

Review

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Review on the treatment of scars

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Abstract

Scarring is a major concern for patients. From acne scarring to surgical scars, scars can have a dramatically negative effect on one's self-esteem and are a common complaint for which patients seek treatment. This review will focus on the treatment of acne scarring including ice pick, boxcar and rolling scars, and also the treatment of surgical scars including atrophic and hypertrophic scars.

Keywords: Scarring, acne scarring, surgical scars

INTRODUCTION

Scarring is a condition that aesthetic physicians are frequently called upon to improve. The treatment of scars can be a rewarding albeit frustrating endeavor. Scars or scarring come in a number of varieties, and treatment must be tailored specifically for each patient. This chapter will focus on the treatment of acne scars and surgical scars as these are most routinely encountered in practice. Acne can produce ice pick, rolling or boxcar scars and treatment can vary widely from the use of fillers, trichloroacetic acid (TCA) or energy-based devices. Similarly, surgical scars can be treated with a number of modalities from injectables such as intralesional triamcinolone or 5-fluorouracil (5-FU) to resurfacing technologies.

ACNE SCARS

When it comes to facial rejuvenation, the treatment of acne scars is one of the things that can make the most dramatic improvement. While acne, and thereby acne scarring, generally occurs in one's teens or



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twenties, patients can come in requesting treatment of acne scarring at any age. Acne scarring is generally classified as ice pick, rolling or boxcar, and the treatments of each subtype can vary. That said, patients typically have a variety of these subtypes at any given time, and this must be taken into account when deciding on the preferred treatment approach. One challenge in determining the optimal approach for treating acne scars is that there is a dearth of high-quality studies. The studies that exist are often small and underpowered, biased, without uniform baseline variables or outcomes or without long-term follow-up^[1].

Ice pick scars

Ice pick scars are deep but narrow (< 2 mm) scars that look like they could have been created by an ice pick. Due to the depth of the scars, which can extend into the dermis, they are often more resistant to the typical treatment modalities used for rolling or boxcar scars. Although they have less treatment options in general, the ones that they have can provide superb results.

Punch excision is an excellent treatment option for ice pick scars. Although this is essentially trading a scar for a scar, the scars created by the punch excision itself often heal to the point they are difficult to see^[2]. For the best cosmetic outcome, scars should be at least 4-5 mm apart to be treated at the same time. Otherwise, there will be too much tension on the skin surface for them to heal optimally. If scars are within 4-5 mm of one another, then waiting 4 weeks between treatments will provide the best long-term results^[3].

The use of TCA, particularly with the CROSS technique (chemical reconstruction of skin scars), has more recently emerged as a treatment option for ice pick scars. The CROSS technique involves using an instrument such as a syringe needle or a sharpened wooden applicator that is dipped into high-concentration TCA and then applied directly onto the scar. The desired endpoint is a white frosting of the scar. TCA creates coagulative necrosis of the epidermis, thereby increasing collagen production which ultimately results in improvement of the scar^[2].

In a study of 30 patients treated with the CROSS technique utilizing 100% TCA every two weeks for a total of 4 sessions, Khunger *et al.*^[4] found that 73% of patients achieved excellent improvement in ice pick scars, whereas 20% achieved good improvement. Side effects of this technique include hypopigmentation which is largely transient, a burning or tingling sensation at the time of treatment and erythema or edema^[4]. The CROSS technique has also been described using other chemicals such as 88% phenol with similar results as TCA^[5].

Although energy-based devices often provide less-than-satisfactory results for the treatment of ice pick scars, Ramesh *et al.*^[6] found that ice pick scars responded better than rolling or boxcar scars to a fractional radiofrequency (FRF) device. Conversely, other studies found the opposite result^[6,7].

Rolling scars

Rolling scars are typically ≥ 4 mm in diameter and have soft, irregular walls which gives them a rolling appearance. These are caused by bands that tether the subcutis to the dermis. As such, the treatment of these scars generally targets these bands to improve their appearance.

Subcision has been a longstanding technique to target and release these bands. In this method, an instrument, such as a needle, is inserted into the subcutaneous plane and fanned back and further in an effort to sever these bands. Blunt blade subcision has also been used, in which a blunt blade is inserted in a single puncture site and is able to safely treat a wider area. A study by Barikbin *et al.*^[8] involving 18 patients with mainly rolling scars found that this method led to marked improvement in 50% of patients, while 33% had moderate improvement and 17% mild improvement^[8].

Fillers have also been used to treat rolling scars. Sapra *et al.*^[9] looked into the use of poly-L-lactic acid for the treatment of rolling scars in 22 patients and found that 68.2% of patients had a satisfactory response as judged by blinded-evaluators. Hyaluronic acid and calcium hydroxyapatite have also been used to treat acne scars with success^[10,11].

Resurfacing is also used to treat rolling scars but will be discussed further below. Although it is not directly targeting the bands tethering the scars down, it can be effective in many circumstances.

Boxcar scars

Boxcar scars are wider than ice pick scars (1-4 mm in diameter) which gives them a U-shaped appearance. Their sharply demarcated edges are in contrast to the soft edges of rolling scars and can extend 0.1-0.5 mm into the dermis. Although boxcar scars are indeed a distinct form of acne scar, they are seldomly studied in isolation but rather are most often grouped together with the treatment of other types of scars.

In general, boxcar scars are treated with resurfacing, which can be performed with anything from a chemical peel or microneedling to a number of different energy-based devices. The aggressiveness of the treatment is often correlated to the results obtainable, but also must be weighed against the risks as well as the acceptable downtime for the patient.

Microneedling can be performed either with a dermaroller or a microneedling pen, and can be performed alone or with the use of a variety of topical applications to the pores created by microneedling such as platelet rich plasma (PRP). Alam *et al.*^[12] performed a randomized, split-face study with a dermaroller on a number of morphologic acne scar types and found that after 3 treatments there was improvement in scarring, with a mean difference of 3.4 based on the quantitative global scarring grading system ($P = 0.03$)^[12]. A separate blinded, randomized controlled trial involving 42 patients comparing microneedling to a non-ablative fractional erbium 1,340-nm laser found that both were effective and that there was no statistically significant difference between the two ($P = 0.264$). Microneedling had fewer side effects and less downtime^[13]. One study found microneedling combined with the use of PRP to be more effective than microneedling alone; however, an alternative study demonstrated no difference in these outcomes^[14,15].

Of the energy-based devices, fully ablative lasers typically offer the best cosmetic outcomes, but at the cost of the longest downtime and greatest risk for adverse events. Walia and Alster^[16] demonstrated a 75% improvement in atrophic acne scars at 18 months after high-energy CO₂ laser treatment^[16]. However, erythema lasting on average 3.5 months and a 36% incidence of hyperpigmentation help explain why this is not a commonly used modality to treat acne scars.

Fractional ablative lasers have helped to fill this void. They are effective but have a more acceptable recovery and side effect profile than fully ablative lasers. Bjørn *et al.*^[17] found that a fractional CO₂ laser improved acne scarring with minor postoperative adverse effects, and that a treatment interval of either 1 month or 3 months did not influence the final outcome. Cho *et al.*^[18] compared the efficacy of fractional CO₂ to non-ablative fractional laser (NAFL) treatment with the 1,550-nm erbium:glass laser. They found that while the fractional CO₂ laser demonstrated greater improvement, it was not statistically significant as there were only 8 patients in the study^[18]. This improvement came at the cost of greater adverse effects including erythema and crusting.

NAFL are a mainstay in the treatment of acne scarring. With a lower downtime than ablative fractional lasers, patients often prefer them even if they may require more treatment sessions to achieve equal results. Sardana *et al.*^[19] found that boxcar scars were most responsive to treatment with the 1,540-nm erbium:glass laser, demonstrating a 52.9% improvement compared to rolling scars which had a 43.1% improvement.

Boxcar scars had a statistically significant improvement after four sessions ($P < 0.05$). Ice pick scars showed the lowest improvement rate of only 25.9%, although this was not statistically significant ($P = 0.09$)^[19].

Radiofrequency devices can be monopolar, bipolar or fractional. Of these, FRF devices seem to provide the best results, with an expected improvement of 25% to 75% after 3 to 4 sessions. Although adverse effects are limited, the procedure itself can be associated with a significant amount of pain, even with nerve blocks or topical anesthesia^[20,21].

Erythematous scars

Beyond treating the textural changes of acne scarring, a typical complaint is post-inflammatory erythema. Although with time, this typically resolves on its own, but it can take months if not years. Vascular lasers such as the 595-nm pulsed dye laser (PDL) or 532-nm potassium titanyl phosphate (KTP) laser are widely used to treat this erythema because of their consistent and reliable results with minimal adverse effects.

SURGICAL SCARS

Physicians must be well-versed in the treatment of surgical scars. Every patient heals differently, and even the most precise surgical technique can lead to scarring. The treatment of an unfortunately placed or unsightly scar can be the most immediate thing a patient can do to improve his or her appearance, as the scar is often the first thing one's eye is attracted to upon seeing a person.

There are a number of things to consider when treating a surgical scar, including the timing of when interventions should be implemented, and what specific interventions should take place. Scars can manifest in a number of ways, and may be erythematous, raised or depressed.

Perhaps the earliest question that physicians or surgeons face in the management of scars is what should patients do in the immediate aftermath of surgery. Beyond appropriate wound care and timely suture removal, patients frequently inquire about the benefit of silicone gel sheeting. Although there have been a number of studies published touting the effects of silicone gel sheeting not only for preventing hypertrophic scars but also to treat those that are already present, a systematic review involving 20 trials and 873 patients found the evidence to be weak and heavily susceptible to bias^[22].

Hypertrophic scars

Hypertrophic scars are commonly treated with a number of modalities including intralesional kenalog (ILK), 5-FU or laser treatments. ILK has long been considered the first line treatment of hypertrophic scars. ILK suppresses inflammation, causes vasoconstriction which reduces the delivery of oxygen and nutrients to the scar and also has an antimetabolic effect, inhibiting the growth of keratinocytes and fibroblasts. Additionally, it reduces plasma protease inhibitors which degrade collagen through collagenase^[23]. The concentration used needs to be carefully considered for each individual scar and is dependent on the size and location of the scar. It is prudent to start with a lower dose with the expectation that multiple treatments may be necessary rather than risk using a higher dose which may lead to atrophy and pigmentary changes. It is much easier to treat conservatively than to have to treat additional complications down the line.

5-FU is a well-established albeit less commonly used technique for the treatment of hypertrophic scars. 5-FU is an antimetabolic agent that has been demonstrated to inhibit fibroblast proliferation and decrease collagen synthesis^[24]. It can be used alone or in combination with ILK, and has been shown to decrease the risk of side effects of ILK when used in combination^[25,26]. 5-FU should not be used in patients who have an infection, are pregnant or have anemia, leukopenia or bone marrow suppression. 5-FU is typically injected at a dose of 50 mg/mL for a maximum dose ranging from 50-150 mg. It can be diluted with ILK, which is typically diluted to a dose of 2 to 10 mg/mL dependent on the size and location of the scar. Care must be taken to avoid overtreating the scars, which can lead to atrophy, being more challenging to treat.

Both ablative and non-ablative resurfacing are also popular techniques in treating hypertrophic scars. More recently, these have been combined with laser-assisted drug delivery with corticosteroids or 5-FU^[27,28]. The use of 5-FU has been demonstrated to be as effective but with fewer side effects than the use of corticosteroids in laser-assisted drug delivery^[28].

Dermabrasion is one of the oldest methods used to revise scars. It can be done manually with sandpaper, or mechanically with a rotating wire brush or diamond fraise. Dermabrasion, particularly mechanical dermabrasion, is extremely operator dependent and carries a number of risks including making the scar worse. A randomized controlled trial comparing fractional ablative resurfacing to dermabrasion found that while both were effective, laser resurfacing was safer and showed quicker clinical recovery^[29]. Conversely, in a randomized, blinded, split-scar study involving 14 patients, manual dermabrasion with sterilized sandpaper was demonstrated to be an effective but safe, simple and cost-effective treatment option for surgical scars^[30]. Mechanical dermabrasion has fallen out of favor due to the risks associated with aerosolization of blood.

Atrophic scars

Atrophic surgical scars show a different set of challenges than hypertrophic scars and can generally be more difficult to treat.

Fractional laser therapy with either non-ablative or fully ablative lasers has been shown to improve the color, texture, thickness and patient satisfaction of atrophic surgical scars^[31-33]. These lasers are effective because they stimulate neocollagenesis and dermal remodeling.

The use of fillers has been shown to improve the appearance of atrophic surgical scars. Both hyaluronic acid and calcium hydroxyapatite have been shown to be safe and effective with the additional benefit of having an immediate improvement^[34]. One downside to the use of fillers is that the results are not permanent.

Pigmentary changes

Pigmentary changes can affect both hypertrophic and atrophic scars. The most common color change is typically erythema, resulting from the healing process that stimulates neovascularization. Scars can also be hyper- or hypopigmented. Although the previously mentioned techniques to treat scar texture may provide the added benefit of improving such pigmentary changes, in many cases this must be addressed separately.

Erythematous scars tend to be relatively receptive to treatment. PDL has long been used to treat erythematous surgical scars. It has been shown to be effective at both short and long pulse durations^[35]. Although improvement in erythema should be the main objective when treating surgical scars with PDL, it has been shown to improve texture as well^[36]. The 532-nm KTP laser is also well-established for the treatment of scars and has been demonstrated to be comparable in safety and efficacy to PDL^[37].

Hypopigmented scars can be challenging to treat; however, the combination of fractional resurfacing with the use of topical tretinoin, pimecrolimus or bimatoprost has been shown to be effective at re-pigmenting the scar^[38]. Similarly, laser-assisted drug delivery of bimatoprost has been shown to be effective at repigmenting hypopigmented scars^[39].

EMERGING TECHNOLOGIES

Although this chapter focused on the most commonly used techniques to treat scars, the field of medicine is always working on emerging technologies that may one day complement or replace standard therapies. One such technology that may play a role in the management of scarring is laser speckle contrast imaging (LSCI). LSCI illuminates tissue with coherent laser light and then detects backscatter from the tissue

which ultimately can be used to detect blood flow^[40]. This is relevant to scarring because adequate tissue perfusion is necessary for the healing process to take place. This technology has been studied in patients with systemic sclerosis and can detect a reduction of blood perfusion in areas affected by Raynaud's phenomenon. It also has been used to demonstrate that a decrease in blood perfusion is found in patients with microangiopathy^[41]. LSCI has also been used to help evaluate burn wounds which is important, because it can detect the severity of partial-thickness wounds, which in turn influences treatment^[42].

CONCLUSION

Scarring, regardless of etiology, is a challenging but treatable condition that can make a significant difference in the lives of patients. Although energy-based devices are the workhorses of many treatment regimens, they are not absolutely necessary, and any physician can be equipped to manage them. A thorough understanding of different types of scars is crucial to tailor a treatment course for individual patients. The treatment of acne scars differs depending on whether they are ice pick, rolling or boxcar scars. Surgical scars may be raised or depressed, or suffer from pigmentary changes, and treatments vary for each. As our understanding of the formation and maturation of scars continues to develop, new technologies will likely emerge to target scars or even inhibit their formation altogether.

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Contribute solely to the article: Callaghan DJ

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