Scars: Prevention, Correction, and Reduction

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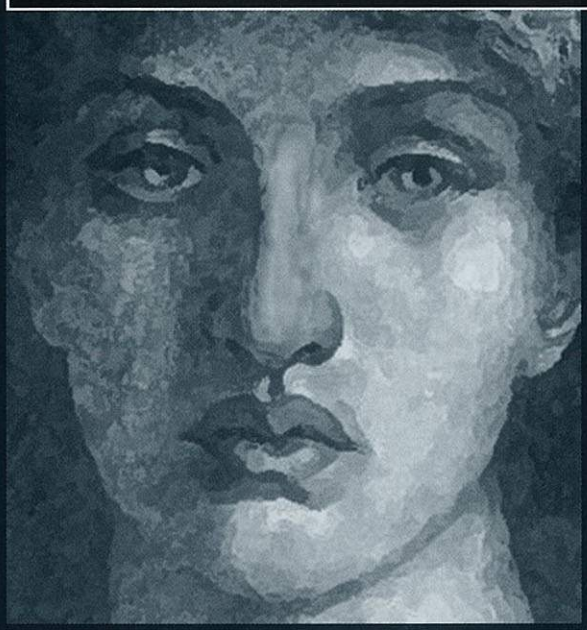

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Scars: Clinical Evidence Base and Patient Impact

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Guest Editor

As Facial Plastic Surgeons, we are trained to evaluate scars in terms of clinical variables. Are they flat? Are they wide? Are they in parallel to relaxed skin tension lines? For many patients, though, the potential impact of scars is far greater than simple, measurable assessments, and that effect is much more difficult to assess.

As an example from my own life, I have had a premalignant lesion removed from my cheek. I left the dermatologist's office with a small circular bandage over the repair site. While this adhesive bandage was probably no more than one inch in diameter, I still remember being stared at by complete strangers in the halls of the hospital, each of them seeming to wonder, "What happened to him?" I was experiencing firsthand how the treatment of this small facial lesion was altering the way in which I normally interacted with other people. This admittedly minor experience nevertheless gave me pause and has helped me to have better empathy for all facial reconstruction patients.

At times, doctors may forget the profound impact a facial scar can have on a patient's self-perception. I have treated a patient with 70% burns from mining slag who seemed to be unaffected by what any casual observer would consider a completely disfiguring facial injury. I have also treated a very attractive 55-year-old female who had lost nearly half her nose and underwent a near-flawless reconstruction with a paramedian forehead flap. For this woman, however, her experience with facial scarring marked the beginning of her life into a downward spiral. For her, no longer being "perfectly" beautiful was too great a burden to bear. She lost her family and her career as a result of depression and feeling incapable of interacting in public. While most people would say she had an excellent surgical result, for her, things would never be the same.

I thank each author for their excellent contributions to this *Facial Plastic Surgery Clinics of North America*. The information within this volume should help each of us to improve our techniques, to follow guidelines established by evidenced-based literature, and, in the final result, to relieve both the physical and the psychosocial burdens of facial scars. As a patient with significant facial scarring once wrote me, "My bark is much worse than my bite. Don't be frightened by first impressions—In my heart I truly am smiling."

As Facial Plastic Surgeons, we must remember that each patient we care for can, and will, have a different reaction to facial scarring. I hope that the articles contained within this *Facial Plastic Surgery Clinics* review will bestow some new knowledge on surgeons across the country. If just one surgeon is able to improve his or her practice by implementing a few of the "pearls" included here, then the efforts and contributions of the authors of this volume will have been worth it.

Topical Modalities for Treatment and Prevention of Postsurgical Hypertrophic Scars

KEYWORDS

• Topical treatment scar • Hypertrophic scar • Vitamin E
• Onion extract • Silicone gel sheets • Imiquimod
• Massage • Pressure garments

Key Points

- There is no single, optimal topical modality that can eliminate or prevent hypertrophic scars.
- Silicone gel sheeting (SGS) remains the most accepted modality in the treatment and prevention of hypertrophic scar.
- Onion extract and vitamin E have not been shown to consistently improve scar appearance as single agents.
- Topical imiquimod 5% cream in a small study was shown to improve scarring.
- Pressure therapy is described predominantly for management of postburn scars.
- Massage therapy is a common modality in the management of scarring in patients with burns, but scientific evidence for its efficacy is limited.

Any cutaneous injury, including surgical incisions, that extends into the dermis will always heal with a scar. The wound healing process is a complex hierarchy of events centered on inflammation, cell proliferation, and remodeling. Cutaneous wounds occasionally heal with scarring that is in excess of what is considered to be a normal physiologic scar. This exuberant scarring results in hypertrophic scars and keloids. Both types of scars are raised, initially pink to purple lesions that are often painful or pruritic. Clinically, hypertrophic scars are limited to the area of original injury with a tendency toward gradual resolution in time. Keloids extend beyond the original wound margin and seldom resolve spontaneously.

Hypertrophic scars are caused by a variety of factors including mechanical forces on the healing wound (excess tension at wound edge, improper suture placement), poor wound healing, bleeding, or infections. Therapeutic modalities for the prevention and management of scars have been postulated to act by correction of abnormal collagen

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metabolism, alteration of the immune/inflammatory response, or manipulation of the mechanical properties of wound repair.[1] This article focuses on topical treatments such as SGS and ointment, onion extract, vitamin E, pressure garment therapy, massage therapy, and topical imiquimod 5% cream in the management of hypertrophic scars.

SGS

Silicone polymers are inert, mixed inorganic-organic polymers with a wide array of forms and applications. Polydimethylsiloxane is the most widely used silicon polymer, including in medical products such as SGS. The mechanism of action of SGS is uncertain, but has been postulated to be caused by hydration and occlusion,[2,3] increased oxygen tension,[4,5] and the production of a local static field,[6,7] all of which result in improved remodeling of the scar. The beneficial effects of SGS were first shown in 1983 by Perkins and colleagues[8] in patients with burn scars and contractures. In a controlled study comparing SGS and nonsilicone gel dressing, de Oliveira and colleagues[9] reported improvement in size and induration of hypertrophic scars and keloids in both groups compared with control, but there was no significant difference in results between SGS and nonsilicone gel dressing groups. This finding further suggests that the mechanism of SGS is related to hydration and occlusion.

Several studies have been reported to show clinical efficacy in the treatment of hypertrophic scars with SGS. Ahn and colleagues[10] reported clinical and elastometric improvement of hypertrophic burn scars treated with SGS for 8 weeks compared with untreated scars. The improvement in scar volume lasted up to 6 months. Momeni and colleagues[11] performed a randomized, double-blind, placebo-controlled split-scar trial involving 38 people with hypertrophic burn scars. Using the modified Vancouver Scar Scale, he showed an improvement in pigmentation, vascularity, pliability, and pruritus of treated scars after 4 months of treatment. A prospective controlled study investigating 42 patients with 47 hypertrophic scars comparing 2 types of SGS with no treatment showed improvement in scar color and induration in the treatment group.[12] However, in the study by de Oliveira and colleagues,[9] who compared SGS with nonsilicone gel sheets, there was no difference in scar size or induration between the 2 groups.

The usefulness of SGS in the prevention of scar formation has also been shown. In a prospective study of 20 women with bilateral reduction mammaplasties, patients were instructed to use SGS to 1 breast for 12 hours each day for 2 months.[13] At 2 months, 60% of the nontreated scars were hypertrophic and only 25% of the treated scars were hypertrophic ($P<.05$). Conversely, in another split-scar study of 155 women who underwent reduction mammaplasties, comparing SGS and nonocclusive Micropore (3M, Ad Leiden, The Netherlands), there were no difference in the occurrence of hypertrophic scarring between the SGS-treated and untreated portions of the scars.[14] Gold and colleagues[15] treated 96 patients who had undergone skin surgery with routine postoperative care or topical SGS for 48 hours after surgery. They showed that patients with a history of abnormal scarring had a lower rate of developing hypertrophic or keloid scar when treated with SGS compared with routine postoperative care (39% vs 71%). In the patients who subsequently underwent scar revision, 36% of patients treated with SGS developed recurrent abnormal scar versus 83% (10 patients) within the routine wound care group. Most recently, in a case series of 7 patients, a liquid silicone gel applied twice a day for 3 months to one-half of a new surgical scar was reported to show noticeable improvement in scar appearance.[16]

In a meta-analysis of SGS for the prevention or treatment of hypertrophic or keloid scars, SGS was found to reduce the incidence of hypertrophic scarring for individuals prone to scarring (relative risk [RR], 0.46; 95% confidence interval [CI], 0.21–0.98).[17] Overall, a significant reduction in scar thickness (RR, −1.99; 95% CI, −2.13 to −1.85) and color amelioration (RR, 3.05; 95% CI, 1.57–5.96) was observed. However, the studies reviewed were deemed highly susceptible to bias. In 2002, an international advisory panel after reviewing more than 300 published articles recommended SGS as a primary option in the management of hypertrophic or keloid scars.[18]

Based on our review of current published studies on SGS, this modality should be considered in the treatment and prevention of hypertrophic scars. The authors typically advise the patients with the earliest signs of hypertrophic scaring to use over-the-counter (OTC) SGS sheets daily for up to 2 months as tolerated. Based on our experience, there are minimal risks, and there is improvement in scar thickness.

VITAMIN E

Vitamin E is a family of essential micronutrients composed of lipid-soluble tocopherols and tocotrienols with strong antioxidant activity. The proposed mechanism of action of vitamin E in modulation of wound healing and scar formation is inhibition of collagen synthesis, and it reduces both fibroblast proliferation and inflammation.[19,20] It is used by the general population to treat

wounds, burns, and surgical incisions, with the belief that it improves the cosmetic outcome of scars. In a double-blinded, controlled study, 15 patients who had undergone skin cancer removal surgery applied Aquaphor with and without vitamin E to their wounds twice daily for 4 weeks.[21] In 90% of the cases in this study, topical vitamin E either had no effect on, or worsened, the cosmetic appearance of scars. Of the patients studied, 33% developed a contact dermatitis to the vitamin E. A study of 159 operative procedures for postburn contractures treated postoperatively for 4 months with topical vitamin E showed no beneficial effect in cosmetic appearance or reducing scar formation, but was associated with increased adverse reactions.[22] In a recent prospective, randomized, double-blinded study on 122 patients with surgical scars less than 2 weeks old, topical tocotrienol twice a day for 6 weeks showed no significant difference in treatment and placebo groups using the Patient and Observer Scar Assessment Scale (POSAS), a photographic scar assessment by 2 independent assessors using a visual analogue scale and laser Doppler imaging (LDI).[23]

A limited number of studies have shown a potential beneficial effect with vitamin E. Eight adult patients with hypertrophic scars and keloids were treated with SGS with and without vitamin E.[24] Using a visual analogue scale, a 50% scar improvement was noted in 95% of patients treated with combined vitamin E and SGS compared with 75% of patients treated with SGS alone; the improvement was statistically significant. In another randomized controlled study a combination lotion of silicone and vitamin E showed significant improvement in scar induration, pigmentation, and erythema compared with placebo.[25] Given that the aforementioned 2 studies used a combination of silicone and vitamin E in the active arm, it is unclear whether the silicone or vitamin E component played a larger role in the improvements seen. In a recent study on children with perioperative topical vitamin E on the incision site showed that 96% of patients treated with topical vitamin E reported good cosmetic results compared with 78% of patients treated with emollients.[26]

Based on our review of current published studies on topical vitamin E, and the lack of scientific evidence, we do not recommend the routine use of topical vitamin E for management and prevention of postsurgical scars. In addition, contact allergy is a potential risk with the use of this agent.

ONION EXTRACT

Allium cepa (onion extract) is a common ingredient in several commonly used OTC scar therapy agents. *A cepa* has been found to contain both antibacterial and fibrinolytic activity.[27,28] Mederma (Contractubex, Merz, Frankfurt, Germany), is a topical gel containing 10% aqueous *A cepa* as the active ingredient. The other components of Contractubex gel are 50 IU heparin per gram of gel and 1% allantoin. A few studies have examined the potential effects of onion extract in treatment of surgical scars. In an open trial of Contractubex gel in patients with surgical wounds after thoracic surgery, Willitel and colleagues[29] reported a reduced scar width and reduced frequent of hypertrophic and keloidal scars in the treatment group. In a separate study, Ho and colleagues[30] evaluated the efficacy of Contractubex gel in the prevention of scarring after laser removal of tattoos in 120 Chinese patients. They reported a lower rate of scarring in the treatment group (11.5% in the treatment group vs 23.5% in the control group). Koc and colleagues[31] studied the combination of intralesional triamcinolone and topical onion extract gel versus intralesional triamcinolone alone in 27 patients with keloid or hypertrophic scars of 1 year or more in duration. They reported that intralesional triamcinolone with topical onion extract was more effective than intralesional triamcinolone alone in pain sensitiveness, itching, and elevation but not in erythema and induration. This study was not blinded and lacked a placebo-controlled arm. Campanati and colleagues[32] studied the effect of topical onion extract gel in 30 patients with hypertrophic or keloid scars using intravital videocapillaroscopy, and reported significant reduction in neoangiogenetic features, shown by an improvement in erythema and all videocapillaroscopic markers of neoangiogenesis. In another blinded, placebo-controlled study, 60 postshave excision sites were treated with an onion extract gel. Onion extract treatment resulted in improvements in scar redness, pliability, texture, and the global appearance.[33] Perez and colleagues[25] reported that significant improvements were obtained with onion extract in volume, length, width, and induration of hypertrophic and keloidal scars with a combination of onion extract gel and 0.5% hydrocortisone.

Jackson and colleagues[34] studied 17 patients with surgical scars resulting from Mohs surgery who were treated with topical onion extract or petrolatum-based ointment from suture removal for 1 month. They reported no statistically significant difference between pretreatment and posttreatment evaluations of scar erythema and pruritus in patients using topical onion extract gel. Instead, a statistically significant reduction in scar erythema was found in patients using a petrolatum-based ointment. A subsequent prospective randomized,

double-blinded, split-scar study comparing topical onion extract gel and petrolatum-based ointment in 24 patients with new surgical wounds after Mohs or excisional surgery also found no significant difference in scar erythema, hypertrophy, or overall cosmetic appearance.[35]

Review of the published studies on the usefulness of onion extract shows weak to no significant improvement for prevention and improvement in hypertrophic scarring. In addition, many of the reported studies lack a proper control arm. The authors do not routinely recommend the use of these agents in their clinical practice.

IMIQUIMOD 5% CREAM

Topical imiquimod 5% cream is an immunomodulator that is currently approved for the treatment of genital warts, actinic keratosis, and superficial basal cell carcinomas.[36] The mechanism of action is believed to be via induction of interferons resulting in collagen breakdown locally at the site of application and alteration of apoptotic genes.[37] Topical imiquimod has been reported to decrease the recurrence of excised keloids.[38–40] A randomized, double-blinded, placebo-controlled study of imiquimod 5% cream in the prevention of hypertrophic scarring after breast surgery in 15 patients reported improved scar quality compared with control groups (treatment with petrolatum and no treatment).[41] In addition, there was no development of hypertrophic scars or keloids in the patients treated with imiquimod. The main limitation of this study is the small sample size. Imiquimod treatment of 6 weeks has also been shown to improve the cosmetic outcome of scars after curettage of basal cell carcinomas.[42] Local skin reactions including erythema, edema, ulceration, scaling, and hypopigmentation are common, and can be seen in more than 75% of patients. From 1% to 2% of patient may experience flulike symptoms such as headache, myalgias, fatigue, fever, and diarrhea. These side effects limit the routine use of topical imiquimod in the treatment and prevention of hypertrophic scars. Additional studies are necessary to determine the role of topical imiquimod in scar therapy.

PRESSURE GARMENT THERAPY

Pressure therapy is generally accepted as one of the best nonsurgical means of preventing and controlling hypertrophic scarring after burn injury. The prevalence of hypertrophic scarring after burns was estimated to be about 67% in a single-center retrospective study.[43] The garments are typically custom-made from an elastic material and are intended to be worn for approximately 1 year during the active process of scar maturation.[44] The mechanism of action is uncertain, but is postulated to be related to thinning of the dermis, decrease in edema, and reduction of blood flow resulting in a hypoxic environment with decreased collagen synthesis.[45] The first study to report clinical efficacy of compression pressure garments to treat burn hypertrophic burn scars was in children.[46]

Table 1
Outcomes of topical treatments for scars

Therapy	Potential Pros	Potential Cons	Expert Opinion from this Review
Vitamin E	May improve cosmetic appearance	Contact dermatitis in >30% of patients	Insufficient evidence to recommend
SGS	Prevent hypertrophic scars; scars are flatter and less red	None reported	Recommend
Onion extract	May prevent hypertrophic scars; may improve cosmetic appearance	None reported	Insufficient evidence to recommend
Imiquimod cream	Prevent hypertrophic scars and keloids; may improve cosmetic appearance	Local skin adverse reaction; flulike symptoms	Insufficient evidence to recommend
Pressure garments	May prevent hypertrophic scars after burn injury; scars are flatter and less sensitive	Discomfort from wearing garments for long periods of time	May be used in burn injury; insufficient evidence to recommend for other types of scars
Massage therapy	May reduce pain and itching	None reported	Insufficient evidence to recommend

This was followed by a larger study in Singapore of 280 patients with burns and hypertrophic scars, where pressure garments were shown to result in soft, pliable scars with relief from pain and itch.[47] In a Belgian study, 60 patients with 76 hypertrophic burn scars were assigned to 2 different levels of pressure therapy (mean value of 15 mm Hg vs 10 mm Hg).[48] Scars that were treated with higher pressure garments (15 mm Hg) had a significantly lower scar thickness than scars treated with a lower pressure (10 mm Hg).

A recent meta-analysis was unable to show a difference between global assessments of scars treated with pressure garment therapy and control scars (weighted mean differences, −0.46; 95% CI, −1.07 to 0.16].[39] The meta-analysis for scar height showed a small, but statistically significant, decrease in height for the group treated with pressure garment therapy (standardized mean differences, −0.31; 95% CI, −0.63 to 0.00). Results of meta-analyses of secondary outcome measures of scar vascularity, pliability, and color failed to show a difference between groups. The investigators concluded that the beneficial effects of PGT remain unproven, whereas the discomfort of wearing pressure garments and the cost are significant.

MASSAGE THERAPY

Massage therapy is frequently used in rehabilitation centers in the treatment of burns and scars. Cutaneous hydration, cutaneous mobilization, and pulpar massage are techniques specifically cited to manage hypertrophic scars and keloids. Although massage therapy has been reported to improve pain, itching, and anxiety,[49,50] there have been few studies of its clinical efficacy in treating scars. In a study of 30 children with hypertrophic burn scars, frictional massage combined with pressure garments were compared with pressure garments alone.[51] The study failed to show any appreciable effects of massage therapy on the vascularity, pliability, and height of the hypertrophic scars studied. Because of the limited number of studies available on this subject; we are unable to make any recommendations on the use of massage therapy in the treatment of scars. However, the authors routinely recommend massaging to prevent the risk of postsurgical hypertrophic scars. Patients are instructed to start massaging 4 weeks after surgery, 2 to 3 times daily for 3 to 5 minutes after application of either petrolatum or moisturizing cream for 3 to 4 months. In their experience, this simple regimen results in improvement in scar thickness and contour.

SUMMARY

There is no universally accepted treatment regimen and no evidence-based literature to guide the management of hypertrophic scars. Leventhal and colleagues[52] reviewed 70 treatment modalities in a meta-analysis and estimated the overall success rate to be approximately 60%, with no statistically significant difference between different therapies. In conclusion, there is no single, optimal topical modality that can eliminate or prevent hypertrophic scars. SGS remains the most accepted modality for the treatment and prevention of hypertrophic scar. There are minimal data to support the direct benefit of onion extract and vitamin E as single agents. Pressure therapy and massage therapy are predominately used for treatment of burn scars. Topical imiquimod 5% cream in a small study was shown to improve scarring and requires further clinical studies. **Table 1** gives a summary of the agents and the authors' experience with outcomes.

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