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Review

Laser in the management of burn scars

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ABSTRACT

Background and objective: Burn scars are associated with significant morbidity ranging from contractures, pruritus, and disfigurement to psychosocial impairment. Traditional therapies include silicone gel, compression garments, corticosteroid injections, massage therapy, and surgical procedures, however, newer and advanced therapies for the treatment of burn scars have been developed. Lasers, specifically ablative fractional lasers, show potential for the treatment of burn scars.

Methods: Both MeSH and keyword searches of the PubMed, Medline and Embase databases were performed and relevant articles were read in full for the compilation of this review.

Results: Fifty-one relevant observational studies, clinical trials, and systematic reviews published in English from 2006 to 2016 were reviewed and summarized.

Conclusion: Laser therapy is effective for the treatment of burn scar appearance, including measures such as pigmentation, vascularity, pliability, and thickness. Ablative fractional laser therapy, in particular, shows significant potential for the release of contractures allowing for improved range of motion of affected joints. Patients may benefit from the use of lasers in the treatment of burn scars, and the safety profile of lasers allows the benefits of treatment to outweigh the risks. Laser therapy should be included in burn scar treatment protocols as an adjuvant therapy to traditional interventions.

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Abbreviations: VSS, Vancouver Scar Scale; POSAS, Patient and Observer Scar Assessment Scale; TGF, Transforming growth factor; CO₂, Carbon dioxide; Er:YAG, erbium:yttrium-aluminum-garnet; HSP, Heat shock protein; SOFT, Selective objective fractional technique.

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1. Introduction

In 2016, there will be 486,000 burn injuries in the United States requiring medical treatment with 40,000 of those patients requiring hospitalization [1]. With current treatment protocols, 97% of the patients admitted to burn centers will survive [1]. However, non-fatal burns are an important cause of morbidity, with burn scars causing contractures, pruritus, and disfigurement with associated psychosocial impairments.

Burn scars can be classified by their pigmentation, erythema, texture, and thickness [2]. Scars can be either hyper- or hypo-pigmented compared to the patient's unaffected skin, and many burn scars are erythematous. Also, irregularities in scar texture are common among patients suffering from burns with the meshing of skin grafts being a common culprit for these irregularities [3]. Up to 91% of burn scars are hypertrophic, and this hypertrophy is caused by excessive and disorganized fibroblast deposition of type III, mostly, and type I collagen in dermis [4]. Hypertrophic scars form within weeks to months of the burn insult [4] and peak in thickness at 6-12 months. Thereafter, scar thickness decreases, and at 24-months post-burn injury, less than 30% of scars are hypertrophic [5]. This hypertrophic tissue, along with altered pigmentation, erythema, and irregular texture, is a target of interventions.

To help quantify changes in the characteristics of burn scars, there are 2 commonly used scar scales. One is the Vancouver Scar Scale (VSS) [6], which quantifies pigmentation, vascularity, pliability, and scar height. The other is the Patient and Observer Scar Assessment Scale (POSAS) [7], which is divided into a patient assessed portion and a physician assessed portion. The patient component quantifies pain, itchiness, color, stiffness, thickness, and irregularity of the burn scars, while the investigator component quantifies vascularity, pigmentation, thickness, relief, and pliability of the burn scars.

In addition to cosmetic effects of burn scars, there are several other morbidities associated with these scars. One important, and unfortunately common, morbidity of burn scars is contractures whereby the location of scar tissue limits the movement of nearby joints. Contractures can be classified as diffuse or linear, with linear contractures being comprised of prominent, well-defined bands and diffuse contractures spanning larger areas without discrete bands. Another major morbidity associated with burn scars is pruritus. Up to 87% of patients with burns report pruritus, specifically with hypertrophic burn scars, and symptoms disrupt sleep and daily activities [8]. Studies have shown this might be mediated by

inflammatory factors as well as increased densities of substance P positive nerve fibers [8]. In addition to changes at the site of injury, generalized anxiety, depression, and social anxiety are associated with burn scars [9]. Patients with burn scars report avoiding public places where scars would be visible, such as swimming pools, feeling unattractive and sexually undesirable because of the scars, and hiding scars even from people in close relationships [10].

There are several interventions traditionally used in the management of burn scars. Silicone gel sheeting increases the elasticity of burn scar tissue with studies also suggesting a reduction in pruritus, erythema, and scar thickness [11,12]. Similarly, compression garments result in decreased erythema, thickness, and hardness of burn scars [11,12], and this change is likely due to inhibition of transforming growth factor (TGF) β 1 release and ultimately decreased fibroblast activity [13]. Due to discomfort, appearance, interference with movement, and social stigma, patient compliance can be low [13]. Burn scar corticosteroid injections are another commonly used intervention and inhibit inflammatory processes in the dermis such as cell migration and fibroblast proliferation, which ultimately contribute to scar regression [14]. However, topical steroids often do not produce similar effects due to a lack of penetration of scar tissue [14]. As for massage therapy, a decrease in pain and pruritus can be reported immediately after the first session with improvements in the Vancouver Scar Scale, scar thickness, hyperpigmentation, and erythema after longer treatment regimens [11,15]. Overall, silicone gel sheeting, compression garments, corticosteroid injections, and massage therapy are often combined as part of a treatment protocol specific to each institution.

In addition to the traditional standard of care for the treatment of burn scars, several surgical interventions are also available [2]. A common surgical intervention involves the step-wise resection of the burn scar with incremental approximation of unaffected skin. Alternatively, the burn scar can be resected with placement of a new skin graft, although this new graft is at risk of developing similar undesirable characteristics in the future. Diffuse contractures are typically released with a transverse incision and subsequently grafted or covered with an advancement, rotation, or transposition flap from adjacent unaffected tissue while variations of a z-plasty are used to release linear contractures. Often these surgical interventions are combined with non-surgical interventions as a comprehensive management of burn scars.

Lasers are now playing an important role in burn scar management. A recently published treatment algorithm recommends all adult and pediatric patients begin a series

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