Improvement of Postfractional Laser Erythema with Light-Emitting Diode Photomodulation

Tina S. Alster, MD and Rungsima Wanitphakdeedecha, MD*

BACKGROUND The most common side effects of fractional laser skin treatment are erythema and edema. Low-level light therapy and light-emitting diode (LED) devices have been used to stimulate fibroblast activity and hasten wound healing.

OBJECTIVE To determine whether LED treatment immediately after fractional laser skin resurfacing affects the severity and duration of postoperative eythema.

MATERIALS AND METHODS Twenty patients received treatment with a 590-nm wavelength LED array to randomly selected facial halves immediately after undergoing full-face fractional laser skin resurfacing with a 1,550-nm erbium-doped fiber laser. Differences in erythema between LED-treated and untreated facial halves were recorded at 24, 48, and 96 hours post-treatment.

RESULTS The LED-treated facial halves were less erythematous in all 20 patients 24 hours postoperatively. The six patients who received the highest mean energy densities during fractional laser treatment continued to exhibit decreased erythema in the LED-treated areas at 48 hours. At 96 hours post-treatment, no discernible differences between facial halves were observed in any patient.

CONCLUSIONS Photomodulation with a 590-nm-wavelength LED array can decrease the intensity and duration of postfractional laser treatment erythema.

The authors have indicated no significant interest with commercial supporters.

Fractional laser skin treatment has become popularized for the amelioration of photodamaged and scarred skin because of its high clinical efficacy and low postoperative side-effect rate.[1–3] Transient erythema, edema, and xerosis of treated skin are expected side effects of treatment, but severe or long-standing complications are rare.[4] Despite the limited recovery period after fractional laser resurfacing, patients are often inconvenienced by skin erythema and edema that prevent them from immediately pursuing their activities of daily living. Light-emitting diode (LED) therapy using a variety of red, blue, and yellow wavelengths has been reported to accelerate cutaneous wound healing after various injuries, including surgical procedures and radiation.[5,6] The purpose of this study was to evaluate the effectiveness of a 590-nm nonthermal LED array in reducing the intensity and duration of postfractional laser cutaneous erythema.

Materials and Methods

Twenty consecutive patients undergoing full-face fractional laser skin resurfacing with a 1,550-nm erbium-doped fiber laser (Fraxel, Reliant Technologies, Inc., Mountain View, CA) for cutaneous photodamage or atrophic scars were randomized to receive 590-nm nonthermal LED treatment (Gentlewaves, Light BioSciences, Virginia Beach, VA) at 0.1 J/cm^2 with a device-specific (fixed) sequence of pulsing to one facial half immediately postprocedure. The contralateral facial half was used as a nontreated control for comparison. Specific patient demographics are outlined in Table 1. All patients were eligible for treatment and were provided the 35-second split-face LED therapy free of charge.

Facial photographs were taken using identical camera settings, lighting, and patient positioning immediately after fractional laser treatment (pre-LED treatment) and 24, 48, and 96 hours after fractional

*Both authors are affiliated with Washington Institute of Dermatologic Laser Surgery, Washington, District of Columbia

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TABLE 1. Patient Demographics

Skin Phototype	*I*	*II*	*III*	*IV*	*Total*
# Patients	5	10	4	1	20
Age, in years (mean)	39–59 (50)	41–74 (57.4)	47–65 (58.5)	53 (53)	39–74 (55.6)
Gender (M/F)	1/4	1/9	0/4	0/1	2/18

laser–LED treatment. Two clinical medical assessors blinded to study protocol independently viewed before and after LED photographs in random order to determine whether differences in erythema between treated and untreated facial halves were evident using the following rating scale: 0 = both sides equal, −1 = left side redder, + 1 = right side redder.

Results

Twenty-four hours after treatment, the LED-treated facial halves were rated as appearing less erythematous in all 20 patients (Figure 1). Six patients continued to exhibit decreased erythema in the LED-treated areas 48 hours postoperatively. At 96 hours post-treatment, no discernible differences in erythema intensity between facial halves were observed (Table 2).

The six patients who showed continued differences in the severity of erythema between facial halves at 48 hours post-treatment were the ones who received the highest total energy densities (averaging 5.3 kJ, compared with a mean of 4.2 kJ for the remainder of the study group). No differences were observed between different skin phototypes, sexes, or ages.

Figure 1. Decreased erythema was seen on the light-emitting diode–treated facial half (left cheek) 24 hours after full-face 1,550-nm fractional laser skin resurfacing.

Discussion

Low-level laser therapy (LLLT) has been reported for many decades to exert a positive effect on wound healing.[7] Mester and colleagues introduced the biostimulative effects of LLLT in the late 1960s.[8,9] Otherwise known as "low-intensity laser," "low power laser," or "cold laser," LLLT takes place at irradiation intensities so low that any biological effects that occur are due to direct cellular effects of the radiation rather than as a result of tissue heating. Treatment energies are limited to a few J/cm^2 and laser powers range only to 50 milliwatts (mW), which is in contrast to surgical lasers that generate exponentially higher powers.

LLLT is distinguished from LED therapy in that the latter is a semiconductor device emitting light of varying wavelengths that are neither monochromatic nor coherent. Early animal and human studies demonstrated LED-induced diminution in wound size and protection from skin inflammation and ulceration.[10,11] Subsequent studies have deemed the positive effects to be related to stimulation of fibroblast activity through mitochondrial functional

TABLE 2. Erythema Rating (*n* = 20)

Score	*0 hours*	*24 hours*	*48 hours*	*96 hours*
−1	0	10	2	0
0	20	0	14	20
+ 1	0	10	4	0

0 = both sides equal, −1 = left side redder, + 1 = right side redder. NB: LED sites equally distributed between right and left facial halves.

enhancement.[12] In addition, upregulation of procollagen synthesis in human fibroblast cultures and downregulation of matrix metalloproteinases (collagenase) can be achieved by varying LED fluences and pulse duration.[13–15] Fibroblast stimulation is probably responsible for enhanced wound healing and for decreased inflammation.

The results of prior research can thus explain the antiinflammatory effect with decreased erythema observed when LED treatment was immediately delivered to fractional laser-irradiated skin in this study. The ease of application of LED treatment and its clinical benefit have led us to recommend its use after every fractional and ablative laser procedure performed in our center. Patients are pleased with the noticeable improvement in skin healing and postoperative comfort, as well as their ability to return to their regular activities more quickly.

Conclusions

This is the first prospective study specifically designed to evaluate the effect of a 590-nm wavelength LED array on recovery after fractional laser skin resurfacing. Our results indicate that photomodulation using this particular LED device can decrease the intensity and duration of post-treatment erythema. Additional investigations should be performed to better determine the exact protocol needed to optimize clinical outcomes and to further elucidate the mechanisms of action whereby this treatment exerts its effect on tissue.

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Address correspondence and reprint requests to: Tina S. Alster, MD, Washington Institute of Dermatologic Laser Surgery, Washington, DC, or e-mail: talster@skinlaser.com