Chapter 4

The Therapeutic Effects of Conservative Treatments on Burn Scars

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Abstract

Hypertrophic scar, which can be seen even after minor burn injuries, is a common complication and generally develops within 6–8 weeks following reepithelization. Hypertrophic scar/keloid is often seen when the injury affects the reticular dermis and, in particular, after a deep dermal or full thickness burn. There are various options used in the treatment of burn scar. The purpose of this chapter is to provide the reader a brief information on the conservative treatment methods used in burn scar treatment.

Keywords: burn injury, hypertrophic scar, keloid, burn scar, conservative treatment

1. Introduction

Animals developed a generally well-functioning pathway in the healing of damaged tissues. While some species have the ability to regenerate damaged or missing tissues, it is rare for people. Only the epidermis has full regeneration capacity, after the second trimester of fetal development, so any damage involving the dermis always heals with a scar. In humans, wounds usually heal with a normal scar, and hypertrophic scar process is not common. In some cases, the scar overcomes the original injury and results in the lesion known as keloid. Both hypertrophic scars and keloids cause a significant discomfort and malformation.

Although we believe that the word of "keloid" was first used by Aliberti in the nineteenth century, there were hypertrophic scar and keloid definitions among ancient Egypt hieroglyphs [1].

1.1. Epidemiology

Keloid and hypertrophic scars can occur all over the world and in all skin types. The risk of keloid formation increases as the skin color becomes darker, and the incidence of keloid in

the Black population was found as high as 16%. Keloid develops equally in both men and women. Although reported in all ages, it is rare in young children and elderly people. It is thought that there is a familial predisposition for hypertrophic scarring and keloid development. Although previous reports have implied an autosomal recessive inheritance pattern, an autosomal dominant transition with incomplete clinical penetrance and variable expression was considered in a recent review. Two rare syndromes involving spontaneous keloid development are Rubinstein-Taybi and Goeminne syndromes [2, 3].

1.2. Pathogenesis

The pathogenesis of hypertrophic scarring and keloid formation is unknown. In patients with hypertrophic scars and keloids, wound healing process shifts in a different direction than normal, and spontaneous involution does not generally occur. Its cause is unknown, but events such as infections, extreme wound tightness, and foreign bodies that are known to trigger for inflammation have been emphasized in the keloid development.

Melanocytes may play a role in the development of hypertrophic scar, because keloids have not been reported in patients with oculocutaneous albinism and keloids are more common in dark-skinned individuals. Mast cells are found intensely in hypertrophic scars and keloids. Mast cell mediators regulate collagen synthesis and are known to contribute to excessive accumulation.

Transforming growth factor-B (TGF-B) appears to be another molecule that causes scarring and keloid formation, because both transforming growth factor-B (TGF-B)-1 and TGF-B-2 are produced more from fibroblasts in keloid tissue than in normal fibroblasts [1–5].

1.3. Clinical features

Hypertrophic scars and keloids have many common features. Both are rough, often painful, itchy, pink-purple lesions. The epidermis is typically flat and the dermal part of the lesion is felt hard with palpation. Hypertrophic scars and keloids are malformed and may prevent normal movement of the surrounding tissues. Hypertrophic scars and keloids may appear anywhere of body, but especially ear lobe, upper part of body, and deltoid region are more risky areas. On the other hand, keloids are rare in the middle of the face, eyelids, and genital area.

Although hypertrophic scars and keloids usually appear after a trauma, they can also develop spontaneously. Before the onset of hypertrophic scars and keloids, various skin injuries such as acne, infection, burns, and piercing can be found. Clinical findings of lesions distinguish hypertrophic scars from keloids. Although hypertrophic scars remain in the area of original damage and tend to regress progressively over time, keloids tend to slowly heal in the middle parts, but tend to invade the surrounding tissues [1, 2].

1.4. Pathology

Both hypertrophic scars and keloids have increased cellularity, vascularity, and connective tissue compared to normal skin and normal scar. Hypertrophic scars include myofibroblasts,

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small vessel walls, and nodules with fine collagen fibrils. Over time, these nodules become thinner and the collagen bands become parallel to the skin surface. Keloids are histologically characterized by large, thick collagen fibers composed of numerous, firmly attached fibrils. An ultrastructurally amorphous extracellular material surrounds the fibroblastic cells in the keloid [5].

1.5. Hypertrophic scar-keloid and burn injury

Hypertrophic scarring/keloid is often seen when the injury affects the reticular dermis and, in particular, after a deep dermal or full thickness burn.

Severe burns caused high mortality rates in the past. The development of specialized burn centers and advances in treatment options have led to more survivors of the burn victim. Due to long hospitalization periods and deprivation of daily physical activity, burn patients suffer from problems such as reduction in muscle strength, limitation of joint movements, and decrease in fitness level. Moreover, hypertrophic scarring, which can be seen even after minor burn injuries, is a common complication and generally develops within 6–8 weeks following reepithelialization. Although children are particularly susceptible to hypertrophic scarring due to the rapid nature of their cell formation, burn scars are common both in children and adults and can result in extensive skin damage [6–8].

There are many different options used in the treatment of burn scar. The purpose of this chapter is to provide the reader a brief information on the conservative treatment methods used in burn scar treatment.

2. Conservative treatments

- Pressure therapy
- Silicone gel therapy
- Hydration
- Ultrasound
- Electroacupuncture
- Onion extract
- Massage therapy
- Combined therapy

2.1. Pressure therapy

Formation of hypertrophic scar (HS) is a common undesirable consequence of trauma directing to the skin [6]. A classical scar is in red-pink or purple color, rigid, and raised and usually

together with pain and/or itchiness. Hypertrophic scar that significantly disrupts normal skin functions may lead to further restriction of daily activities [6, 7] and psychosocial troubles among the patients [8–14].

Pressure therapy is considered as the first-line treatment option in improving the appearance of hypertrophic scar and reducing the rate of maturation. The general application way of pressure therapy is pressure garments [11–13]. Pressure therapy, dating back to Ambroise Pare in the sixteenth century, is a treatment that has been used for a long time by different methods. But, the popularity of pressure therapy for hypertrophic burn scars has been increased after successful results with this therapy reported from the Shriners Galveston Burn Hospital. In 1971, burn hospital team from Galveston declared a decrease in hypertrophic scar formation rate after thermal injury with pressure therapy application [13–17].

So far, the mechanism of action of pressure therapy has remained theoretical, and the efficacy and benefits of pressure garments are still a mystery. The optimal pressure level is also still a controversial topic. Theoretically, the minimum pressure to be applied during pressure therapy should be greater than the capillary pressure, meaning that the pressure should be at least 24 mmHg or more. But, there are studies in which 5–15 mmHg pressure was applied and successful clinical results such as less itching, better appearance of the scar, and so on were observed [18]. On the other hand, it was reported that paresthesia and maceration may occur shortly after application of high levels of pressure (over 40 mmHg) [19].

It was showed in studies that application of pressure significantly decreases the thickness of hypertrophic scar and the number of surgical procedures needed for correction. It is still unclear how the pressure has reduced the scar thickness. It is claimed that the pressure provides the rearrangement of collagen fibers, decreases the development of whorled typed collagen nodules, and thus, provokes the softening of scar tissue and the reduction of its thickness [6, 11, 13]. Despite the general acceptance that pressure therapy is effective, there is no clear consensus about the minimum effective amount of pressure. Although partially good results with low pressure values (5–15 mmHg) were reported in previous studies, it is thought that the higher amount of pressure provides more reduction in scar thickness [6, 11, 19]. In their study, Candy et al. observed that high pressure (>20 to 25 mmHg) garment demonstrated its superior effects on reducing scar thickness after 5 months treatment, leading to an overall reduction of 40.05% in thickness and the most prominent improvement was observed after the first month of intervention. Although scars with low pressure treatment also showed significant improvement, for this group overall thickness reduction was 19.79% [6].

The presence of erythema has always been considered as a major marker of hypertrophic scarring after burns. It has been shown that redness is increased in scar tissues which have higher vascularity, determined using Laser Doppler from previous studies [6, 20, 21]. Parallel to this, a reduction in redness/erythema may imply a decrease of vascular flow to the scar tissues [21, 22]; meaning that, the nutrient and oxygen supply for cellular activities was reduced. Hypoxic milieu due to pressure therapy may trigger fibroblasts apoptosis process [20–23]. Although it was reported that higher pressure (>20 to 25 mmHg) values lead to reductions in erythema, the pressure must be at least 24 mmHg or higher to provide a significant reduction [6, 11].

Pressure therapy also improves the hardness of hypertrophic scar and increases pliability, but data on this topic are quite limited [13, 24]. And finally, pressure therapy (only high pressure) causes a significant improvement in pigmentation of scar tissue [6].

The most important problems with the use of pressure therapy are the long duration of treatment and need to wear pressure garment during 14–23 h/day, which reduce the patient's compliance with treatment [24].

An important point to be aware of during pressure therapy is that pressure loss of the garments over time. Pressure garments lose their elasticity over the wearing period. The reason is probably that pressure garments are usually made of spandex and nylon fabric and these materials decrease their elasticity upon prolonged wear. Pressure loss of the garments can lead to treatment failure, so the physician should be careful in this regard [6, 25].

2.2. Silicone gel

Hypertrophic scar emerges as a consequence of an excessive response of the skin to trauma. Hypertrophic scar can cause pain and itching as well as cause cosmetic problems and may restrict range of motion [26].

There is very limited evidence to show the effectiveness of treatments to reduce or prevent scar formation. Most of the available information and recommendations are based on experience of practitioners and small scale studies. Also, there are very limited scientific data on the long-term effects of these treatments. Nevertheless, treatments such as the use of intralesional corticosteroid injections, silicone sheets, occlusive dressings, and custom-made pressure garments have a general acceptance [27].

The earliest known silicone gel sheet was developed by Perkins et al. for use at 6–8 weeks after the initial injury, when the scars started to develop. Since its first use in the early 1980s, silicone gels have a wide use in burn scar treatment. Although the mechanism of how to heal burn scars is not yet fully understood, the noninvasive character of silicone gels makes them easily acceptable for patients in treatment and prophylaxis of hypertrophic scars [26–28].

Studies demonstrated the effectiveness of silicone gels in the treatment of scars, but the mechanism of how to heal scars and physiological effects of silicone gel are not yet fully understood. It is believed that silicone gels affect the stratum corneum by decreasing evaporation and providing a better hemostasis in the scar tissue. Stratum corneum on the hypertrophic scar and keloid tissue causes more evaporation of water from the underlying tissue than in normal skin. Silicone gels reduce evaporation and thus provide an optimal hydration in the stratum corneum. The silicone gels may influence the stratum corneum by inhibiting mast cell activity and reducing edema, vasodilatation, and excessive extracellular matrix synthesis, but perhaps the main mechanism of action of gels may depend on their simpler effects such as changes in temperature, oxygen, pressure, hydration, and tension produced by wound coverage. Another hypothesis is that static electricity on silicone gels may cause the re- alignment of collagen deposition [26, 27, 29–31].

In studies, different types of silicone were used, such as silicone sheets (not specified), cica-care silicone gel sheets, silastic gel sheets, Sil-K silicone, and Epiderm silicone sheets or

Dermatix topical silicone gel in diverse patient populations. Therefore, it is not easy to assess which kind of silicone gels is more effective and optimal [24].

In a prospective randomized clinical trial, the authors applied silicone gel sheeting (SGS) 24 hour per day for 6 months. In this study, subjects with 6-month silicone gel intervention showed a reduction of scar thickness measured by tissue ultrasound palpation system. The scar in the group used silicone gel was softer and more pliable as measured by The Vancouver Scar Scale and there was reduction on pain and itchiness from patients. Although the vascularity and pigmentation did not show any statistical significant difference, individuals in the SGS groups stated that the scar became less reddish, paler, and more resembled normal skin. When compared to the control group, patients in the SGS group also had faster rate of recovery from pain and itchiness, but the results at the 6-month assessment were not different between the two groups [32].

The topical silicone gel was applied twice a day and was typically worn 12–24 h a day, excluding bathing time. The duration of application varies between 12 and 28 weeks [24].

Despite the effectiveness of silicon gels, there are some limitations to their use. Patient compliance can be low when silicone gels are used on scars on visible regions, the appearance can make them less popular for the patient to use, and scar located near to joints, due to their potential restriction of movements and because gels sometimes do not stay adherent on these regions.

In addition, hygiene of gels and involved skin must be considered, especially in hot climates, to avoid irritation or rash and infections [26, 27, 32–34].

2.3. Hydration

When the wound healing reaches enough strength to tolerate skin massage, it is a routine practice to perform a scar massage with a solution that usually contains a moisturizing product [33]. Because hydrating effect of silicone gels on the stratum corneum has been suggested as a mechanism underlying its therapeutic effectiveness, many authors have reported the efficacy of treatment with topical silicone gel sheet for keloids and hypertrophic scars. Additionally, it is recommended that hydration/moisturizing of scar tissue, since transepidermal water loss rates are higher when compared to healthy skin [24, 32, 33].

Various products, including aqueous cream BP, bees wax and herbal oil creams, silicone-based creams, and paraffin/petroleum-based products, have been reported for use in practice as well as in literature on scar management [35].

Aqueous cream BP, which is fragrance and color free, is a readily available and relatively not expensive emollient production. Purified water, white soft paraffin, cetearyl alcohol and sodium lauryl sulfate (SLS), liquid paraffin, and phenoxyethanol are carried in this formulation [35].

Bees wax and herbal oil cream are the other two agents providing a greater decrease in the symptom of itch following burn injury when compared to aqueous cream BP, especially along with the use of antipruritic medications [35, 36].

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Different formulations, including silicone- and petroleum-based products (such as vaseline), are applied by burns units around the world with their selection appearing to be based on historical practice, clinical experience, and because patients have confidence in such treatments [36].

Although the need for scar tissue hydration is supported by almost all researches because of the enhanced transepidermal water loss rates compared to healthy skin, information and literature on the ideal composition of moisturizers for burn scar treatment are quite limited [24].

2.4. Ultrasound

Tissues with high collagen content such as scar tissue show a high attenuation for ultrasound energy. It has been reported that topical therapeutic ultrasound application to scar tissue causes a temperature rise in scar tissue, which provides an increase in the elasticity of collagen and thus enlarges the range of motion. It is also declared that application of topical ultrasound improves the pain seen in scars [24, 37–39].

But, in their randomized placebo controlled double blind study, with a low overall bias rating score, Ward et al. found no significant intergroup results on range of motion and pain [37].

2.5. Electroacupuncture

Cuignet et al. designed a study to observe the effects of a combination of manual (MA) and electro-acupuncture (EA) on the pain scores and on the sensory thresholds of the nociceptive pathways in patients presenting with pathological burn scars (PPBS). And, at the end of the study, they demonstrated that EA combined to MA reduces the pain scores of patients suffering from pain associated with burn scar. Using quantitative sensory testing (QST), they confirmed that the pain of PPBS comes from a peripheral hyperalgesia eliminated by E/MA. And, they also observed a significant relief of pruritus after E/MA [40].

2.6. Onion extract

It was reported that, in a study with 120 Asian patients, onion extract decreased the rate of scar formation in dark-skinned patients receiving laser treatment of tattoos, and the enhancement in width of scar after thoracic surgery was less for onion extract-treated fresh scars than in untreated scars after 1 year of treatment. On the other hand, in a side-by-side, randomized, double-blinded, split-scar study, scar cosmesis or symptomatology did not show any improvements with application of onion extract gel, when compared with standard therapy in the management of postoperative wounds [41, 42]. It is thought that the effect of onion extract therapy on decrease in scar height may increase when used with occlusive silicone dressing [43]. In a randomized controlled trial with 60 patients of median sternotomy, the combination of onion extract and silicone products was seen effective in the prevention of hypertrophic scar formation. Onion extract is also effective in burn scars. It was observed that combination of onion extract and silicone gel provided good results in 45 patients with postburn hypertrophic scar [44, 45].

2.7. Massage therapy

Hypertrophic scar development is a common complication after burn injury and the incidence is up to 77%. The existence of hypertrophic scar after a burn trauma may lead to many physical and psychological impairments, including pruritus, increased pain levels, scar contracture and limited ROM, elevated anxiety levels, and decreased health-related quality of life [46].

Massage therapy is a non-surgical conservative method that is used to reduce the negative results of hypertrophic scar after burn injuries [47]. The aim of massage therapy is to produce relaxation, reduce the pain, or improve circulation with the manipulation of the skin and underlying tissues with varying degrees of hand pressure. Classical massage consists of movements such as petrissage (kneading), effleurage (stroking and gliding), and tapotement (percussion). But, in different burn rehabilitation centers, many kinds of massage techniques are applied [47, 48].

Scar massage has various positive clinical utilities in scar management including decreased scar thickness, decreased pruritus, decreased pain and skin sensitivity, increased scar pliability and range of movement, and decreased anxiety [46].

Severe itching/pruritus is a common complication after burn injuries, especially in patients who have wounds on leg and arm, and the incidence in adult patients is up to 87%. Itching is not just itching and usually associated with disruption of daily living activities, anxiety and sleep disturbance. Pain is another common complication after burn trauma. Pain and related conditions such as depression and anxiety may influence the wound healing process and consequently adversely affects the patient's functioning. In patients who have been exposed to burn trauma, alternative or complementary treatments may be beneficial in the decrease of itching or pain, and these applications are not widely used. The research has shown that massage therapy reduces various types of pain [49].

A possible mechanism of the pain relief effect of the touch may be through the gate theory. Gate theory expresses that pain can be relieved by pressure or cold application. Since receptor fibers-related pressure and cold stimuli are larger and more myelinated, they reach the brain receptors more rapidly and close the gate before the smaller, less myelinated pain fibers reach the brain receptors. Massage therapy has been also showed to lessen anxiety and stress hormone levels in burn patients and provides an improvement in redness, pruritus, lichenification, scaling, and excoriation. Increased vagal activity, which may enhance more relaxation and decrease the peripheral vasoconstriction associated with sympathetic activity, provided by massage therapy may be the potential mechanism for reducing stress and improving other skin findings mentioned above [49].

Additionally, it is showed that massage therapy has some mechanical effects associated with an improvement in venous return and lymphatic drainage. Moreover, massage therapy stimulates movement between muscle fibers, which results in more fluid muscle movement. In their randomized controlled trial, Cho et al. reported that massage therapy affects the scar thickness, scar elasticity, scar melanin and erythema, and scar transepidermal water loss (TEWL) positively as well as reducing pain and itching [50].

In summary, findings from studies show that scar massage is effective in improving scar height, vascularity, pliability, pain, pruritus, and depression in patients with hypertrophic scarring as a result of burn injury [46–50].

2.8. Combined therapy

Among the conservative therapies, the most common options used as a combination treatment for burn scars are pressure therapy and silicone gel therapy. Since the mechanisms of action of silicone gels and pressure therapy are complementary to each other, it appeared to be evident that the combined therapy of silicone and pressure would give mixed and more effective results [24].

Pressure therapy has been used since the early 1970s as a conservative method in hypertrophic scar prevention or treatment and usually applied in the forms of garment or dressing. It was reported that pressure therapy has potential to prevent hypertrophic scar formation or limited its maturation and consequently to provide a better appearance of scars. Pressure therapy can reduce itching and pain as well as improve the appearance of scars.

Although how pressure therapy prevents the formation or maturation of hypertrophic scar has not yet been fully elucidated, the pressure caused by the pressure garments which is thought to reduce blood flow, oxygen, and nutrient support to the scar tissue can diminish collagen synthesis. Because of the mechanical load effect of the pressure therapy on the scar zone also leads to the rearrangement of the collagen fibers, thickness of scar tends to reduce and scar tissue becomes more pliable [18, 22, 24].

Silicone gels have been used as a conservative method in the treatment of hypertrophic scar since 1980. It is thought that silicone gels diminish evaporation, provide a better homeostasis, reduce edema and vasodilatation, inhibit activity of mast cells, prevent excessive extracellular matrix formation, form a pressure on scar zone, and hydrate the scar tissue [26, 51].

In some previous studies, it was showed that combination of pressure therapy and silicone gel therapy is more effective in reduction of scar thickness, pliability, pigmentation, pain, and pruritus than the use of these treatments alone. Furthermore, it was reported that combination therapy provided an earlier response to these scar parameters. On the other hand, in some other studies, no significant different results were found between combination and non-combination groups [51, 52].

The general view is that combined treatment with both pressure therapy and silicone gels should be implemented on hypertrophic scar to enhance the effectiveness of treatments and reduce the duration needed for treatment [51].

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References

[1] Alhady SM, Sivanantharajah K. Keloids in various races. A review of 175 cases. Plastic and Reconstructive Surgery. 1969;**44**(6):564-566

[2] Niessen FB, Spauwen PH, Schalkwijk J, Kon M. On the nature of hypertrophic scars and keloids: A review. Plastic and Reconstructive Surgery. 1999;**104**(5):1435-1458

[3] Marneros AG, Norris JE, Olsen BR, Reichenberger E. Clinical genetics of familial keloids. Archives of Dermatology. 2001;**137**(11):1429-1434

[4] Smith P, Mosiello G, Deluca L, Ko F, Maggi S, Robson MC. TGF-beta2 activates proliferative scar fibroblasts. The Journal of Surgical Research. 1999;**82**(2):319-323

[5] Ehrlich HP, Desmoulière A, Diegelmann RF, Cohen IK, Compton CC, Garner WL, Kapanci Y, Gabbiani G. Morphological and immunochemical differences between keloid and hypertrophic scar. The American Journal of Pathology. 1994;**145**(1):105-113

[6] Candy LH, Cecilia LT, Ping ZY. Effect of different pressure magnitudes on hypertrophic scar in a Chinese population. Burns. 2010;**36**(8):1234-1241

[7] Armour A, Scott GP, Tredget EE. Cellular and molecular pathology of HTS: Basis for treatment. Wound Repair and Regeneration. 2000;**15**:6-17

[8] Tejero-Trujeque R. How do fibroblasts interact with the extracellular matrix in wound contraction? Journal of Wound Care. 2000;**10**:237-242

[9] Leblebici MHF, Akman M, Noyan T, Tarim A, Bagis S, Adam M. Quality of life after burn injury: The impact of joint contracture. Burns. 2007;**33**:47

[10] Rumsey N, White P. Exploring the psychosocial concerns of out-patients with disfiguring conditions. Journal of Wound Care. 2003;**12**:247-252

[11] Van den Kerckhove E, Stappaerts K, Fieuws S, Laperre J, Massage P, Flour M, Boeckx W. The assessment of erythema and thickness on burn related scars during pressure garmenttherapy as preventive measure for hypertrophic scarring. Burns. 2005;**31**(6):696-702

[12] The Scar Information Service. What is a scar? Available from: http://www.scarinfo.org [Retrieved September 4, 2007]

[13] Engrav LH, Heimbach DM, Rivara FP, Moore ML, Wang J, Carrougher GJ, Costa B, Numhom S, Calderon J, Gibran NS. 12-year within-wound study of the effectiveness of custom pressure garment therapy. Burns. 2010;**36**(7):975-983

[14] Staley MJ, Richard RL. Use of pressure to treat hypertrophic burn scars. Advances in Wound Care. 1997;**10**:44

[15] Linares HA, Larson DL, Willis-Galstaun BA. Historical notes on the use of pressure in the treatment of hypertrophic scars or keloids. Burns. 1993;**19**(1):17-21

[16] Lawrence H. Keloid (alibert) and intractable patches of chronic inflammation of the skin treated by scarification. British Medical Journal. 1898;**1**:151

[17] Larson DL, Abston S, Evans EB, Dobrkovsky M, Linares HA. Techniques for decreasing scar formation and contractures in the burned patient. The Journal of Trauma. 1971;**11**(10):807-823

[18] Ward RS. Pressure therapy for the control of hypertrophic scar formation after burn injury. The Journal of Burn Care & Rehabilitation. 1991;**12**:257-262

[19] Naismith RS. Hypertrophic scar therapy: pressure-induced remodeling and its determinants [PhD thesis]. Glasgow: University of Strathclyde; 1980

[20] Costa MAA, Peyrol S, Porto C, Comparin JPL, Foyatier LJ, Desmouliere A. Mechanical forces induce scar remodeling. American Journal of Pathology. 1999;**155**:1671-1679

[21] Hosoda GH, Holloway GA, Heimbach DM. Laser doppler flowmetry for the early detection of hypertrophic burn scars. Journal of Burn Care and Rehabilitation. 1986;**7**:496-497

[22] Leung KS, Sher A, Clark JA, Cheng CYJ, Leung PC. Microcirculation in hypertrophic scar after burn injury. Journal of Burn Care and Rehabilitation. 1989;**10**:436-444

[23] Clark JA, Leung KS, Cheng JCY, Leung PC. The hypertrophic scar and microcirculation properties. Burns. 1996;**22**:447-450

[24] Anthonissen M, Daly D, Janssens T, Van den Kerckhove E. The effects of conservative treatments on burn scars: A systematic review. Burns. 2016;**42**(3):508-518

[25] Ng SFF. Medical clothing: The stress relaxation and shrinkage of pressure garments. International Journal of Clothing Science and Technology. 1994;**6**:17-27

[26] Momeni M, Hafezi F, Rahbar H, Karimi H. Effects of silicone gel on burn scars. Burns. 2009;**35**(1):70-74

[27] Van der Wal M, van Zuijlen P, van de Ven P, Middelkoop E. Topical silicone gel versus placebo in promoting the maturation of burn scars: A randomized controlled trial. Plastic and Reconstructive Surgery 2010;**126**:524-531

[28] Perkins K, Davey RB, Wallis KA. Silicone gel: A new treatment for burn scars and contractures. Burns, Including Thermal Injury. 1983;**9**:201-204

[29] Glenn LW. The plastic surgery educational foundation DATA committee. Silicone gel sheeting. Plastic and Reconstructive Surgery. 2001;**107**:272-275

[30] Musgrave MA, Umraw N, Gomez M, Cartotto RC. The effect of silicone gel sheets on perfusion of hypertrophic burn scars. The Journal of Burn Care & Rehabilitation. 2002;**23**:208-214

[31] Gilman TH. Silicone sheet for treatment and prevention of hypertrophic scar: A new proposal for the mechanism of efficacy. Wound Repair and Regeneration. 2003;**11**:235-236

[32] Li-Tsang CW, Lau JC, Choi J, Chan CC, Jianan L. A prospective randomized clinical trial to investigate the effect of silicone gel sheeting (Cica-care) on post-traumatic hypertrophic scar among the Chinese population. Burns. 2006;**32**(6):678-683

[33] Serghiou MA, Ott S, Farmer S, Morgan D, Gibson P, Suman OE. Comprehensive rehabilitation of the burn patient. In: Herndon D. Total Burn Care. Third ed. Philadelphia: Saunders, Elsevier Inc; 2007

[34] Suetake T, Sasai S, Zhen Y, Tagami H. Effects of silicone gel sheet on the stratum corneum hydration. British Journal of Plastic Surgery. 2000;**53**:503-507

[35] Lewis PA, Wright K, Webster A, Steer M, Rudd M, Doubrovsky A, et al. A randomized controlled pilot study comparing aqueous cream with a beeswax and herbal oil cream in the provision of relief from postburn pruritus. Journal of Burn Care & Research: Official Publication of the American Burn Association. 2012;**33**(4):e195-e200

[36] Klotz T, Kurmis R, Munn Z, Heath K, Greenwood JE. The effectiveness of moisturizers for the management of burn scars following severe burn injury: A systematic review protocol. JBI Database of Systematic Reviews and Implementation Reports. 2014;**12**:212-220

[37] Ward R, Hayes-Lundy C, Reddy R, Brockway C, Mills PJRS. Evaluation of topical therapeutic ultrasound to improve response to physical therapy and less scar contracture after burn injury. The Journal of Burn Care & Rehabilitation. 1994;**15**:74-79

[38] Bierman W. Ultrasound in the treatment of scars. Archives of Physical Medicine and Rehabilitation. 1954;**35**(4):209-214

[39] Gersten JW. Effect of ultrasound on tendon extensibility. American Journal of Physical Medicine. 1955;**34**(2):362-369

[40] Cuignet O, Pirlot A, Ortiz S, Rose T. The effects of electroacupuncture on analgesia and peripheral sensory thresholds in patientswith burn scar pain. Burns. 2015;**41**(6):1298-1305

[41] Chung VQ, Kelley L, Marra D, Jiang SB. Onion extract gel versus petrolatum emollient on new surgical scars: Prospective double-blinded study. Dermatologic Surgery. 2006;**32**:193-197

[42] Ho WS, Ying SY, Chan PC, Chan HH. Use of onion extract, heparin, allantoin gel in prevention of scarring in Chinese patients having laser removal of tattoos: A prospective randomized controlled trial. Dermatologic Surgery. 2006;**32**:891-896

[43] Hosnuter M, Payasli C, Isikdemir A, Tekerekoglu B. The effects of onion extract on hypertrophic and keloid scars. Journal of Wound Care. 2007;**16**:251-254

[44] Karagoz H, Yuksel F, Ulkur E, Evinc R. Comparison of efficacy of silicone gel, silicone gel sheeting, and topical onion extract including heparin and allantoin for the treatment of postburn hypertrophic scars. Burns. 2009;**35**:1097-1103

[45] Jeenwitheesuk K, Surakunprapha P, Jenwitheesuk K, et al. Role of silicone derivative plus onion gel extract in presternal hypertrophic scar protection: A prospective randomized,

double-blinded, controlled trial. International Wound Journal. 2012;**9**:397-402. E-published ahead of print December 14, 2011

[46] Ault P, Plaza A, Paratz J. Scar massage for hypertrophic burns scarring-systematic review. Burns. 2017 pii: S0305-4179(17)30296-6

[47] Roques C. Massage applied to scars. Wound Repair and Regeneration. 2002;**10**(2):126-128

[48] Roh YS, Cho H, Oh JO, Yoon CJ. Effects of skin rehabilitation massage therapy on pruritus, skin status, and depression in burn survivors. Taehan Kanho Hakhoe Chi. 2007;**37**(2):221-226

[49] Field T, Peck M, Hernandez-Reif M, Krugman S, Burman I, Ozment-Schenck L. Postburn itching, pain and psychological symptoms are reduced with massage therapy. The Journal of Burn Care & Rehabilitation. 2000;**21**:189-193

[50] Cho YS, Jeon JH, Hong A, Yang HT, Yim H, Cho YS, et al. The effect of burn rehabilitation massage therapy on hypertrophic scar after burn: A randomized controlled trial. Burns. 2014 Dec;**40**(8):1513-1520

[51] Li-Tsang CWP, Zheng YP, Lau JC. A randomized clinical trial to study the effect of silicone gel dressing and pressure therapy on posttraumatic hypertrophic scars. Journal of Burn Care & Research. 2010;**31**:448-457

[52] Harte D, Gordon J, Shaw M, Stinson M, Porter-Armstrong A. The use of pressure and silicone in hypertrophic scar management in burns patients: A pilot randomized controlled trial. Journal of Burn Care & Research. 2009;**30**:632-642

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