

---

# A Randomized Clinical Trial to Study the Effect of Silicone Gel Dressing and Pressure Therapy on Posttraumatic Hypertrophic Scars

---

Cecilia Wai Ping Li-Tsang, PhD,\* Yong Ping Zheng, PhD,† Joy C. M. Lau, MPhil\*

To investigate the effect of pressure therapy (PG), silicone gel sheeting (SGS), and combined therapy on the management of posttraumatic hypertrophic scar (HS) using a randomized controlled clinical trial. A total of 104 subjects with HS mostly resulting from burns and scald injuries (63 men and 41 women; average age:  $21.8 \pm 18.7$  years) were recruited from Jiangsu People's First Affiliated Hospital in Nanjing, China. The mean scar formation period was  $14.9 \pm 30.8$  months. All subjects were randomly allocated into four groups, namely the PG, SGS, combined PG and SGS groups, and single-blinded control group for the treatment of 6 months. Standardized scar assessments (pigmentation, vascularity, thickness, pain, and itchiness) were conducted before the intervention, 2, 4, and 6 months of the intervention, and 1 month after completion of the program, respectively, to observe the progress of the treatments. The results showed that the combined therapy seemed to be more effective in improving the thickness of scar after 2 months of intervention ( $P < .001$ ). After 6 months of intervention, both the combined therapy group and the PG group showed significant improvement in scar thickness. The improvement in scar thickness was most significant in the combined therapy group. SGS was found to be more effective in alleviating the pain and pruritus rather than the scar thickness. This randomized clinical trial has demonstrated the evidence of the effect of combined PG and gel intervention on posttraumatic HS. The PG group showed an improvement in scar thickness too. Further studies are needed to investigate the biomechanical and physiological effect that PG and gel sheeting would exert on the scar tissues. (*J Burn Care Res* 2010;31:448–457)

Medical and surgical advancement in the Mainland China has greatly increased the survival rate of victims with more than 90% traumatic injury of body surface such as burns or severe body trauma.<sup>1</sup> However, the formation of hypertrophic scar (HS) over the burnt or traumatized skin is common and can result in poor appearance, hyperpigmentation, or hypopigmentation, and some will develop severe joint contractures or limb deformities. HS is characterized by its red, raised, and hard features, which might also bring

about itchiness and pain.<sup>2–4</sup> The severity of scar is often related to the depth of injuries.<sup>5–7</sup> A previous study showed that the prevalence of hypertrophic scarring in severe burns could be up to 67% in whites.<sup>8</sup> The non-white individuals seemed to have a higher prevalence in developing HS.<sup>8</sup> Our previous study has also found that Chinese people tend to have a higher prevalence rate of HS after surgical procedures (74.67%). The common problems on HS include increased skin thickness and decreased pliability, thus leading to skin contracture and deformation of the body parts. Some will have increased pigmentation and other physical discomforts.<sup>9</sup> In Mainland China, most of these HS were treated by surgical excision, and often, bigger scar problems arise. Other interventions such as steroid injection and laser therapy are recommended, but side effects were reported. An effective method for the treatment of HS would be critical to serve the massive numbers of patients with HS in Mainland China.

*From the Departments of \*Rehabilitation Sciences and †Health Technology and Informatics, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR, China. Supported by the Internal Central Research Grant, Hong Kong Polytechnic University, Hong Kong SAR. Address correspondence to Cecilia Wai Ping Li-Tsang, Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China. Copyright © 2010 by the American Burn Association. 1559-047X/2010*

DOI: 10.1097/BCR.0b013e3181db52a7

Pressure therapy (PG), usually administered in the forms of pressure garment and padding, has been used as a conservative intervention for the management of HS since the early 1970s.<sup>10–14</sup> It was reported that PG can aid HS maturation and may prevent its formation, and thus it can improve the appearance of scars; it also claims to minimize itchiness and pain.<sup>15</sup> However, a recent meta-analysis has been conducted and found that there is a lack of objective clinical studies to prove its effectiveness. Although the exact mechanisms of how pressure positively influences the development or maturation of HS are not fully understood, it is widely believed that the pressure exerted by pressure garments can control collagen synthesis by limiting the supply of blood, oxygen, and nutrients to the scar tissue; reduce collagen production to the levels found in the normal scar tissue more rapidly than the natural maturation process by replacing the pressure exerted by the destroyed skin on underlying tissues; and encourage realignment of collagen bundles already present.<sup>16</sup> It is also believed that the mechanical loading added through pressure will mechanically align the collagen fibers of scar tissues, so that the thickness will be reduced and it will become more pliable.

Silicone gel sheeting (SGS) has also been claimed to be effective for the prevention and management of HS since the last decades.<sup>17–22</sup> It was suggested that the silicone gel can affect the stratum corneum and, by reducing evaporation, restore better homeostasis in the tissue, keeping the stratum corneum in optimal hydration and protecting the skin from environmental hazards. It may also affect the stratum corneum by inhibiting mast cell activity, diminishing edema, vasodilatation, and excessive extracellular matrix formation, but the simple changes in temperature, pressure, oxygen tension, and hydration produced by wound coverage probably constitute the main mechanism of action.<sup>23–25</sup>

However, both interventions, although claim to be effective, seemed to take a long time (4–6 months) to exert their effect on HS. It is postulated that if combined therapy is implemented, the effect would be proven more effective in a shorter period of time. Therefore, this study aimed to find out the effect of the combined therapy on HS when compared with single intervention using a randomized clinical trial. A Chinese sample would be selected in this study to find out the combined therapy effect, because most of the previous studies were conducted on whites.

## METHODS

### Subjects

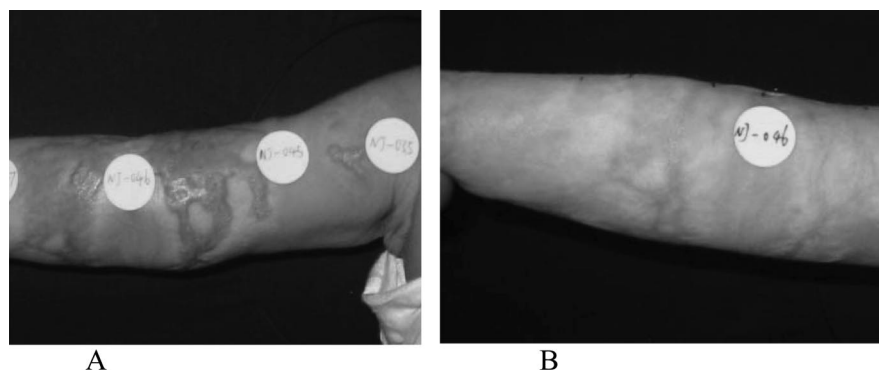
Ethical approval was obtained from the Nanjing Medical University and Jiangsu People's First Affiliated Hos-

pital in Nanjing, China and the Ethics Committee of Hong Kong Polytechnic University. A total of 104 subjects were recruited from the hospital. The inclusion criteria were as follows: those who had developed active HS over their limbs or body due to burns, scalds injuries, or traumatic injuries; and the scar surface area should not be greater than 16 cm<sup>2</sup>. As the scar maturation process varies among different scar tissues, it was decided that the criteria of HS would be defined based on the actual scar assessment rather than the period postinjuries. A scar is defined as an active scar when the Vancouver Scar Scale is higher than 5 (each subscore higher than 1). Because this study aimed to study the effect on scar tissue, it was decided that a smaller scar area would be chosen in order to minimize the occurrence of confounding factors from scars that were too big and extensive. Those suffering from other medical diseases such as diabetics mellitus were excluded from the study. Written consent form was collected from each participant before the study.

### Research Design

This study was a randomized, double-blinded, prospective, controlled clinical trial. The successfully recruited 104 subjects were randomly assigned into four experimental groups using the draw lots method, namely: 1) PG group (n = 30), 2) SGS group (n = 24), 3) combined PG and SGS therapy group (CTG) group (n = 29), and 4) control group (CG; n = 21). All the subjects chosen for the study were informed of their own intervention regime, and they had no idea of what intervention other subjects were given.

The subjects in PG group were instructed to wear the tailor-made pressure garment with padding, whereas those in SGS group had SGS applied on the scar area for 24 hours per day except bathing time. Micropore tape was used to secure the silicone gel sheet if needed. The subjects in the combined therapy group were administered with both pressure garment and SGS that was inserted underneath the garment using the same wearing regime. The participants in the CT group and all those in the other three groups were instructed to conduct lanolin massage on the scar for 15 minutes daily. The intervention would last for 6 months, and all subjects were asked to comply with their own intervention program. They were assessed before the intervention and 2, 4, and 6 months after the intervention to observe the effectiveness of the different treatments. The assessments were then conducted by the research assistant who did not know the intervention given to each subject but only their group number.



**Figure 1.** An example of scar in pressure treatment group at (A) initial assessment and (B) 6-month follow-up.

### Outcome Measures

Previous studies often use subjective feedback from the patients regarding their perception on the scar conditions including cosmesis, pain, and pruritus. In this study, an objective standardized evaluation adopting both objective and subjective assessments was developed to assess the scar conditions before the intervention and 2, 4, and 6 months after the implementations of the four intervention regimes. The spectroradiometer and the Tissue Ultrasound Palpation System (TUPS) were used to measure the scar color and thickness, respectively, in an objective manner. These instruments were validated to measure the scar tissues.<sup>26–28</sup> The Vancouver Scar Scale was used to measure the pliability of the scar,<sup>29</sup> and the Visual Analog Scale (10-level scale) was applied to indicate the pain and itchiness as perceived by the subjects. During the measurements, the raters were also blinded to each subject's intervention regime. In addition, all subjects were interviewed after the completion of the intervention regime regarding the effect of intervention on the scar tissues. It will be reported in a descriptive method.

### Statistical Analysis

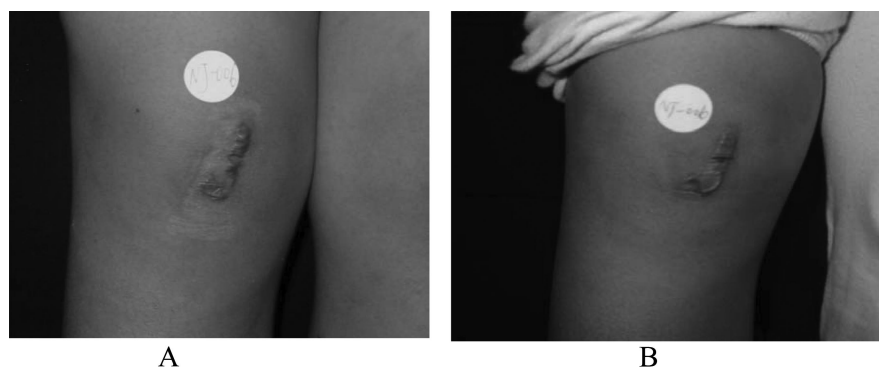
All data obtained at different treatment period, including 1) the scar thickness measured by the TUPS,

2) the color parameters (lightness, redness, and yellowness) measured by the spectroradiometer, 3) the pliability score by Vancouver Scar Scale, and 4) the score of pain and itchiness by Visual Analog Scale, were analyzed using the SPSS version 14.0 (SPSS, Inc., an IBM Company, Chicago, IL). Normalization was made for the color parameters using the following equation:

Percentage change of color parameter

$$= \frac{\text{Difference between hypertrophic scar and adjacent normal skin} \times 100\%}{\text{Adjacent normal skin}}$$

Two-way repeated analysis of variance was used to investigate the change among the four groups throughout the treatment period. As there was a 19.23% drop-out rate, a mixed model was used for analysis. The data collected at 2, 4, and 6 months after treatment were analyzed to observe the differences between and within group over 6 months. Tukey's post hoc comparison analysis was conducted to observe the differences between two groups or more. To protect against type I error, Bonferroni correction was needed for adjustment of significance level ( $0.05/10 = 0.005$ ).



**Figure 2.** An example of scar in silicone gel sheeting group at (A) initial assessment and (B) 6-month follow-up.



**Figure 3.** An example of scar in combined therapy group at (A) initial assessment and (B) 6-month follow-up.

## RESULTS

### Demographic Data

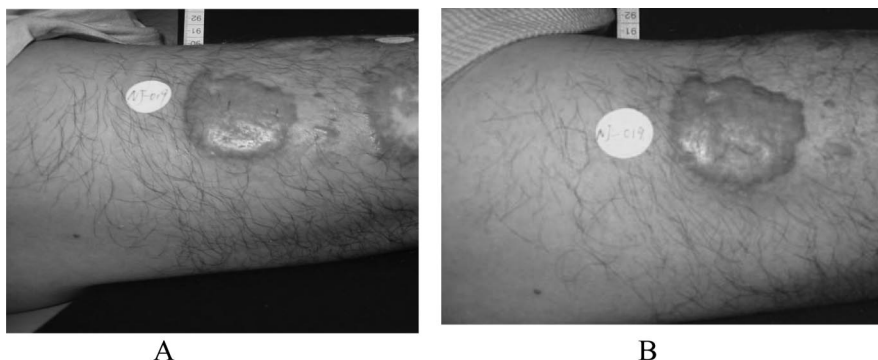
A total of 104 subjects were successfully recruited (63 men and 41 women) with a mean age of  $21.8 \pm 18.7$  years. They had developed HS on the upper limbs (44.2%), lower limbs (28.8%), or other areas (26.9%). Most of the scars were caused by scald (32.7%) or thermal burns (25%), followed by traumatic injuries (18.3%), chemical burns (10.6%), and other injuries. The mean period since injury was  $14.9 \pm 30.8$  months. Because of the practical reasons such as living far away from the city, only 84 participants completed all assessments with a high final drop-out rate (19.23%), with most of the absentees from the CG (final  $n=12, 26, 22,$  and  $24$  for CG, PT, SGS, and CTG, respectively).

Figures 1 to 4 show an example of scar at initial assessment and 6 months follow-up for different groups, respectively. It was obvious that the three treatments resulted in positive effect while the scar appeared to have changed little in the CG. The measurements of parameters also revealed that the treatments improved the scars and accelerated their

maturation process with the combined therapy tending to have the best performance.

### Scar Thickness

Table 1 shows the scar thickness change across time for the different groups. As demonstrated in Figure 5, it was obvious that CG changed the least in comparison with the three treatment groups. For the scar thickness improvement among the three treatment groups, statistical analysis revealed no significant differences ( $F(3,242) = 2.47, P = .066$ ). There was an interaction effect in two-way repeated analysis of variance in a mixed model ( $F(9,242) = 3.49, P < .0001$ ). The CTG group showed its effect on scar thickness since the second month ( $F(1,242) = 20.02, P < .001$ ), and the continuous improvement was observed at the fourth month ( $F(1,242) = 14.84, P < .001$ ) and sixth month assessments ( $F(1,242) = 24.78, P < .001$ ) when compared with the CG group. Conversely, the scars in PG group showed a significant improvement at sixth month assessment ( $F(1,242) = 11.45, P < .001$ ), and there was no statistical difference in thickness for the SGS group.



**Figure 4.** An example of scar in control group at (A) initial assessment and (B) 6-month follow-up.

**Table 1.** Scar thickness in millimeter measured by TUPS over 6 months of treatment and at 1-month follow-up

	0 mo	2 mo	4 mo	6 mo	Follow-Up
CG	6.20 ± 1.98	5.39 ± 1.70	5.77 ± 1.44	5.44 ± 1.21	6.7 ± 2.76
PT	6.07 ± 2.70	5.69 ± 2.27	5.48 ± 2.34	5.15 ± 2.01	4.49 ± 1.59
SGS	5.76 ± 1.68	5.28 ± 1.56	4.90 ± 1.13	4.61 ± 0.84	4.25 ± 0.95
CTG	6.39 ± 2.31	4.91 ± 1.26	4.72 ± 1.38	4.63 ± 1.20	4.02 ± 0.98

CG, control group; PT, pressure therapy group; SGS, silicone gel sheeting group; CTG, combined therapy group; TUPS, tissue ultrasound palpation system.

## Scar Pigmentation

The scar pigmentation as measured by the spectrophotometer in terms of lightness, redness, and yellowness across the treatment period for the four groups is shown in Table 2, whereas the corresponding percentage change in comparison with the normal skin is demonstrated in Figures 6 to 8. All the four treatment protocols seemed to have a similar effect on the pigmentation of scar tissues. Except redness, all subjects did show improvements of scar pigmentation in terms of lightness ( $F(3,242) = 22.85$ ,  $P = .332$ ) and yellowness ( $F(3,242) = 8.76$ ,  $P < .001$ ) across 6 months of treatment. All the scars at fourth month (mean difference =  $4.60 \pm 1.32\%$ ,  $P = .001$ ) and sixth month (mean difference =  $7.21 \pm 1.30\%$ ,  $P < .001$ ) were lighter than those in the initial assessment. However, statistical analysis revealed that for all scars, the significant improvements occurred only after 6 months of treatment ( $F(3,242) = 22.95$ ,  $P < .001$ ). The scars at 6-month time were significantly lighter than at the 2-month time postinitial treatment (mean difference =  $4.69 \pm 1.35\%$ ,  $P = .001$ ). The scars in the CTG group seemed to have a greater improvement compared with those in the other groups.

For the yellowness, all scars were more yellowish after 2 months (mean difference =  $8.76 \pm 3.25\%$ ,  $P < .001$ )

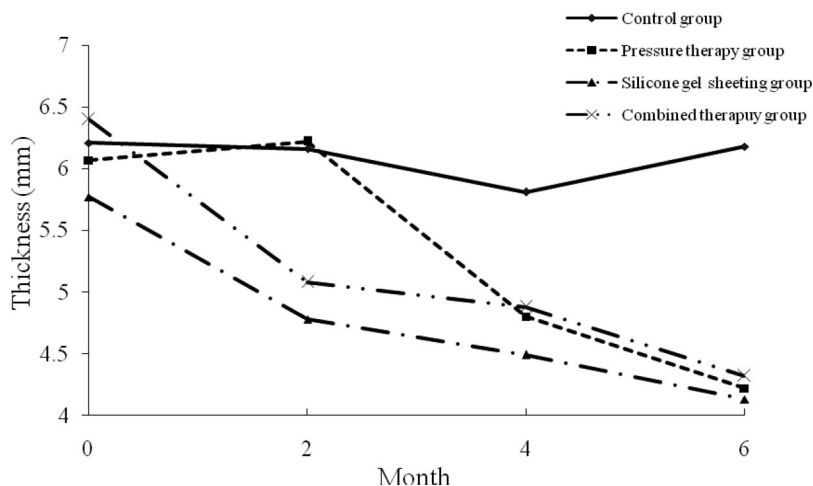
and 6 months (mean difference =  $14.36 \pm 3.13\%$ ,  $P < .001$ ). The scars in CTG group were significantly more yellowish than those in CG at 4-month posttreatment test ( $F(1,242) = 3.82$ ,  $P = .01$ ).

## Scar Pliability

As shown in Table 3, across the 6-month treatment period, all the scars in different groups showed an improvement in pliability ( $F(3,242) = 37.21$ ,  $P < .001$ ). The significant improvement was observed in 2-month ( $P = .0023$ ), 4-month ( $P < .001$ ), 6-month ( $P < .001$ ) postinitial treatment. The scars in the CTG group were found to be significantly softer than those in the CG group at after 2-month ( $F(1,242) = 9.12$ ,  $P = .002$ ) and 4-month assessments ( $F(1,242) = 15.87$ ,  $P < .0001$ ; Figure 9).

## Pain and Pruritus

The pain and pruritus level as reported by the subjects across the treatment time is also shown in Table 3. Although initial pain for all the participants seemed not so severe, their subjective rating showed that there was a great improvement in pain across time. The pain was alleviated statistically significant along the 6-month intervention ( $F(3,157) = 5.17$ ,  $P = .002$ ) and for the three



**Figure 5.** The change of scar thickness among the four groups across the 6-month treatment.

**Table 2.** The pigmentation of the scars measured by spectrophotometer over 6 months of treatment and at 1-month follow-up for different groups

	0 mo	2 mo	4 mo	6 mo	Follow-Up
<b>Lightness</b>					
CG	45.8 ± 4.27	47.0 ± 5.73	47.0 ± 4.07	47.5 ± 4.71	48.0 ± 5.07
PT	46.5 ± 3.86	47.4 ± 5.95	47.9 ± 5.47	49.7 ± 5.17	51.5 ± 5.33
SGS	45.6 ± 2.73	45.9 ± 3.45	47.0 ± 4.17	48.8 ± 5.25	49.5 ± 4.30
CTG	47.3 ± 4.91	47.6 ± 5.44	49.2 ± 4.47	49.8 ± 4.94	51.6 ± 3.77
<b>Redness</b>					
CG	8.13 ± 1.49	7.12 ± 2.20	6.91 ± 1.71	6.65 ± 2.05	7.96 ± 1.78
PT	8.56 ± 2.09	7.61 ± 2.05	7.76 ± 1.66	7.94 ± 1.78	7.05 ± 1.65
SGS	9.33 ± 2.77	9.67 ± 1.31	8.94 ± 1.62	8.49 ± 1.95	8.35 ± 1.99
CTG	8.49 ± 2.30	8.18 ± 1.69	8.25 ± 2.23	7.31 ± 2.21	7.07 ± 1.53
<b>Yellowness</b>					
CG	8.59 ± 2.54	7.76 ± 3.63	9.08 ± 3.14	7.86 ± 2.85	9.63 ± 2.45
PT	9.65 ± 2.78	9.65 ± 3.67	10.30 ± 2.88	11.10 ± 2.86	11.80 ± 2.45
SGS	9.95 ± 2.67	10.70 ± 2.98	11.30 ± 3.17	10.60 ± 2.86	11.80 ± 3.50
CTG	10.2 ± 2.71	10.30 ± 2.23	10.10 ± 3.18	11.10 ± 2.74	12.40 ± 2.77

CG, control group; PT, pressure therapy group; SGS, silicone gel sheeting group; CTG, combined therapy group.

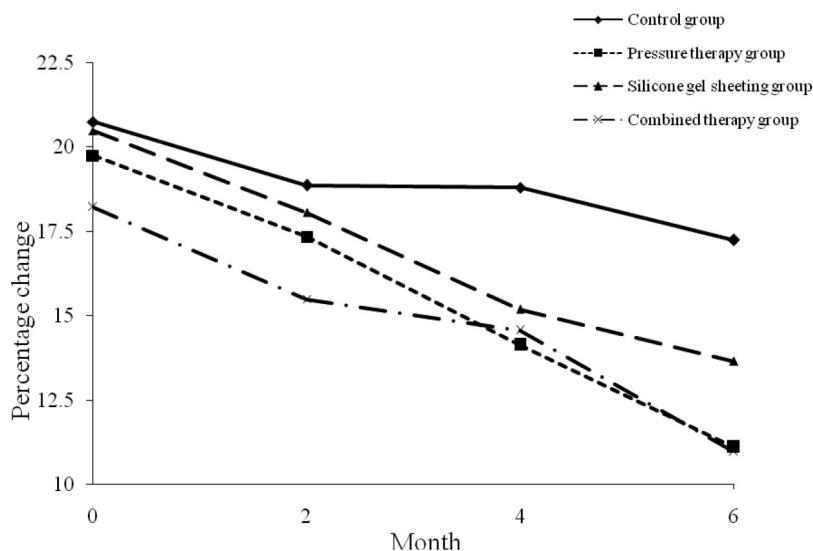
treatment groups ( $F(3, 77.81) = 3.68, P = .016$ ). The subjects reported significantly less pain after 6-month time ( $P = .05$ ). Combined therapy ( $P = .004$ ) and silicone gel dressing intervention ( $P = .001$ ) were both found to have a significant effect on pain in comparison with the control.

Pruritus level was found to decrease across the 6-month treatment for all the groups ( $F(3, 157) = 16.30, P < .001$ ) when compared with the initial assessment. SGS seemed to have better performance in alleviating itching; however, statistical analysis revealed no significant difference among the groups ( $F(3, 77.12) = 2.29, P = .09$ ). All subjects

reported that the scars became less itchy at the 4-month ( $P = .034$ ) and 6-month postinitial treatment ( $P < .001$ ).

## DISCUSSION

As the prevalence rate of HS among the Chinese population was high<sup>9</sup> and without effective treatment, the complications might occur, which may require surgical or other medical interventions. Conservative treatments including PG and silicone gel are commonly used methods in practice; unfortunately, their clinical effect remains questionable because of inade-



**Figure 6.** The percentage change in lightness among the four groups over the 6-month treatment.

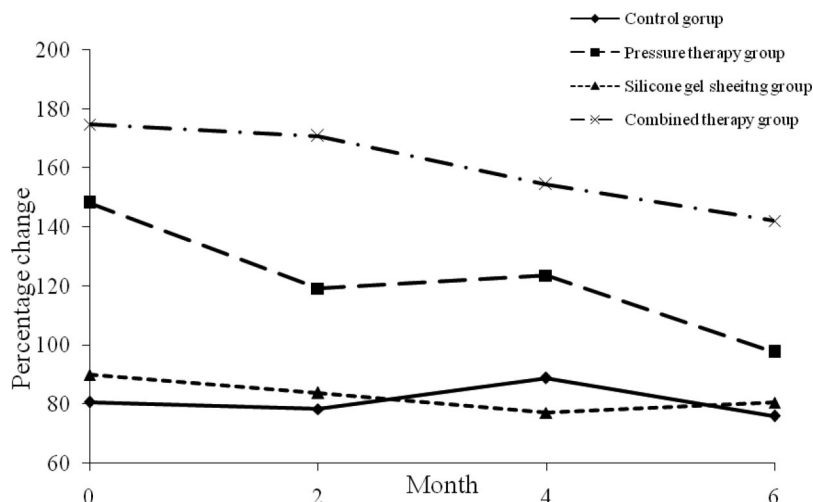


Figure 7. The percentage change in redness among the four groups over the 6-month treatment.

quate evidence from previous research studies,<sup>13,30</sup> especially in China where the management of the scars using these methods is only in emerging stage, and the extensive research on their effectiveness still lacks. Furthermore, no previous study has reportedly investigated the treatment efficacy of combined PG and SGS in scar management. Therefore, in this study, a randomized clinical trial was designed to find out the effect of PG, silicone gel, and their combined effect on the management of HS. It was the first comprehensive study conducted among Chinese population.

The results showed that all the treatment modalities had positive effects on the scars in comparison with CG. The combined intervention program seemed to be more effective when compared with either the PG or the silicone gel treatment group, in reduction of scar

thickness, pliability, and pigmentation in terms of lightness and yellowness. At the 2-month intervention assessment, subjects in the CTG showed better improvement in scar thickness when compared with those in other groups, implying that combined treatment may stimulate earlier responses from the scars. Besides, the scar pliability and color were also observed to be improved in the CTG after 4 months of intervention.

In alleviating pain and pruritus, both combined therapy and silicone gel dressing performed better than the other treatments. The results further affirmed the effect of combined PG and SGS accelerated the scar maturation process.

Previous studies have postulated that PG results in improvements in scar thickness and pliability through the mechanisms of 1) reducing local blood flow to

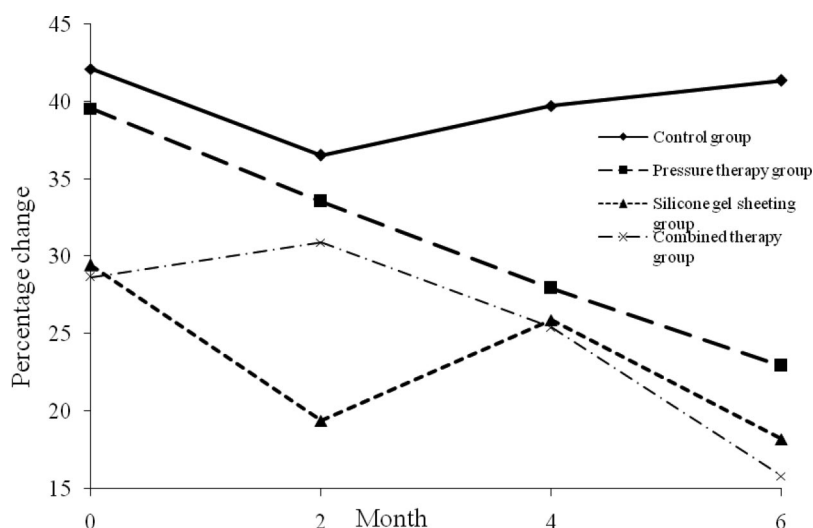


Figure 8. The percentage change in yellowness among the four groups over the 6-month treatment.

**Table 3.** The pliability measured by Vancouver Scar Scale, and pain and pruritus measured by the Visual Analog Scale over 6 months of treatment and at 1-month follow-up among different groups

	0 mo	2 mo	4 mo	6 mo	Follow-Up
<b>Pliability</b>					
CG	2.95 ± 0.80	2.76 ± 0.72	2.88 ± 0.69	2.66 ± 0.88	2.91 ± 0.79
PT	3.26 ± 0.78	2.92 ± 0.93	2.76 ± 0.95	2.68 ± 0.94	2.30 ± 0.97
SGS	3.16 ± 0.81	2.87 ± 0.67	2.59 ± 0.85	2.28 ± 0.78	1.95 ± 0.78
CTG	2.82 ± 0.80	2.74 ± 0.85	2.62 ± 0.71	2.52 ± 0.73	2.12 ± 0.74
<b>Pain</b>					
CG	1.42 ± 2.47	0.41 ± 0.90	1.25 ± 1.77	1.54 ± 2.20	1.36 ± 1.74
PT	2.28 ± 0.78	2 ± 2.69	2.09 ± 2.66	2.70 ± 3.16	2 ± 2.79
SGS	1.61 ± 2.26	1.19 ± 2.06	0.78 ± 1.18	0.84 ± 1.64	0.10 ± 0.45
CTG	1.88 ± 2.34	1 ± 1.69	0.64 ± 1.44	0.46 ± 1.19	0.33 ± 1.04
<b>Pruritus</b>					
CG	4.47 ± 2.45	3.66 ± 2.80	3.68 ± 2.79	2.09 ± 2.07	2.63 ± 1.91
PT	4.78 ± 3.35	5.5 ± 2.43	5.18 ± 2.99	5.6 ± 2.71	3.09 ± 2.34
SGS	3.61 ± 2.88	2.19 ± 2.69	2 ± 1.45	1.63 ± 1.49	1.05 ± 1.31
CTG	4.35 ± 3.01	4.33 ± 2.38	3 ± 3.32	3.23 ± 3.65	1.86 ± 3.09

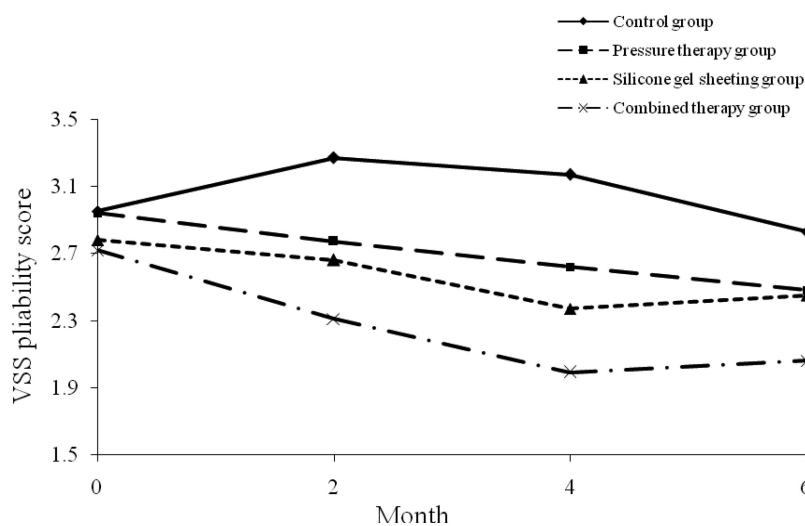
CG, control group; PT, pressure therapy group; SGS, silicone gel sheeting group; CTG, combined therapy group.

lower the fibroblasts activity; 2) promoting more collagenase secretion to dissolve scar fibers. From our results, it was found that there was a decrease in redness measured in both PG and CTG groups during the course of intervention although the effect was insignificant. Previous studies also reported that the redness of the scar was highly correlated with the microvasculature.<sup>15,31,32</sup> The reduction of redness may indicate the decrease of microcirculation on the scar tissues, thus reducing the scar thickness. The decrease of redness was not observed in the SGS or CG group.

The pain level was similar among the three treatment groups (PT, SGS, and CTG) on the completion

of the intervention program. However, when compared with the CG, it seemed that pain was more persistent among the subjects in the CG. This might be due to the proliferation of scar tissues causing skin contracture and pain.

The level of pruritus was decreased over 6-month time for all the groups, but a lower level of pruritus was noted in both SGS and CTG groups. This may indicate that silicone gel might be more effective in relieving itchiness when compared with PG. The hydration and lubrication effect of the silicone gel sheet may explain its positive effect on reduction of pain and pruritus. Moreover, in the summer months, prolonged wear of pressure garment might affect the skin



**Figure 9.** The pliability value among the four groups over the 6-month treatment.

perspiration and, thus, create pruritus. The similar finding was reported in the study by Eishi et al,<sup>33</sup> where pain and pruritus were also found diminished after silicone gel application.

Scar pigmentation did not seem to show any improvement from the four groups of subjects based on the measurement using the spectrophotometer. All scars looked paler, and only subjects in the CTG group demonstrated an improvement in scar yellowness after 6 months. There seems little correlation of pressure intervention and silicone gel intervention on scar pigmentation. More investigations are needed to explore the mechanism of scar color changes during its maturation process.

The subjects in the single intervention (PG or silicone gel) and combined intervention groups showed positive responses to the intervention program. It further affirms the efficacy of PG in combination of silicone gel on control of scar thickness, pliability, pain, and pruritus.

Subjective feedback from patients also reported positive responses toward the intervention protocol. However, there were also comments that the combined group might find it hard to put on the silicone gel and then apply the pressure garment. They reported that the silicone gel may be displaced while pulling up the garment. The adhesive properties of the silicone gel were easily destroyed after a few days of wear. Further studies should take note of the technical challenges in applying both silicone gel sheet and pressure garment.

## LIMITATIONS

This study had some limitations. First, more subjects declined to show up for the follow-up assessments throughout the 6-month treatment period, causing a relative high drop-out rate (19.23%). To reduce its statistical impact on the results, a mixed model had been used to analyze the data. As some subjects live in remote rural area, it was understandable that they had difficulties in coming back to our clinic for follow-up assessments. However, it was observed that most of the absentees were from the CG, possibly implying that lanolin massage on the scar alone may not provide enough motivation for the assessment among the subjects in this group. There were more patients from the CG who lived quite far away from the hospital (30% of the CG) when compared with the treatment groups, thus some of them declined the follow-up. For those patients from other treatment groups, their motivation to return for follow-up might also be due to the needs to renew the pressure garments and to replace

new silicone gel sheets. All subjects were also waived for any treatment fees.

In addition, it is very hot in summer time in Nanjing, China; sometimes the temperature can be 40°C. Possibly because of this, some subjects reflected discomfort because of prolonged pressure garment wearing during summer. Further advancement in improving pressure garment materials may help to solve this problem.

Because the intervention protocol only lasted for 6 months, it would be better if the intervention protocol could be lengthened to over 6 months for follow-up, particularly for those with more severe scar problems. To see the maintenance effect of the treatments, after the 6-month follow-up assessment, we surveyed the scar condition and progress among the participants. No complaints for deterioration were reported.

In summary, this study investigated the effectiveness of PG and SGS in the management of postburn HS among Chinese patients. It was recommended that the combined treatment with both PG and SGS should be implemented on HS to enhance the positive treatment effect and reduce treatment duration.

## ACKNOWLEDGMENTS

We thank Mr. Law Yu Wing for his kind donation to conduct this project in the Mainland China. We also thank Smith and Nephew (HK) Company Limited for providing all the silicone gel sheeting (Cica-Care) for our study; Prof. Li Jianan, Ms. Dai Ling, Mr. Lu Peng, and Dr. Song Fan; and the rehabilitation professionals in Department of Rehabilitation Medicine of the First Affiliated Hospital of Nanjing Medical University for their effort to provide the intervention program to the patients. We also thank all patients who participated in this study.

## REFERENCES

1. The Chinese Burn Association of the Integration of Traditional and Western Medicine; available from <http://www.chinaburn.org/about/>; Internet; accessed October 12, 2006.
2. Bayat A, McGrouther DA, Ferguson MWJ. Skin scarring. *BMJ* 2003;326:88–92.
3. Beldon P. Abnormal scar formation in wound healing. *Nurs Times* 2000;96:44–5.
4. Fette A. Influence of silicone on abnormal scarring. *Plast Surg Nurs* 2006;26:87–92.
5. Baur PS, Larson DL, Stacey TR, Barratt GF, Dobrkovsky M. Ultrastructural analysis of pressure-treated human hypertrophic scars. *J Trauma* 1976;16:958–67.
6. Deitch EA, Wheelahan TM, Rose MP, Clothier J, Cotter J. Hypertrophic burn scars: analysis of variables. *J Trauma* 1983;23:895–8.
7. Ng BHP, Yu TKF. Pressure therapy for the treatment of post-burn hypertrophic scars. *Hong Kong J Occup Ther* 1985;4:9–11.

8. Esselman PC, Thombs BD, Magyar-Russell G, Fauerbach JA. Burn Rehabilitation: state of the science. *Am J Phys Med Rehabil* 2006;85:383-413.
9. Li-Tsang CWP, Lau JCM, Chan CCH. Prevalence of hypertrophic scar formation and its characteristics among the Chinese population. *Burns* 2005;31:610-6.
10. Leung KS, Cheng JCY, Ma GFY, Clark JA, Leung PC. Complications of pressure therapy for post-burn hypertrophic scars: biomechanical analysis based on 5 patients. *Burns* 1984;10:434-8.
11. Leung KS, Sher A, Clark JA, Cheng JCY, Leung PC. Microcirculation in hypertrophic scar after burn injury. *J Burn Care Rehabil* 1989;10:436-44.
12. Ward RS. Pressure therapy for the control of hypertrophic scar formation after burn injury: a history and review. *J Burn Care Rehabil* 1991;12:257-62.
13. Anzarut A, Olson J, Prabhjyot S, Rowe BH, Tredget EE. The effectiveness of pressure garment therapy for the prevention of abnormal scarring after burn injury: a meta-analysis. *J Plast Reconstr Aesthet Surg* 2009;62:77-84.
14. Zurada JM, Krieger D, Davis IC. Topical treatments for hypertrophic scars. *J Am Acad Dermatol* 2006;55:1024-31.
15. Kischer CW, Shetlar MR, Shetlar CL. Alternation of hypertrophic scars induced by mechanical pressure. *Arch Dermatol* 1975;111:60-4.
16. Macintyre L, Baird M. Pressure garments for use in the treatment of hypertrophic scars—a review of the problems associated with their use. *Burns* 2006;32:10-5.
17. Quinn KJ. Silicone gel in scar treatment. *Burns* 1987;13: S33-40.
18. Ahn ST, Manafo WW, Mustoe TA. Topical silicone gel: a new treatment for hypertrophic scars. *Surgery* 1989;106:781-7.
19. Ahn ST, Manafo WW, Mustoe TA. Topical silicone gel for the prevention of hypertrophic scars. *Arch Surg* 1991;126: 499-504.
20. Ahlering PA. Optical silastic gel sheeting for treating controlling hypertrophic and keloid scars: case study. *Dermatol Nurs* 1995;7:295-7.
21. Fulton JE. Silicone gel sheeting for the prevention and management of evolving hypertrophic and keloid scars. *Dermatol Surg* 1995;21:947-51.
22. Gold MH, Foster TD, Adair MA, Burlison K, Lewis T. Prevention of hypertrophic scars and keloids by the prophylactic use of topical silicone gel sheets following a surgical procedure in an office setting. *Dermatol Surg* 2001;27:641-4.
23. Momeni M, Hafezi F, Rahbar H, Karimi H. Effects of silicone gel on burn scars. *Burns* 2009;35:70-4.
24. Chang CC, Kuo YF, Chiu HC, Lee JL, Wong TW, Jee SH. Hydration modules the effects of keratinocytes on fibroblasts. *J Surg Res* 1995;559:705.
25. Katz BE. Silicone gel sheeting in scar therapy. *Cutis* 1995; 56:65-7.
26. Li-Tsang CWP, Lau JCM, Choi J, Chan CCH, Li J. A prospective randomized clinical trial to investigate the effect of silicon gel sheeting (Cica-Care) on post-traumatic hypertrophic scar among the Chinese population. *Burns* 2006;32: 678-83.
27. Li-Tsang CWP, Lau JCM, Liu SKY. Validation of an objective scar pigmentation measurement by using a spectrophotometer. *Burns* 2003;29:779-84.
28. Lau JCM, Li-Tsang CWP, Zheng YP. Application of tissue ultrasound palpation system (TUPS) in objective scar evaluation. *Burns* 2005;31:445-52.
29. Sullivan T, Smith J, Kermod J, McIver E, Courtemanche DJ. Rating the burn scar. *J Burn Care Rehabil* 1990;11: 256-60.
30. Mustoe TA, Cooter RD, Gold MH, Hobbs FDR, Ramelet AA, Shakespeare PG, Maurizio S, Teot L, Fiona W, Ziegler UE. International clinical recommendation scar management. *Plast Reconstr Surg* 2002;110:560-71.
31. Kischer CW, Thies AC, Chvapil M. Perivascular myofibroblasts and microvascular occlusion in hypertrophic scars and keloids. *Hum Pathol* 1982;13:819-24.
32. Clark JA, Leung KS, Cheng JCY, Leung PC. The hypertrophic scar and microcirculation properties. *Burns* 1996;22: 447-50.
33. Eishi K, Bae SJ, Ogawa F, Hamasaki Y, Shimizu K, Katayama I. Silicone gel sheets relieve pain and pruritus with clinical improvement of keloid: possible target of mast cell. *J Dermatol Treat* 2003;14:248-52.
34. Lansdown AB, Williams A. A prospective analysis of the role of silicon in wound care. *J Wound Care* 2007;16:404-7.
35. Chan KY, Lau CL, Adeeb SM, Somasundaram S, Nasir-Zahari M. A randomized, placebo-controlled, double-blind, prospective clinical trial of silicone gel in prevention of hypertrophic scar development in median sternotomy wound. *Plast Reconstr Surg* 2005;15:1013-20; discussion 1021-2.
36. Davey RB, Wallis KA, Bowering K. Adhesive contact media: our update on graft fixation and burn scar management. *Burns* 1991;17:313-9.