
Nonablative Laser Skin Resurfacing using a 1540 nm Erbium Glass Laser: A Clinical and Histologic Analysis

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BACKGROUND. A variety of laser systems have recently become available that allow for selective dermal remodeling without disruption of the epidermal surface. Modest clinical improvement in mild to moderate photoinduced facial rhytides with minimal morbidity is typical of these nonablative lasers, providing a significant advantage over traditional ablative laser systems.

OBJECTIVE. To determine the clinical and histologic effects of a novel 1540 nm erbium glass laser on facial rhytides.

METHODS. Patients with mild to moderate periorbital and perioral rhytides received a series of three monthly treatments with a 1540-nm erbium-doped phosphate glass laser by a single operator. Photographic and clinical evaluations were independently conducted by the patient and a masked medical observer at each treatment visit and at 1, 3, and 6 months following the

final treatment session. Skin biopsies were obtained for histologic analysis by a board-certified dermatopathologist at baseline, immediately following laser irradiation, and at one and six months post-treatment.

RESULTS. Slow, progressive clinical improvement of rhytides was noted in all patients after each treatment and continued throughout the extended follow-up period. Side effects of treatment were limited to transient erythema and edema immediately following laser irradiation. No serious adverse effects were noted. Histologic skin changes were not apparent until several months following treatment, when an increase in dermal collagen was noted.

CONCLUSIONS. The nonablative 1540 nm erbium glass laser system with contact cooling produces gradual clinical and histologic improvement in mild to moderate facial rhytides with minimal risk of serious adverse sequelae.

J.R. LUPTON, MD, C.M. WILLIAMS, MD, AND T.S. ALSTER, MD HAVE INDICATED NO SIGNIFICANT INTEREST WITH COMMERCIAL SUPPORTERS.

ABLATIVE LASER skin resurfacing with high-energy, pulsed and scanned carbon dioxide (CO₂) and erbium:yttrium-aluminum-garnet (Er:YAG) lasers is now considered a mainstay of treatment for severely photo-damaged facial skin.¹⁻⁷ Although treatment with these systems consistently provides significant improvement in photoinduced facial rhytides and atrophic scars, they are often associated with a prolonged postoperative recovery and potentially permanent adverse sequelae.^{1,4,8-11} At standard treatment parameters, these lasers ablate the entire epidermis, part of the superficial dermis, and impart varying depths of coagulative thermal necrosis in residual tissue. Tissue ablation removes signs of superficial photodamage such as solar lentigines, while the induced thermal damage initiates a wound healing response that affects tissue tightening and stimulation of prolonged neocollagenesis.^{1,12,13}

The exposed skin resulting from the ablative process requires that reepithelialization take place before recovery is complete. The typical seven to 10-day period during which this occurs increases the risk of untoward side effects and complications. The more com-

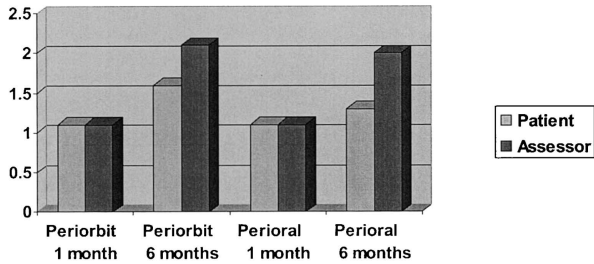
mon adverse effects of ablative laser treatment include prolonged postoperative erythema, edema, acne and milia formation, pigmentary alteration, hypertrophic scar formation, and delayed wound healing.^{1,4,8-11} For these reasons, research in laser technology over the past few years has focused on alternative modes of facial rejuvenation. Several different nonablative lasers and light sources have subsequently been developed in an effort to ameliorate scars or rhytides without epithelial disruption—thereby eliminating most of the risks associated with ablative laser treatment.¹⁴⁻²⁴

Similar to the 1320 nm Nd:YAG laser system, the 1540 nm erbium glass laser is a novel, mid-infrared range laser that targets intracellular water to a depth of 0.4 mm to 2 mm. Because minimal absorption of energy by melanin occurs at this wavelength, safer treatment of darker complected or tanned individuals would be anticipated. This study was conducted to determine the effectiveness of a 1540-nm erbium glass laser in the treatment of a series of patients with mild to moderate photoinduced periorbital and perioral rhytides.

Materials and Methods

Twenty-four females (ages 31–69; mean 47 years, skin phototypes I-II) with mild to moderate periorbital and/or perio-

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Grading: 1 = <25%, 2 = 26-50%, 3 = 51-75%, 4 = >75% improvement

Figure 1. Clinical improvement scores.

ral rhytides were included in the study. Three consecutive monthly treatments were delivered to the treatment areas using a 1540-nm erbium glass laser (Aramis, Quantel Medical, Clermond-Ferrand, France).

A single operator (JRL) delivered all treatments using a 4-mm spot size, 2 Hz repetition rate, 10 J/cm² fluence, and a 3.5-ms pulse duration. Three laser passes were delivered in the periorbital areas and five passes were delivered in the perioral areas. Skin surface cooling was achieved with the concomitant use of a contact sapphire lens cooled to a temperature of 5°C.

Photographic documentation and clinical improvement scores were determined at each treatment visit and at 1, 3, and 6 months following the final treatment. Every patient completed the three laser sessions and returned for each of the three follow-up evaluations. Each patient and a masked medical evaluator independently performed clinical assessments using a well-established quartile grading scale of 1 = < 25%, 2 = 26-50%, 3 = 51-75%, 4 = > 75% improvement. Standardized photographs were shown to help evaluators determine what constituted each clinical grade. Three millimeter diameter skin punch biopsies were obtained at baseline, immediately following the first laser treatment, and at 1 and 6 months following the final treatment session and processed for blinded evaluation by a board-certified dermatopathologist (MCW). Side effects were recorded and rated in severity (0 = none, 1 = mild, 2 = moderate, 3 = severe) at each treatment visit and follow-up.

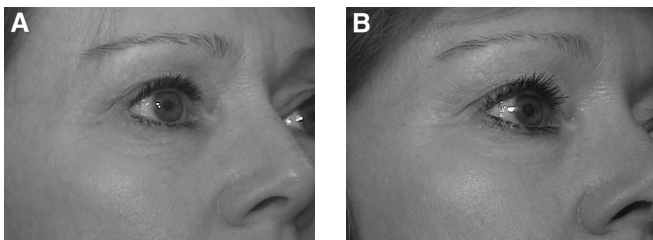


Figure 2. A) Periorbital area pre-treatment. B) Periorbital area six months after the third 1540nm erbium glass laser treatment (mean improvement score = 2).

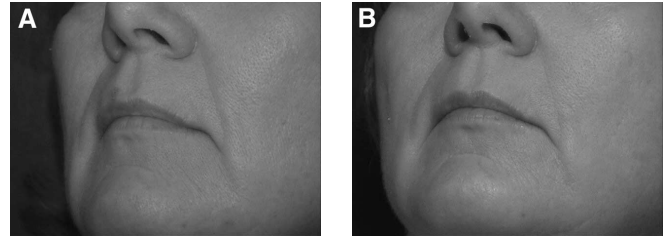


Figure 3. A) Perioral area pre-treatment. B) Perioral area six months after the third 1540nm erbium glass laser treatment (average clinical assessment score = 1.5).

Results

Clinical Improvement

Average improvement scores by the patient and the masked assessor for both the periorbital and perioral areas were 1.1 one month after treatment (Figure 1). Six months post-treatment, mean improvement scores of 1.6 and 2.1 were given for the periorbital area by the patient and masked assessor, respectively. (Figure 2A,B) Lower average improvement scores of 1.3 (patient) and 2.0 (assessor) were observed in the perioral region (Figure 3A,B).

Histologic Evaluation

Baseline (pretreatment) biopsies demonstrated mild to moderate solar elastosis in the upper dermis (Figure 4A). Mild tissue edema and acute inflammatory cells were seen immediately after laser irradiation. (Figure 4B) Six months after the final (third) treatment, a mild but noticeable increase in dermal fibroplasia was evident (Figure 4C).

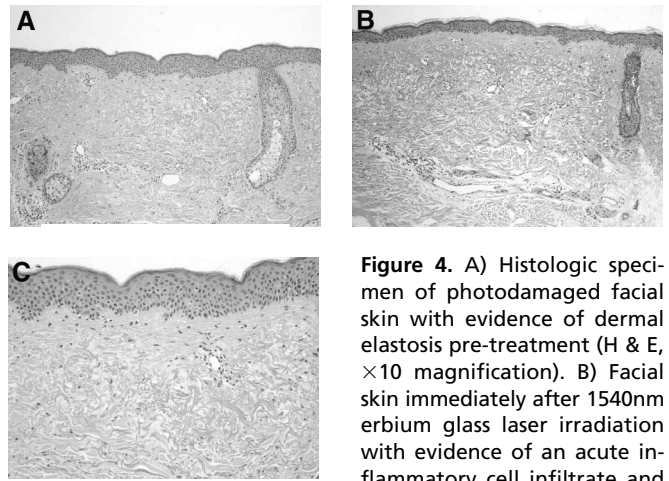


Figure 4. A) Histologic specimen of photodamaged facial skin with evidence of dermal elastosis pre-treatment (H & E, ×10 magnification). B) Facial skin immediately after 1540nm erbium glass laser irradiation with evidence of an acute inflammatory cell infiltrate and mild tissue edema (H & E, ×10 magnification). C) Histologic specimen six months after the third 1540nm erbium glass laser treatment demonstrates increased dermal collagen (H & E, ×20 magnification).

Side effects

In general, side effects of treatment with the 1540 nm erbium glass laser were minimal and transient. Of the 24 patients treated, 100% developed mild transient erythema with a mean grade of 0.43. Mild transient tissue edema was noted in 92% of patients treated with a mean grade of 0.64 and 40 percent of patients experienced mild treatment pain (mean grade of 0.11). One patient experienced reactivation of an oral herpes simplex infection following the first treatment. Prophylactic use of valacyclovir (500 mg twice daily for five days) for the remaining treatment sessions prevented further recurrence. No other patients were treated with prophylactic antiviral medications during the study. There were no instances of pigmentary alteration or scarring as a result of treatment. The treatment sessions were generally well-tolerated with minimal patient complaints.

Conclusions

This study demonstrates that the 1540 nm erbium glass laser is a safe and effective treatment modality for mild to moderate photoinduced facial rhytides. A mild to moderate clinical improvement in the appearance of fine lines in the periorbital and perioral regions was noted in all of the patients studied. The periorbital area appeared to be more responsive to treatment than was the perioral region using the laser parameters outlined. This observation is most likely related to the thinness of the skin in the periorbital region with the use of low treatment fluences producing more erythema and therefore increased dermal wounding and new collagen formation. Histologic findings in this study also support the results of previous nonablative laser studies that have demonstrated a lack of correlation between the degree of dermal fibroplasia produced after treatment with the amount of clinical improvement achieved.^{15-17,20-24}

Side effects of treatment with the erbium glass laser were minimal. The severity and duration of erythema observed post-treatment was universally mild and resolved within one hour after treatment.

While the clinical results achieved with this laser system are similar to those produced by other nonablative lasers and light sources, it is not surprising that none of the nonablative systems is yet able to produce clinical results comparable to those of CO₂ or Er:YAG laser resurfacing. Nonablative laser skin resurfacing thus appears to be ideally suited for patients who are either unable to undergo an ablative laser procedure because of the associated prolonged recovery time or for those with only mild cutaneous pathology. With continued refinements in the technology and tech-

nique over time; however, advances are anticipated that will produce even further clinical enhancements without significant risk of adverse sequelae.

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