A Combination Approach to Surgical Scars

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BACKGROUND Scar formation from surgical procedures is an unavoidable risk. Despite measures taken by both the surgeon and patient during the perioperative and postoperative periods to maximize cosmesis, some patients will wish to pursue surgical or laser scar revision.

OBJECTIVE The authors propose a treatment algorithm to assist in approaching surgical scar revision with combination treatments.

MATERIALS AND METHODS A PubMed search was performed on various surgical scar revision techniques. The authors augment these findings with their own personal experiences.

RESULTS Reports of surgical excision, intralesional corticosteroid injection, intralesional 5-fluorouracil injection, pulse dye laser treatment, nonablative fractional laser resurfacing, ablative fractional laser resurfacing, and microneedling and fractional needle radiofrequency, used in isolation or combination, were found. The authors also provide clinical photographs documenting improvement in appearance of surgical scars using these treatments.

CONCLUSION Surgical scars are best treated with a combination approach to address various features of the scar. The authors propose a treatment algorithm with multiple treatment options and how to combine them safely and effectively.

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scar formation from surgical procedures is an unavoidable risk. Despite measures taken by both the surgeon and patient during the perioperative and postoperative periods to maximize cosmesis, some patients will wish to pursue surgical or laser scar revision. A number of treatment modalities for scar revision exist. These procedures are best used in combination to achieve the greatest cosmetic outcome. The authors propose a treatment algorithm to assist in approaching surgical scar revision with combination treatments.

Initial Evaluation of the Surgical Scar

When selecting the optimal therapeutic option for scar revision, the clinician must consider both the timing of the surgical scar intervention in relation to the initial surgical procedure and the clinical features of the scar.

Timing of Surgical Scar Revision

Surgical scars take approximately 1 year to fully mature, although it is well recognized that scars continue to improve in appearance after 1 year. According to the authors’ practice, surgical scar revision approximately 3 months after surgery may be considered, but laser therapy can be considered as early as a few weeks after surgery. Studies have examined surgical revision as early as 2 weeks after surgery, although immature scars are prone to hypertrophy and may tend to give poor results after scar revisions.[1]

It is important to remember that watchful waiting is
also an option, given that surgical scars continue to improve with time.

**Clinical Features of the Surgical Scar**

The initial clinical evaluation should take into account the tension, texture, and erythema of the surgical scar. Successful revision of surgical scars is optimized with a combination approach to address these features. A discussion of various options, realistic outcomes, and managing expectations is a salient component of patient counseling. It should be stressed that treatment usually results in improvement of the scar rather than complete resolution. The patient should also understand that a number of treatment sessions, scheduled several weeks apart, are frequently required.

Figure 1 provides a treatment algorithm to guide the clinician through a combined approach to address varying clinical features of surgical scars. Although many treatment modalities are effective as monotherapies for scar revision, optimal improvement is often achieved by combining multiple treatment strategies. These combination treatments will be discussed below.

**Tension**

First, the clinician should assess if there is significant tension or webbing associated with the surgical scar. In this case, surgical revision of the scar is often warranted before considering laser scar revision.

Fusiform excision is the most basic technique for revising surgical scars. It involves re-excision of the entire linear surgical scar with narrow margins. Although a fusiform excision will improve the appearance of a poorly healed scar, it will result in a longer incision line compared with the previous one. Therefore, this technique is best suited for shorter scars.

If a fusiform excision is not possible, a Z-plasty may be used to both reorient surgical scars and elongate a contracted scar. As the name implies, the procedure breaks a linear scar down into a series of irregular lines, which makes the scar less apparent. In a similar manner, a W-plasty involves outlining a linear surgical scar with a zigzag irregular line on one side of the scar with a mirror image on the opposite site. The surgical scar is excised and the defect is approximated with numerous irregular lines, forming a single zigzag line, leading to a less noticeable scar. The V-Y repair and Y-V repairs are used primarily to release contracted scars. A V-Y repair elongates the original scar, whereas a Y-V repair results in a shorter scar.

**Erythema**

Next, the clinician should assess whether the surgical scar has appreciable erythema. The patient should be counseled that erythema secondary to inflammation in the first few months after surgery will often improve with time. However, laser therapy can help to hasten the process and may be considered as early as the time of suture removal. Surgical scars demonstrating postoperative erythema may be treated with vascular lasers, most commonly the 585 or 595-nm pulsed-dye laser (PDL) or 532-nm potassium titanyl phosphate lasers. Alternatively, an intense pulsed light (IPL) can be applied.

The PDL laser is most commonly used to target vascular structures within scars. This laser targets oxyhemoglobin within very small blood vessels in the scar as well as telangiectasia in the surrounding skin, leading to decreased erythema and an improved cosmetic outcome. The procedure is well tolerated with minimal downtime. Side effects generally resolve within 7 to 10 days and include temporary increase in erythema, edema, and posttreatment purpura, seen with higher fluences and shorter pulse durations. The authors’ approach to the treatment of scar erythema with the PDL is to use short pulse durations and low-fluence settings (i.e., 0.45 milliseconds and 5–6 J/cm²). However, Nouri and colleagues demonstrated that results obtained with a 1.5-millisecond pulse duration was similar to a 4.5-millisecond pulse duration. Transient to mild purpura is an appropriate end point when treating scar erythema.

In addition to decreasing erythema, the PDL laser has been shown to stimulate collagen production.
and improve scar texture, particularly at lower subpurpuric fluences.\(^3\) Nouri and colleagues\(^3\) demonstrated that shorter pulse durations of 1.5 milliseconds with the 585-nm laser resulted in an average of 89% improvement in scar appearance compared with untreated controls. Furthermore, this study also demonstrated that both short-pulse and long-pulse PDL are safe and effective in improving the quality and cosmetic appearance of surgical scars in Fitzpatrick skin Types I to IV beginning on the day of suture removal with no appreciable difference between the 2 pulse durations.

**Texture**

Finally, the clinician should assess the texture of the surgical scar, specifically whether the scar is hypertrophic or atrophic in nature. This distinction is imperative in selecting appropriate treatments for the revision. When addressing the texture in addition to erythema, the clinician may address both these features safely during a single clinic visit. It is recommended to treat erythema first before performing additional procedures as other procedures will increase the surrounding erythema and will change the optic absorption of the vascular laser.
Revision of Hypertrophic/Keloidal Surgical Scars

Intralesional Kenalog and Intralesional 5-Fluorouracil

After erythema has been addressed, injection of intralesional Kenalog (ILK) or intralesional 5-fluorouracil (5-FU) may be performed as first-line treatment for hypertrophic or keloidal surgical scars. The use of ILK is a simple technique reserved for hypertrophic scars and bulky, elevated skin resulting from round, U-shaped flaps described as a “trap door” deformity. A low-strength steroid, such as triamcinolone acetonide, is injected into the scar and may be repeated on a monthly basis until there is flattening of the scar. Several treatments are generally required. The authors recommend small aliquots of 20 to 40 mg/mL. Skin blanching usually occurs when the appropriate amount is injected. Injection volume does not usually exceed 0.1 mL per 1 cm of scar. Caution must be taken to avoid epidermal atrophy, which may occur when steroid is injected too frequently, too deep into the subcutaneous fat, or at high concentrations. In addition, the use of intralesional 5-FU may be used for the treatment of hypertrophic scars without the risk of atrophy. Davison and colleagues demonstrated that the combination of 75% 5-FU (various concentrations) and 25% triamcinolone (40 mg/mL) is superior to intralesional triamcinolone alone when 0.1 mL is injected into 1 cm of scar. There was an average reduction in 92% of the lesion size reported for this combination therapy compared with 73% for triamcinolone therapy alone. The authors generally use 0.9 mL of 5-FU (50 mg/mL) mixed with 0.1 mL of ILK (10 mg/mL). It is essential to keep in mind that 5-FU is pregnancy category X.

Nonablative Fractional Laser Resurfacing

If an irregular or hypertrophic surgical scar requires additional improvement in texture beyond ILK or 5-FU, then another option is the use of nonablative fractional laser resurfacing (NAFR). Fractional nonablative lasers, such as the 1,550-nm erbium glass fiber laser (Fraxel; Solta Medical, Hayward, CA) or the 1,540-nm erbium glass fiber laser with XD Microlens (Cynosure, Westford, MA), create hundreds of microscopic thermal zones, separated by undamaged skin leading to rapid reepithelialization as well as collagen induction. Studies have shown that NAFR in creating a number of narrow deeper wounds maximizes improvement in texture and are safe for darker skin types. Pham and colleagues reported clinically significant improvements in pigmentation and/or color, thickness, and irregularity of Mohs surgical scars on the face using a nonablative 1,550-nm laser at least 6 months postoperatively. Figure 2 shows improvement in a surgical scar after 4 treatments with NAFR. A significant advantage of this device over traditional ablative lasers is the minimal downtime coupled with an improved side-effect profile.

As noted above, scars with an erythematous component should always be treated with a vascular laser before the use of any fractional resurfacing device to specifically target the erythema inherent to the surgical scar rather than the erythema from the inflammatory response caused by fractional lasers. The authors have had success in scar revision when using a combined approach with PDL treatments immediately followed by nonablative fractional resurfacing (Figure 3). Several treatments are generally required and are spaced at least 4 weeks apart. When combining multiple devices such as PDL or IPL devices with NAFR (or ablative resurfacing), it is prudent to lower the settings of each device to avoid complications. However, with more experience, the authors find that one may cautiously approach standard settings. Combination treatments may be considered as soon as 2 weeks after suture removal. The authors recommend the use of moderate to high-pulse energies and low-density settings with NAFR for scars (i.e., approximately 30–50 mJ and 20%–39% density, respectively). Also of importance, ILK and intralesional 5-FU should be performed after NAFR to avoid ulceration from bulk heating secondary to the increase in the aqueous target of NAFR.

Fractional Ablative Laser Resurfacing

Ablative fractional photothermolysis produces a pattern of ablation and coagulation extending from the stratum corneum into the dermis with varying density and depths separated by undamaged skin. Through immunohistochemistry, these devices were shown to...
induce collagen remodeling for at least 3 months after treatment.\(^8\) Ablative fractional photothermolysis has an improved safety profile compared with full ablation and increased efficacy compared with NAFR making it a popular treatment modality for improving skin surface and texture abnormalities, such as surgical scarring (Figure 4).

Despite their role in improvement of texture and color of surgical scars, nonablative fractional lasers are not as helpful for thicker scars. Ablative fractional lasers have been associated with greater overall scar reduction compared with NAFR even when creating the same injury patterns. The ablation has been shown to create greater tissue contraction, collagen production, and tissue remodeling than seen with nonablative fractional lasers.\(^9\) In general, fewer ablative fractional laser treatments are required to achieve a similar result with nonablative fractional lasers.

Ablative fractional laser resurfacing has recently been coupled with percutaneous drug delivery as a means of revising both hypertrophic and atrophic surgical scars. Microscopic ablative channels allow for deeper penetration of larger drug moieties and more even distribution within the tissue. Waibel and colleagues\(^10\) reported laser-assisted drug delivery of topical corticosteroids, which lead to an enhanced improvement in hypertrophic scars. Although ablative channels remain open for several days, optimal absorption occurs when the topical medication is applied immediately after laser procedure. The authors like to use a Kenalog concentration of 20 to 40 mg/mL, depending on the thickness of the scar, applied topically until there is uniform coverage of the treatment area.

**Microneedling and Fractional Needle Radiofrequency**

Microneedling therapy, or percutaneous collagen induction, is an alternative technique that may be used for the treatment of hypertrophic surgical scars. The process of microneedling includes the use of
small, minimally invasive microneedles that break collagen bundles in the superficial layer of the dermis that are responsible for scars, leading to the subsequent induction of more collagen just beneath the epidermis. The use of fractional needle radiofrequency devices has become increasingly popular in recent years. These newer devices use radiofrequency in combination with microneedling to augment remodeling of the dermis.

As the microneedles cause small wounds in the epidermis, there are anecdotal reports of topical steroids being applied to hypertrophic surgical scars immediately after microneedling and fractional needle radiofrequency. However, laser-assisted drug delivery seems to be more effective.

**Revision of Atrophic Surgical Scars**

*Fractional Nonablative Laser Resurfacing*

While fractional nonablative lasers can improve thickened scars, paradoxically, they are also beneficial in the treatment of atrophic surgical scars. To achieve an enhanced effect, the clinician may elect to inject a variety of soft tissue fillers into atrophic scars after laser therapy to provide additional volume to atrophic scars. Authors classically inject soft tissue filler after laser therapy has been completed as Kenkel and colleagues demonstrated that aggressive, deeper laser treatments may have a clinical effect on the longevity of the filler or the efficacy of the laser treatments.

Notably, Goldman and colleagues demonstrated that fillers are unaffected by nonablative laser/light and superficial ablative treatments.

Cohen and colleagues published on the advantages of using durable fillers, such as hyaluronic acid and calcium hydroxylapatite, to fill and blend postsurgical depressed scars after the reconstruction of skin cancer defects. Injection of hyaluronic acid fillers, particularly the ones with a lower $G$ prime, may be injected superficially into the dermis with lower risk of a Tyndall effect. Alternative fillers that may be used include poly-L-lactic acid and polymethyl methacrylate. As an alternative to using injectable fillers to revise small contour defects on the nasal tip, Jensen and Cohen reported the immediate improvement of contour and symmetry on the nasal tip with the use of an autologous dermal graft.

Massaki and colleagues reported repigmentation of hypopigmented, atrophic surgical scars using an erbium-doped 1,550-nm fractionated laser combined with topical bimatoprost and tretinoin. A total of 14 patients with hypopigmented scars were treated with a mean of 4.5 sessions at 4- to 8-week intervals, with 12 patients having >50% improvement.

*Fractional Ablative Laser Resurfacing*

Fractional ablative lasers provide another option for atrophic surgical scar revision and may also be combined with topical drug delivery for augmented results. Cohen published a case report documenting significant improvement in texture as well as pigmentation, and color in 2 Mohs surgery scars on the face after 3

![Figure 4.](image-url)
treatments with an ablative fractional Er:YAG laser device. There are reports of topical application of soft tissue fillers immediately after fractional ablative resurfacing. Rkein and colleagues\(^1\) showed improved efficacy of atrophic scars treated with ablative fractional laser resurfacing in conjunction with the application of a thin layer of topically applied poly-L-lactic acid (each bottle diluted with 6 mL of sterile saline and 2 mL of 1 % lidocaine HCl with epinephrine of 1:100,000 concentration). As stated above, the application of fillers should be performed when the series of laser procedures has been completed as ablative devices are more likely to vaporize filler.

**Microneedling and Fractional Ablative Radiofrequency Needle Resurfacing**

Microneedling therapy and fractional ablative radiofrequency needle resurfacing are frequently used for the treatment of atrophic scars in addition to hypertrophic scars. Fractional ablative radiofrequency seems to be more effective than nonablative fractional resurfacing and approaches the efficacy of fractional ablative resurfacing with less downtime. As with fractional ablative laser resurfacing, there are anecdotal reports of topical soft tissue fillers being applied to the surgical scar after resurfacing treatment to enhance the overall treatment effect.

**Conclusion**

In conclusion, surgical scars are best treated with a combination approach to address various features of the scar. The authors propose a treatment algorithm with multiple treatment options and how to combine them safely and effectively.

**References**


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