Management of Trauma and Burn Scars: The Dermatologist's Role in Expanding Patient Access to Care

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PRACTICE **POINTS**

- Burn and trauma scarring represents a major source of morbidity in both the civilian and military populations worldwide and often is mechanically, aesthetically, and symptomatically debilitating.
- Advances in laser surgery and our understanding of wound healing have resulted in a scar therapy paradigm shift from large scar excisions and repair to a multimodal, tissue-conserving approach that relies on remodeling of the existing tissue.
- Dermatologists are uniquely positioned to increase patient access to cost-effective, outpatient-based burn and trauma scar care utilizing devices and techniques that they currently possess.

Recent advances in laser surgery and our understanding of wound healing have ushered in a new era of trauma and burn scar management. Traditional therapy has centered around scar excision followed by primary closure or tissue replacement with flaps and grafts. This approach represents a perpetuation of the common fallacy that extensive scar improvement requires extensive surgical intervention. Laser surgery in conjunction with pharmacotherapy and minor tissue-conserving surgery produces well-healed and remodeled existing tissue that provides the most natural appearance and function of the skin. Now, patients' hypertrophic, contracted, and disfiguring scars represent their most valuable reconstructive anatomy. With this paradigm shift, dermatologists are uniquely positioned to provide transformative and cost-effective scar therapy due to their proficiency in the necessary treatment modalities and expertise in the utilization of local anesthesia. We hope to further expand military and civilian patient access to such care in their local community through peer education and advocacy. We present a brief overview and outline of scar treatment practices that can be performed by dermatologists in office using devices and techniques they often already possess.

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Hypertrophic scarring secondary to trauma, burns, and surgical interventions is a major source of morbidity worldwide and often is mechanically, aesthetically, and symptomatically debilitating. Modern advances in acute trauma care protocols have resulted in survival rates greater than 90% in both civilian and military populations.[1,2] Patients with wounds that have historically proven fatal are now surviving and are confronted with the long-term sequelae of their injuries. With more than 52,000 service members injured in military engagements from 2001 to 2015 and 8.5 million civilians presenting annually with injury patterns at risk for hypertrophic scarring, it is paramount that we ensure access to safe and effective long-term scar care.[2,3]

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At its simplest level, hypertrophic scarring is believed to result from a disequilibrium between collagen production and degradation. This failure to properly transition through the stages of wound healing results in bothersome symptoms, a disfigured appearance, and mechanical dysfunction of the skin (Figure, A). Decreased elasticity and extensibility, increased dermal thickness, and scar contractures impair patient range of motion and functional mobility. Those affected commonly experience varying degrees of pruritus and dysesthesia along the scar. Combined with aesthetic variations in pigmentation, erythema, texture, and thickness, hypertrophic scarring often leads to long-term psychosocial impairment and decreased health-related quality of life.[4]

Hypertrophic burn scar contractures of the left dorsal forearm, wrist, and hand before (A) and after serial treatment with pulsed dye laser, ablative fractional CO_2 laser, and an individual Z-plasty to the dorsal hand (B).

Treatment Approach

Treatment of hypertrophic scars requires a multimodal approach due to the spectrum of associated concerns and the natural recalcitrance of the scar to therapy. Protocols should be tailored to the individual but generally begin with tissue-conserving surgical interventions followed by selective photothermolysis of the scar vasculature. Subsequently, deep and superficial ablative fractional laser (AFL) treatment and local pharmacotherapy also are employed. Treatment can be accomplished in the outpatient setting under local anesthesia in a serial fashion. In the authors' experience, these therapies behave in a synergistic fashion, achieving outcomes that far exceed the sum of their parts, often obviating the need for scar excision in the majority of cases (Figure, B).

Tissue-Conserving Surgical Intervention—Z-plasty is an indispensable surgical tool due to its ability to lengthen scars and reduce wound tension. Treatment is easily customizable to the patient and can be performed using the individual or multiple Z-plasty techniques. Undermining and step-off correction while suturing allow the physician to lower raised scars, elevate depressed scars, and obscure scar presence by minimizing the straight lines that draw the eye to the scar. Z-plasties rely on the creation and transposition of 2 triangular flaps and permit a 75% increase in length along the desired tension vector. As such, Z-plasties decrease wound tension and facilitate scar maturation.

Selective Photothermolysis of the Vasculature—Although there are several devices available to treat vascular and immature hypertrophic scars, the majority of studies have been conducted with the 595-nm pulsed dye laser. By preferentially heating oxyhemoglobin within the dermal microvasculature, the pulsed dye laser irreparably injures the vascular endothelium. The subsequent tissue hypoxia and collagen fiber heating results in collagen fiber realignment, normalization of collagen subtypes, and neocollagenesis.[5] Pulsed dye laser therapy most effectively reduces erythema and pruritus; however, improvements in scar volume, pliability, and elasticity also have been reported.[5] When targeting the fine vasculature of the scar, thermal confinement is critical to prevent injury to the surrounding dermis. As such, pulse widths of 0.45 to 1.5 milliseconds are routinely utilized with a fluence just sufficient to elicit transient purpura lasting 3 to 5 seconds. Employing a spot size of 7 to 10 mm, typical fluences range from 4.5 to 6.5 J/cm^2. Engagement of the dynamic cooling device reduces the risk for complications, allowing the patient to proceed to the next step in their therapy regimen: the AFL.

Ablative Fractional Laser—The AFL creates a pixilated pattern of injury throughout the epidermis and dermis of the treatment area. Ablative fractional laser platforms include the 10,600-nm CO_2 and 2940-nm erbium-doped YAG lasers, both targeting intracellular water. The AFL vaporizes columns of tissue, leaving minute vertical channels with narrow rims of protein coagulation referred to as microscopic treatment zones (MTZs).[6] Scar collagen analysis after AFL treatment has shown a profile resembling unaffected skin.[7] Consistently, patients report improvements in stiffness, range of motion, pain, pruritus, pigmentation, and erythema. Physician observers also have reported similar improvements in these end points.[8,9] Recently, interim data from a prospective controlled trial were presented showing objective improvements in dermal thickness, elasticity, and extensibility after 3 treatments with the CO_2 AFL.[6] The UltraPulse CO_2 laser (Lumenis) is the most well-studied and

widely available AFL for scar therapy and as such we will outline common treatment parameters with this device. Of note, treatment end points may be generalized to any AFL.

The DeepFX UltraPulse configuration is utilized to achieve deep AFL therapy and has a fixed pulse width of 0.8 milliseconds, slightly less than the thermal relaxation time of the skin. The diameter of the MTZs is 120 µm, and MTZ density for scar treatment ranges from 1% to 10% with a goal depth of at least 80% of scar thickness. Maximal penetration of the AFL is 4 mm, which is directly proportional to fluence. The goal of deep AFL is the removal of scar tissue to facilitate remodeling and neocollagenesis. Superficial fractional ablation can then be achieved utilizing the ActiveFX UltraPulse configuration generating a 1.3-mm MTZ spot size. We commonly use a treatment level of 3 (82% density). Typical treatment energy ranges from 80 to 125 mJ, which correlates with depths of approximately 50 to 115 µm. With both configurations, the size and shape of the treatment area can be customized to the scar. In addition, frequency may be adjusted to control the speed of treatment while balancing the risk of bulk heating. The goal of superficial AFL is to minimize scar surface irregularities and ensure blending of deep AFL treatment. Once AFL treatment is complete, local pharmacotherapy can then be employed.

Pharmacotherapy—Intralesional corticosteroids have long represented the standard of care for hypertrophic scars, with concentrations between 2.5 and 40 mg/mL that are titrated to scar thickness and location to avoid unwanted atrophy. Visual blanching of the scar represents the clinical end point for treatment. Corticosteroids act by inhibiting fibroblast proliferation and enhancing collagen degradation.[10] 5-Fluorouracil (5-FU) also is used in scar management. In addition to inhibiting fibroblast proliferation and inducing fibroblast apoptosis, 5-FU inhibits myofibroblast proliferation, which is helpful in the prevention and treatment of scar contracture.[11] As monotherapy, weekly injections with 1 to 3 mL of 50 mg/mL 5-FU has been safe and effective. Combination intralesional corticosteroid and 5-FU therapy has been reported and is associated with improved scar regression, reduced reoccurrence, and fewer side effects.[11] In our experience, a 1:1 suspension is effective with appropriate titration of the corticosteroid component. Although less well defined, topical application of pharmacotherapy and massage to the newly created MTZs appears beneficial and offers another option for delivery of corticosteroids and 5-FU, in addition to a number of promising medications such as bimatoprost, poly-L-lactic acid, timolol, and rapamycin.[12]

Conclusion

Advances in laser surgery and our understanding of wound healing have created a paradigm shift in the treatment approach to trauma and burn scars. In lieu of extensive scar excisions, the summarized multimodal regimen emphasizing tissue conservation and autologous remodeling is gaining favor in the military, academic medical centers, and scar centers of excellence, but patients are finding local access to care difficult. Dermatologists are uniquely positioned to cost-effectively deliver this care in the outpatient setting utilizing devices and techniques they already possess. With the end goal of optimization of functional, symptomatic, and aesthetic state of the patient, it is critical that dermatologists seize this opportunity to truly make a difference for the military and civilian patients that need it most.

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