
Clinical, Histologic, and Ultrastructural Changes after Nonablative Treatment with a 595-nm Flashlamp-Pumped Pulsed Dye Laser: Comparison of Varying Settings

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BACKGROUND. The flashlamp-pulsed dye laser has been used for nonablative dermal remodeling.

OBJECTIVE. We conducted a study analyzing the clinical, histologic, and electron microscopic findings after treatment with different flashlamp-pulsed dye laser settings in the same subject.

RESULTS. Most subjects showed mild to moderate improvement after flashlamp-pulsed dye laser treatment. There

was no statistical difference in the clinical, histologic, or electron microscopic findings with a variety of laser treatment settings.

CONCLUSION. Nonablative dermal remodeling can be accomplished with not only a variety of different technologies, but also with the same laser using markedly different settings.

DAVID J. GOLDBERG, MD, DALE SARRADET, MD, MUSSARAT HUSSAIN, MD, ANNA KRISHTUL, MD, AND ROBERT PHELPS, MD HAVE INDICATED NO SIGNIFICANT INTEREST WITH COMMERCIAL SUPPORTERS.

INTRINSIC, ENVIRONMENTAL, and lifestyle factors all contribute to the development of aging skin.¹⁻⁵

A variety of methods have been used to promote normalization of actinically damaged skin. Topical preparations such as retinoic acid, alpha-hydroxy acids, and vitamin C have all been used to treat photodamaged skin.⁶⁻⁸ In addition to these topically applied agents, physical injury to the skin⁹⁻¹⁵ with resultant removal of the epidermis and superficial dermis can be accomplished with chemical peels, electrical surgical techniques, dermabrasion, and ablative laser resurfacing.

Ablative procedures, with CO₂ and Er:YAG lasers, lead to reactive dermal neocollagen formation and improvement in photodamage.^{13,16-19} These methods, despite being effective,^{13,16,20,21} may also lead to the potential risks of infection, scarring, and either hyper- or hypopigmentation.^{16,22,23} These undesirable side effects have led to intensified research in the use nonablative facial rejuvenation by a variety of nonablative techniques. Some studies have shown significant im-

provement with these nonablative systems; others show only limited cosmetic changes after treatment.¹⁸

The flashlamp-pulsed dye laser is commonly used to treat port wine stains, hemangiomas, telangiectasias, and other vascular anomalies.^{24,25} Studies using this laser have also noted posttreatment improvement in atrophic striae distensa, hypertrophic scars, and rhytides.^{24,26,27,42} In this study we chose not only to evaluate the flashlamp-pulsed dye laser-induced effect on dermal collagen, but also whether varying treatment settings using the flashlamp-pulsed dye laser made any difference on the clinical, histologic, or ultrastructural changes seen after treatment.

Materials and Methods

Ten female subjects with Fitzpatrick skin types I to IV and class II to III rhytides were treated after appropriate informed consent was obtained. The study protocol was approved by our institutional review board and conformed to the ethical guidelines of the 1975 Declaration of Helsinki. Exclusion criteria included a history of dermatitis in the treatment area, photosensitivity, abnormal scar formation, vascular disease, and/or pregnancy. Patients were also excluded if they had used oral retinoids or had any other previous

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aesthetic periorbital treatments, such as other laser procedures, chemical peels, or dermabrasion, within 1 year of study treatments. The subjects were randomly divided in two groups of 5. All subjects received flashlamp-pulsed dye laser treatment to the periorbital and surrounding regions. The first group of 5 subjects was treated once, whereas the second group of 5 subjects was treated twice at a 1-month intervals. All were treated with 595 nm flashlamp-pulsed dye laser (Vbeam, Candela, Wayland, MA). Each side of the subject was treated with distinctly different laser settings. All subjects were treated at the highest possible fluence without induction of clinical purpura. One side of the face was treated with a 1.5-msec pulse; the contralateral side was treated with a 40-msec pulse duration. Laser settings for the 1.5-msec flashlamp-pulsed dye laser-treated side were 5 to 6 J/cm² and a spot size of 7 mm. The contralateral 40-msec flashlamp-pulsed dye laser treatment side received fluences of 8 to 11 J/cm² with an identical 7-mm spot size. Epidermal dynamic cryogen cooling was applied for 30 msec with a delay time of 30 msec before laser treatment of both sides.

Clinical photography, using standardized digital photography, was undertaken before and 6 months after the final treatment. Analysis of improvement was undertaken through photographic evaluation by a nontreating physician. Clinical results based on investigators' assessments of photographs were undertaken using the Fitzpatrick Wrinkle Assessment scale.³ Subjects were also asked whether they noted any degree of improvement in skin quality and texture. Posttreatment complications, including pain, erythema, scarring, and pigmentary changes, were recorded.

Pretreatment and 6-month posttreatment biopsies were taken and preserved in glutaraldehyde. Tissue specimens were then analyzed with both standard histologic analysis and by electron microscopy for collagen fiber size.

Results

Flashlamp-pulsed dye laser treatments were well tolerated. All subjects described the procedure as near painless. Immediately after treatment all subjects were noted to have some degree of erythema; none showed any evidence of clinical purpura. No pigmentary changes or scarring was noted during the course of the study.

Seventy percent (7/10) of the subjects were noted to have mild to moderate improvement after treatment. Six subjects were noted to have equal improvement on both sides (Figure 1). One subject showed greater clinical on the 40 msec pulse duration-treated side (Figure

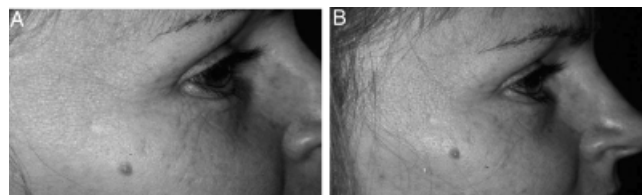


Figure 1. (A) Before treatment using 1.5-msec, 6 J/cm² flashlamp-pulsed dye laser. (B) After treatment of subject in A. Mild improvement noted after treatment.

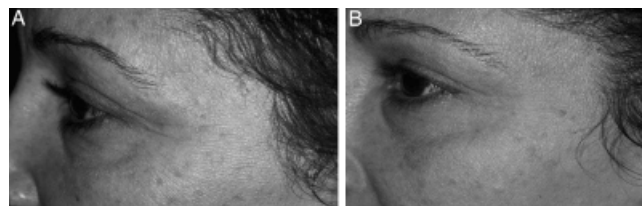


Figure 2. (A) Before treatment using 40-msec, 11 J/cm² flashlamp-pulsed dye laser. (B) After treatment of subject in A. Moderate improvement was noted.

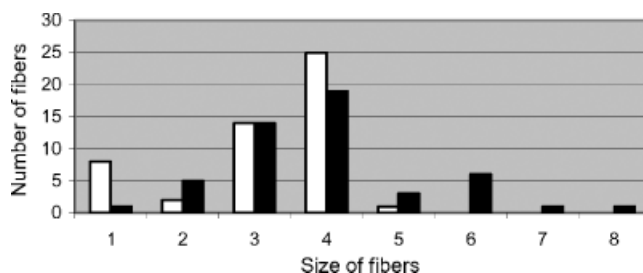


Figure 3. Before treatment (□) there are similar amounts of collagen of various fiber sizes. After treatment (■) there is a relative increased number of larger fibers consistent with an increase in Type I collagen.

2). There appeared to be no difference between a single and double treatment. Histologic findings showed evidence of varying degrees of posttreatment upper papillary dermal fibroplasia. There were no significant differences in the various treated groups. Electron microscopic findings were consistent with an increase posttreatment thicker type I collagen formation in all treated patients with all settings (Figure 3).

Discussion

Type I collagen is the most abundant protein in skin, and type I and type III collagen fibrils provide strength and resiliency to skin. Photoaged skin contains an abundance of degraded, disorganized collagen fibrils and has a reduced production of type I and type III procollagen.^{28,29}

Laser resurfacing, through the theory of selective photothermolysis,³⁰ leads to clinical improvement of photodamaged skin. The clinical efficacy of ablative

laser resurfacing, however, has been limited by potential prolonged healing times, risks of scarring, and pigmentary changes.^{13,22,23} Because of these potential complications, newer skin rejuvenation options have been evaluated, nonablative skin remodeling has now been accomplished with a wide array of lasers and light sources. All promote improvement in skin quality without destruction of the overlying epidermis.³¹⁻³⁵ The energy produced by these systems is predominantly absorbed either by water or hemoglobin contained within the superficial vasculature.

Nonablative treatments have now been shown to improve the appearance of fine lines, skin tones, skin texture, and acne scars.^{34,36-42} Improvement after nonablative treatment is thought to occur either³⁹ through photothermal heating that leads to fibroblast activation, increased procollagen III expression, and subsequent collagen remodeling and/or by vascular hemoglobin absorption leading to endothelial disruption, cytokine activation, and subsequent collagen remodeling.

The pulsed dye laser is commonly used to treat port wine stains, hemangiomas,^{24,25} telangiectasias, and other vascular anomalies. Studies have also shown flashlamp-pulsed dye laser-induced beneficial effects in atrophic striae distensa and hypertrophic scars.^{24,26,27}

Zelickson et al.³⁶ were among the first to show a beneficial effect after flashlamp-pulsed dye laser treatment of photodamaged skin. They evaluated the clinical effect of a single 585-nm flashlamp-pulsed dye laser treatment. Laser settings included a fixed pulse duration of 450 μ sec and fluences varying between 3 and 6.5 J/cm². Nine of 10 patients with mild to moderate wrinkling showed an improvement of 50% or more, with 30% showing improvement of 75% or more. Occasional posttreatment purpura was noted. Histologic analysis revealed a thickened layer of normal-staining collagen within the superficial dermis. Ultrastructural evaluation showed an increased amount of normal appearing elastin and collagen fibers within the superficial dermis. Other investigators have noted improvement in photodamaged skin using a wide array of flashlamp-pulsed dye laser settings.⁴⁰⁻⁴²

Goldberg et al.⁴² analyzed both clinical rhytid improvement and electron microscopic evidence of ultrastructural changes after treatment with a 350- μ sec, 585-nm flashlamp-pulsed dye laser. At 6 months after two treatments, 40% of the treated subjects noted mild improvement in rhytid appearance. Electron microscopic evaluation showed ultrastructural changes that are consistent with new collagen formation.

The current pilot study is the first to evaluate the clinical, histologic, and ultrastructural changes after nonablative treatment, using varying settings in the same subject. Although this study does confirm the

noted flashlamp-pulsed dye laser improvement seen in previous studies, it would appear that the utilization of different treatment settings in the same subject did not lead a difference in results. The study results must be tempered by the small sample size. It may be that a significantly larger sample size may lead to different findings. In addition, the results of two treatments versus one treatment may have been quite different had the treatment intervals been more than 1 month. Finally, although the general practice is to provide three to six monthly nonablative treatments, this study shows that improvement can be seen with even fewer treatments. What has yet to be determined is the ideal number of required treatments.

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