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Application of a Chest Compression Device Combined with Extended Self-Care for Scar Prevention in Patients After Keloid Excision Surgery

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Abstract: *Objective:* To explore the effectiveness of a chest compression device combined with extended self-care for scar prevention in patients following keloid excision surgery. *Methods:* Forty patients (36 lesions) who underwent keloid excision surgery at the Department of Plastic and Reconstructive Surgery, First Medical Center, PLA General Hospital from June 2022 to June 2024 were selected. They were randomly divided into an experimental group and a control group, with 20 patients in each group. The control group received traditional elastic garment compression therapy, while the experimental group used a chest compression device designed for scar prevention. Scar width, hypertrophy, and Vancouver Scar Scale (VSS) scores were compared between the two groups at 6 months post-operation. *Results:* There were no statistically significant differences between the two groups in terms of gender, age, disease duration, lesion area, or location ($P > 0.05$). However, VSS scores (except for pliability) in the experimental group were significantly lower than those in the control group ($P < 0.05$). *Conclusion:* The chest compression device for scar prevention is more effective than traditional elastic garments in preventing scar hypertrophy after chest wall keloid excision surgery, and it has high clinical value, making it worthy of promotion.

Keywords: Scar prevention; Compression device; Scar hypertrophy

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1. Introduction

Keloids are benign skin tumors that result from excessive growth and deposition of extracellular matrix during skin healing, leading to abnormal outcomes. The hallmark characteristic of keloids is local fibrous tissue overgrowth, which manifests as raised red or purplish nodules on the skin surface, often accompanied by itching

and pain [1,2]. Keloids can negatively affect a patient's appearance and may cause functional impairment, greatly impacting their quality of life. Surgical excision is the primary treatment for keloids, but the recurrence rate is extremely high, ranging from 45% to 100% [3,4]. The formation and progression of keloids are closely related to local tension, with higher tension increasing the likelihood of keloid development [5]. Elastic compression, a simple, safe, and low-cost physical therapy method, is widely used for the prevention and treatment of keloids. It works by applying continuous pressure to the scar surface, reducing local blood supply, inhibiting fibroblast proliferation, and collagen synthesis, thereby preventing scar hypertrophy and promoting scar maturation [6].

Currently, the most commonly used compression therapy in clinical practice is the wearing of elastic garments. However, traditional elastic garments have several limitations, such as:

(1) Uneven pressure distribution: It is difficult to precisely control the pressure distribution of elastic garments, particularly for irregularly shaped areas like the chest, leading to excessive or insufficient local pressure.

(2) Inability to adjust pressure: As the patient's chest dimensions and wound healing progress over time, adjustments to the pressure and position of the elastic garment are needed, which traditional garments cannot accommodate.

(3) Discomfort: Traditional elastic garments are made of thick materials with poor breathability, and long-term wear can lead to local skin moisture and itching, reducing patient comfort and compliance.

To address these limitations, novel chest compression devices designed for scar prevention have emerged in recent years. This study aims to investigate the effectiveness of these devices in patients after keloid excision surgery and to compare them with traditional elastic garments, providing a more effective scar prevention treatment for clinical practice.

2. Materials and methods

2.1. General information

Forty patients who underwent keloid excision surgery at the Department of Plastic and Reconstructive Surgery, First Medical Center, PLA General Hospital between June 2022 and June 2024 were selected, with a total of 36 lesions. Inclusion criteria: (1) diagnosed with keloid, meeting the diagnostic criteria for keloid; (2) clear consciousness and able to cooperate with treatment; (3) local patients who can easily return to the hospital for follow-up. Exclusion criteria: (1) patients with severe heart, brain, liver, kidney diseases, or diabetes; (2) patients unwilling to cooperate or with unstable mental status unable to cooperate with treatment.

2.2. Methods

The 40 patients meeting the inclusion criteria were randomly divided into an experimental group and a control group, with 20 patients in each group. Both groups received preoperative health education, including the formation of keloids, surgical treatment, postoperative care, and dietary guidance.

Control group: After planned drainage tube removal (3–7 days post-operation), patients began wearing medical elastic garments for compression therapy, with a daily wear time of no less than 20 hours for 6 months.

Experimental group: Patients used a chest compression device designed for scar prevention (see **Figure 1**).

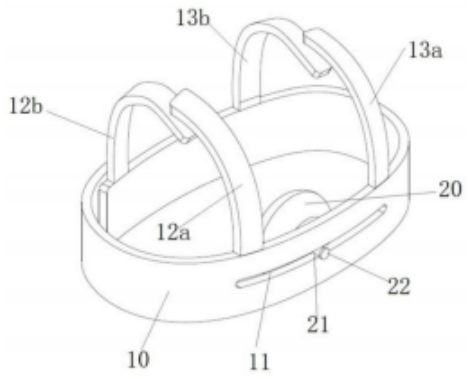

Figure 1. Chest compression device for scar prevention

The establishment of extended self-care via the Douyin platform (a popular social media platform) aimed to enhance communication and connection between healthcare professionals and patients, improving patients' care experience and satisfaction. Regular disease-related health education content was posted, such as prevention knowledge, treatment progress, and rehabilitation techniques, to improve patients' health literacy.

2.3. Observation indicators

2.3.1. Treatment effect

The treatment effects of the two groups were analyzed and compared as follows:

Effectiveness rate: Treatment effects were categorized into three types. "Good effect" refers to the complete disappearance of itching and pain symptoms, with flat scars and no recurrence within six months. "Marked effect" refers to the partial disappearance of itching and pain symptoms, with mild scar hypertrophy and scar thickness reduced by 70% to 80% as measured by 3D morphometric software [7]. "Ineffective" refers to no reduction or alleviation of itching and pain symptoms, with significant hypertrophy and no notable change in scar thickness. The effectiveness rate was calculated as (number of good effect cases + number of marked effect cases) / total number of cases × 100%.

2.3.2. Vancouver Scar Scale

Vancouver Scar Scale (VSS) includes four evaluation indicators [8]:

(1) Pigmentation assessment: skin color similar to the surrounding normal skin is scored as 0 points, lighter pigmentation as 1 point, mixed pigmentation as 2 points, and darker pigmentation as 3 points.

(2) Vascularity assessment: normal skin tone similar to other parts of the body is scored as 0 points, pink tone as 1 point, red tone as 2 points, and purple tone as 3 points.

(3) Thickness assessment: normal thickness is scored as 0 points, 0 to 1 mm as 1 point, 1 to 2 mm as 2 points, 2 to 4 mm as 3 points, and greater than 4 mm as 4 points.

(4) Pliability assessment: normal is scored as 0 points, soft as 1 point, yielding as 2 points, firm as 3 points, banding as 4 points, and contracture as 5 points. The highest possible score on this scale is 15 points, and the lowest is 0 points. The higher the score, the more severe the scar hypertrophy.

2.4. Statistical analysis

Data analysis was performed using SPSS 23.0 statistical software. Measurement data were expressed as mean ± standard deviation (SD), and comparisons between groups were made using the *t*-test. Count data were expressed as [*n* (%)], and comparisons between groups were made using the χ^2 test. A *P*-value of < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of baseline data between the two groups

There were no statistically significant differences between the two groups in terms of gender, age, disease duration, lesion area, or lesion site (P>0.05), indicating comparability (**Table 1**).

Table 1. Comparison of baseline data between the two groups

Group	Number of cases (*n*)	Gender (*n*)		Age (mean ± SD, years)	Average disease duration (mean ± SD, months)	Lesion area (mean ± SD, cm²)
		Male	Female			
Control	20	10	10	35.15 ± 5.52	6.60 ± 2.37	7.31 ± 4.11
Experimental	20	12	8	34.63 ± 6.71	6.81 ± 2.43	8.40 ± 3.74
χ^2/*t*-value		0.404		0.268	0.277	0.877
P-value		0.525		0.790	0.784	0.386

3.2. Postoperative treatment effect in the two groups

The total effectiveness rate in the experimental group was 95.00%, significantly higher than 60.00% in the control group ($\chi^2 = 5.161$, $P = 0.023$), which is statistically significant (see **Table 2**).

Table 2. Postoperative treatment effect in the two groups [*n* (%)]

Group	*n*	Good effect	Marked effect	Ineffective	Total effective rate
Control	20	9 (45.00%)	3 (15.00%)	8 (35.00%)	12 (60.00%)
Experimental	20	17 (85.00%)	2 (10.00%)	1 (5.00%)	19 (95.00%)
χ^2-value	-	-	-	-	5.161
P-value	-	-	-	-	0.023

3.3. Comparison of postoperative VSS scores between the two groups

In the experimental group, the VSS scores for pigmentation, vascularity, thickness, and total score were significantly lower than those in the control group (all $P < 0.05$), with notable differences. However, there was no statistically significant difference in pliability ($P = 0.130$) (see **Table 3**).

Table 3. Comparison of postoperative VSS scores between the two groups (mean ± SD, points)

Group	Vancouver Scare Scale (VSS)				
	Pigmentation	Vascularity	Thickness	Pliability	Total score
Control	1.71 ± 0.93	1.48 ± 0.79	2.48 ± 1.07	1.67 ± 0.96	7.34 ± 2.34
Experimental	1.10 ± 0.57	0.77 ± 0.53	1.45 ± 0.80	1.25 ± 0.74	4.57 ± 1.80
t-value	2.501	3.338	3.448	1.550	4.196
P-value	0.017	0.002	0.001	0.130	< 0.001

4. Discussion

Keloids are an abnormal repair outcome following skin damage, characterized by the excessive accumulation of extracellular matrix components, particularly collagen, and the abnormal proliferation of fibroblasts, eventually forming hard, raised scar tissue on the surface of the skin. Due to the unique anatomical structure and functional characteristics of the chest skin, it is one of the high-risk areas for keloid formation. Various types of skin damage, even minor scratches or acne, can result in noticeable scars on the chest, often accompanied by itching and pain [9]. Keloids that cross the midline of the chest are particularly prone to hypertrophy and recurrence due to the tension exerted by the skin on both sides. Some studies suggest that tension can promote fibroblast proliferation and collagen synthesis, inhibit apoptosis, and induce angiogenesis, thereby encouraging the formation and growth of pathological scars [10]. Therefore, clinical practice often employs tension-reducing measures to decrease tension in chest skin, inhibiting scar hypertrophy and preventing keloid recurrence [11]. For example, using preventive chest compression devices can apply continuous, even pressure to the chest area, effectively distributing skin tension. Compared to traditional compression garments, new compression devices can more precisely control pressure distribution, allowing for personalized adjustments in areas like the chest and scapula, ensuring treatment effectiveness while minimizing the impact on daily activities, thus improving the patient's quality of life and holding great clinical potential.

The results of this study show that, compared to traditional compression garments, preventive chest compression devices are more effective in preventing scar hypertrophy after keloid excision surgery on the chest wall. This may be attributed to the following factors:

(1) More even pressure distribution: The preventive chest compression device adopts an ergonomic design, allowing for personalized customization to ensure sustained, even pressure distribution over the scar area.

(2) Better breathability: Made from breathable materials such as mesh fabric, it keeps the scar dry and reduces the risk of infection.

(3) More comfortable to wear: The device is designed with comfort in mind, using lightweight, soft materials and adjustable straps to enhance the wearer's comfort, ensuring treatment efficacy.

(4) Easier movement: The flexible design reduces restrictions on the patient's movement, making it easier to engage in daily activities and work, thereby improving quality of life.

(5) Precise pressure control: The built-in pressure sensor enables real-time monitoring and adjustment of pressure, ensuring the scar area is always under optimal pressure, thus improving overall treatment outcomes.

5. Conclusion

In conclusion, the preventive chest compression device is more effective than traditional compression garments in preventing scar hypertrophy after chest keloid excision surgery. It offers advantages such as comfort, ease of movement, and precise pressure control, making it highly valuable for clinical application and worthy of widespread promotion.

Disclosure statement

The authors declare no conflict of interest.

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