sham groups (GS), with the electrodes positioned and the device switched on for both groups, except that the voltage was zero for the sham group. The patients were advised that electrical stimulation would not promote any sensation, so the patients in this group were also blinded, and, in part, the Hawthorne effect was minimized.

Randomization was performed in Excel, with concealment in opaque and sealed envelopes, numbered sequentially. The envelopes were opened only at the time of the intervention (GES or GS) by the researcher.

The study participants were 30 burn patients: 15 GS (11 patients with the scalp donor area and 4 patients with thigh donor area) and 15 GES (10 patients with the scalp donor area, and 5 patients with thigh donor area) adults of both sexes who had undergone skin graft surgery with an average thickness of 0.20 mm and with the donor site being the scalp or thigh (Fig. 1). They were admitted to the Burns Unit of the Clinics Hospital of Ribeirão Preto Medical School, University of São Paulo, in the period between December 2011 and December 2012. Participants were adult men and women who had no infections and were invited to participate in the study, which was described as a randomized controlled and blinded clinical trial according to the guidelines of CONSORT (Consolidated Standards of Reporting Trials), having been approved by the Ethics Committee HCFMRP Research/USP (13835/2009) and registered in Clinical Trials (NCT 02785497).

As an inclusion criterion, recruited patients required a surgical procedure with skin use for grafting deep burn wounds obtained from corporal areas such as the scalp and thigh. Children and adults with associated diseases, such as infectious processes or diabetes, that may interfere with the healing process and/or therapeutic procedures, those using medications that alter the healing process (e.g., corticosteroids, chemotherapy, or radiotherapy), and elderly were excluded from the study.

2.2. Instrumentation and procedures

Initially, removal of hair was performed at graft withdrawal sites. The donor area graft was removed with the patient under general anesthesia with an electric dermatome model Humeca D42® (Humeca BV, Enschede, The Netherlands). The thickness was 0.2 mm with standardization of the removal technique and local antisepsis. All grafts were of partial thickness and removed from the anterolateral side of the thigh or the scalp after infiltration with anesthetic and vasoconstrictor solution (saline + adrenaline 1:500,000). After graft removal, the standard procedure was to stabilize the bleeding with compresses of adrenaline solution (1:500,000) while still in the surgical center. A Rayon® dressing (POLARFIX®, Mauá, SP, Brazil) was placed directly on the donor areas and overlaid with sterile gauze and compressive crepe strip. Rayon® is characterized by having holes that allow the drainage of possible bleeding or exudate, which are absorbed by the gauze and crepe band. As per protocol, gauze and compression bands were