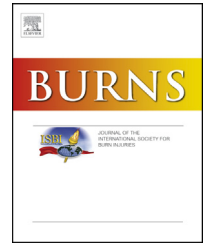


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Skin stretching for primary closure of acute burn wounds

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ABSTRACT

Background: In burn care, a well-acknowledged problem is the suboptimal scar outcome from skin grafted burn wounds. With the aim of improving this, we focused on a new technique: excision of the burn wound followed by primary closure, thereby using a skin-stretching device to stretch the adjacent healthy skin. The short- and long-term effect of Skin Stretch was compared to split skin grafting (SSG) in a randomized controlled trial.

Methods: Patients with burn wounds were randomized for SSG or primary wound closure using Skin Stretch. Follow-up was performed at 3 and 12 months postoperatively. The scar surface area was calculated and the scar quality was assessed, using subjective and objective measurement methods.

Results: No significant differences between the SSG and the Skin Stretch group were found for scar surface area. In the Skin Stretch group, a significant reduction of the surface area from 65.4 cm² (13.6–129.1) to 13.4 cm² (3.0–36.6) was found at 3 months ($p = 0.028$) and at 12 months postoperatively (65.4 cm² (13.6–129.1) to 33.0 cm² (8.9–63.7), $p = 0.046$, Wilcoxon signed ranks test).

Conclusions: Skin Stretch for primary closure of acute burn wounds is a suitable technique and can be considered for specific circumscribed full-thickness burn wounds. However, future research should be performed to provide additional scientific evidence.

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1. Introduction

A well-acknowledged problem in burn care is the suboptimal cosmetic and functional outcome of scars that result from skin

grafted burn wounds. Frequently described problems include pain, itch, visible mesh pattern, hypertrophy, or functional impairment due to contraction or limited elasticity of the scar. These disfiguring and functionally invalidating scars can be treated by pressure garments, silicone application, and if

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necessary plastic surgical reconstructions. Even though these reconstructions can significantly improve functionality and scar appearance, we advocate to improve the surgical technique in the acute burn wound phase to prevent the need for secondary reconstruction. Therefore, in this study we focus on a simple technique which up to now has not been investigated for treatment of acute burn wounds: full-thickness excision of the burn wound followed by primary closure. During primary closure, the adjacent healthy skin was stretched, using a skin-stretching device (Humeca, Enschede, The Netherlands). This skin-stretching device was originally developed by Hirshowitz et al. and is based on the disposable Sure-Closure skin-stretching system (previously produced by Life Medical Sciences, Inc. Princeton, USA) [1].

Recently our study group demonstrated the short and long-term efficacy of skin stretching for burn scar excisions in a multicenter randomized controlled trial (RCT) [2,3]: a significantly larger burn scar could be excised in a one-stage procedure and on the long term a smaller percentage of scar remained compared to burn scar excision without Skin Stretch. Considering these beneficial results of skin stretching for excision of burn scars, we initiated this study to investigate the efficacy for excision and primary closure of burn wounds. At this moment split skin grafting is still considered as the mainstay of treatment of full-thickness burn wounds. Other techniques, such as dermal substitution and local, pedicled, or free flaps have been described as successful in covering acute burn wounds [4–9]. Even though these techniques report good functional and cosmetic results, still burn scars of the size of the original full-thickness burn wound remain or patients suffer from donor site morbidity after flap harvesting. For this reason we focus on a new technique for acute burn wound treatment, which is full-thickness excision of the burn wound followed by primary closure using a skin-stretching device. It may have several benefits compared to the current therapies: smaller scar surface area, better scar texture, faster wound healing, no donor site morbidity, and improved functional outcome. The skin-stretching procedure is a simple concept that takes about 15–30 min during one operation: controlled tension is intermittently applied on the wound edges and healthy skin can be gained without compromising blood supply and quality of the stretched skin. This allows for primary closure of large defects [10]. The skin-stretching technique could be beneficial for circumscribed full-thickness burn wounds that are too large for direct closure using standard techniques. Scientific publications on the technique of total excision of the burn wound followed by primary closure with and without additional skin stretching are scarce. No more than one peer-reviewed report, which was published in the eighties described the technique of primary excision of burn wounds without using Skin Stretch: Lampe et al. reported that primary closure of third degree burn wounds should be advocated, however details of this study are not provided [11]. The use of a skin-stretching device for primary closure of various types of other defects than burn wounds has been described by several authors [1,10,12–14], but this was never performed for burn wounds.

In a multicenter RCT the scar outcome of burn wounds that were treated by primary closure, using a skin-stretching

device was compared to burn wounds treated with split skin grafting. We hypothesized that this new technique for closing burn wounds could result in a smaller burn scar and could improve the appearance of a burn scar. For the first time, primary closure of burn wounds using a skin-stretching device was investigated. In addition, the short and long-term scar outcome was evaluated using subjective and objective reliable and valid measurement methods.

2. Materials and methods

2.1. Trial design

A multicenter RCT was performed in the three burn centers in the Netherlands (Red Cross Hospital in Beverwijk, Maasstad Hospital in Rotterdam, and Martini Hospital in Groningen). This was a parallel group trial with a randomization ratio of one-to-one to ensure balance of the numbers in each treatment group. The study protocol was approved by the medical ethics committee (M07-047) and registered at Clinical Trials (NCT00609908). Two treatment groups were investigated: one being the experimental arm, which included excision of the burn wound followed by wound closure with a skin-stretching device (Skin Stretch). The active comparator included excision of the burn wound followed by split skin grafting (SSG). The CONSORT statement was used as a guideline [15–17].

2.2. Participants

Patients eligibility was based on the inclusion and exclusion criteria as shown in Table 1. Before enrollment in the study, written informed consent was obtained by the coordinating researcher. Patients were randomly assigned to receive treatment with either Skin Stretch or SSG. The allocation was concealed by using non-transparent envelopes. The envelope was opened by the coordinating researcher at the start of surgery in theater, since the wound bed preparation was different for the Skin Stretch than the SSG group. Blinding of clinician and patient was not possible, because it was obvious which treatment was allocated when the operation site was inspected.

2.3. Surgical procedure

After burn trauma, the wounds were treated with silver sulfadiazine or cerium-silver sulphadiazine cream. Swabs of the study wound were taken twice a week. In theater, the burn wound was scrubbed with chlorhexidine and cleaned with saline solution. Before the start of surgery and after wound bed preparation, the surface area of the burn wound that was randomized for either Skin Stretch or SSG, was measured by tracing the wound onto non-stretchable transparent sterile sheets. At the start of surgery randomization was performed: if Skin Stretch was allocated, sharp full-thickness excision of the burn wound was performed up to vital subcutaneous tissue. It was assured that there was sufficient adjacent healthy, unburned skin at both edges of the wound to sustain the stretching forces. Two straight needles of 8 cm were

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