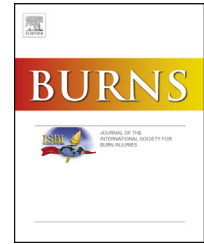


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# The recovery of post-burn hypertrophic scar in a monitored pressure therapy intervention programme and the timing of intervention

Pan Li<sup>a,b</sup>, Cecilia Wai Ping Li-Tsang<sup>a,\*</sup>, Xue Deng<sup>a</sup>, Xiaoyun Wang<sup>b</sup>, Hanjie Wang<sup>b</sup>, Yuting Zhang<sup>a,c</sup>, Ziming Tan<sup>b</sup>, Chengqi He<sup>c</sup>

<sup>a</sup> Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

<sup>b</sup> Department of Rehabilitation Medicine, Chengdu Second People's Hospital, Chengdu, Sichuan, China

<sup>c</sup> Department of Rehabilitation Medicine, Sichuan University, Chengdu, Sichuan, China

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## ABSTRACT

**Introduction:** Pressure therapy used to be considered as the mainstay non-invasive treatment of hypertrophic scar. However, the maturation process of hypertrophic scar during pressure therapy process has seldom be reported. Moreover, although early application of pressure therapy after burn injuries is recommended, minimal evidence exists to support it. This study aimed to examine the maturation trajectory of post-burn hypertrophic scars in a 6-month monitored pressure therapy intervention programme and investigate the difference in the trajectory between patients receiving early intervention and patients receiving late intervention.

**Methods:** Thirty-four patients with sixty-five post-burn hypertrophic scar samples were recruited for the study. All the subjects were treated with a 6-month pressure therapy programme with the pressure dosage regulated using a newly developed pressure therapy system, the Smart Pressure Monitored Suits. The selected scars were assessed with MiniScan XE Spectrocolorimeter on scar pigmentation, and Terason t3000 portable ultrasound imaging equipment on scar thickness. The Vancouver Scar Scale (VSS) was used to evaluate pigmentation, pliability, vascularity and height of the scars. Subjects' report of pain and itch was documented. Assessments were conducted before treatment began and then monthly during the 6 month-intervention process. Patients were further divided into two groups according to the time of intervention post-burn injuries to review differences in the maturation trajectory between those who received early versus late treatment (early intervention group, prescribed within 60days after injuries; late intervention group, prescribed after 61 days). The changes of scar features were recorded to formulate the recovery trajectory of scar, and the outcomes of intervention between the early and the late groups were compared.

**Results:** Pre- and post-treatment comparison demonstrated significant improvement in scar pigmentation, thickness, VSS scores and scores of pain and itch ( $p < 0.01$ ) for the early intervention group. For the later intervention, only scar lightness, yellowness, VSS scores and scores of pain and itch was found with significant improvement ( $p < 0.01$ ). The improvement in these scar characteristics was sustained over time during the treatment process. The early group demonstrated superior effect in improving scar lightness,

\* Corresponding author.

E-mail address: [Cecilia.li@polyu.edu.hk](mailto:Cecilia.li@polyu.edu.hk) (C.W.P. Li-Tsang).

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yellowness ( $p < 0.01$ ), thickness ( $p < 0.01$ ), pigmentation score ( $p < 0.05$ ) and pain score ( $p < 0.01$ ) than the late group in comparison between the two groups at similar post-burn timing.

**Conclusions:** Hypertrophic scars appeared to undergo continuous improvement in the appearance, pain and itch over time during the process of a monitored pressure intervention programme. Early application of pressure therapy after burn injury may contribute to better outcomes as shown by their faster recovery than those with late intervention. In order to achieve the best outcomes, regular evaluation and adjustment for optimal interface pressure is necessary.

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## 1. Introduction

Hypertrophic scar (HS) following burn injuries and other types of trauma or surgeries is a common complication and a major challenge to health professionals and patients [1]. In Asian populations, despite a high survival rate of 98.9% after burns [2], the prevalence rate of HS after burn injury is as high as 70%, much higher than that of Caucasian populations [2,3]. Hypertrophic scar is characterized by its red to purple colour, elevated height, decreased pliability, tenderness, pain and itch [4-7]. Patients with HS may suffer from stiffness, cosmetic disfigurement, joint contractures, as well as impediment in physical function and daily activities, and even psychological problems [1,8,9]. Hypertrophic scar generally develops at around 2 months after burn [10], and will continue to proliferate for a year or longer [6-8]. Researchers have found that scar hypertrophy maturation may not occur until 18 or even 24 months after a burn [10]. The exact time point of regression or maturation of HS remains unknown [6,7].

Among the non-invasive measures for management of HS, pressure therapy has been one of the mainstay management options [4]. The pressure dosage generated by the pressure garment to scar is regarded as a vital factor to the effectiveness of pressure therapy [7,22-24,26]. The variations in the design of pressure garments, the aftercare regime, the durability of the fabrics, the maintenance of pressure garments, may influence the contact pressure generated to the HS [26-28]. It remains difficult to maintain a consistent pressure throughout the intervention process which affects the long-term outcomes [24,25]. In order to maintain an adequate pressure magnitude on the scar tissues, repetitive assessments and adjustments of the pressure garments are often required by therapists or health professionals [27,28]. Yet, these procedures are often based on clinicians' experience and are highly exposed to bias for subjective determination of interface pressure among the therapists [21]. The lack of a standardized application procedure and interface pressure regulatory system might account for inconsistent results in publications of meta-analysis and systematic review [4,10] and could account for results that do not support the effectiveness of pressure garments [29,31].

Although pressure therapy has been widely used for scar management and has been reported to decrease scar thickness [11-13], reduce scar vascularity, erythema or redness [13-15], decrease scar hardness [28], increase scar pliability [29], improve joint range of motion [15,18,19], accelerate scar

maturation and suppress scar contractures [31], the response of HS to pressure therapy remains unclear [5]. Few studies have reported the effectiveness of pressure garments by considering the recovery trajectory of HS. Besides, it is not clear when is the best time of pressure intervention to ensure best effect [14,15]. It is believed that early intervention is better than late intervention when the scar has become very hypertrophic, hard and thick [16,17], but minimal evidence exists to support this. Considering the necessity of combining pressure therapy with other treatment methods in scar management, implementation of pressure therapy at an optimum timing and understanding the possible response of scar tissue to pressure over time, could help to improve the effectiveness of scar management, and shorten length of time that pressure garments need to be worn. Thus, the present study aimed to examine the recovery trajectory of HS over time during the process of a monitored pressure therapy intervention programme, and to compare the trajectory of HS of patients receiving early pressure intervention after wound healing to patients receiving late pressure intervention (commencing two months post-burn).

## 2. Methods

### 2.1. Study design

A longitudinal cohort design was adopted in this study and quantitative scar assessment, namely, measurement of pigmentation and thickness were conducted, together with therapists' clinical assessment using Vancouver Scar Scale (VSS), as well as patients' report on pain and itch. To identify whether patients responded better to early or late application of pressure, subjects were retrospectively classified into two groups based on the time post-burn for analysis: an early intervention group (post-burn time  $\leq 60$  days), and a late intervention group (post-burn time ranged between 61 days and 180 days). Monthly measurements of scarring formed the recovery profile of HS of the two groups.

### 2.2. Subjects

Sixty-five samples of post-burn HS were selected from thirty-four patients (about 2 scars per patient) from a regional hospital in Chengdu, China. The inclusion criteria for the HS samples were: (1) scars with wound healing time longer than 21 days based on the wound healing time documented in

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