

# Histologic and Ultrastructural Analysis of Ultraviolet B Laser and Light Source Treatment of Leukoderma in Striae Distensae

DAVID J. GOLDBERG, MD,\*† ELLEN S. MARMUR, MD,\*† CHRYSALINE SCHMULTS, MD,\*‡ MUSSARRAT HUSSAIN, MD,\* AND ROBERT PHELPS, MD†

\*Skin Laser and Surgery Specialists of NY/NJ, Hackensack, New Jersey; †Department of Dermatology, Mount Sinai School of Medicine, New York, New York; ‡Department of Dermatology, University of Pennsylvania, Philadelphia, Pennsylvania

**BACKGROUND.** Lasers and light sources emitting ultraviolet B (UVB) irradiation have been shown to repigment striae distensae.

**OBJECTIVE.** The purpose of this study was to analyze the histologic and ultrastructural changes seen after UVB laser- or light source-induced repigmentation of striae distensae.

**METHODS.** Ten subjects with hypopigmented striae were selected. Five subjects were treated with an XeCl excimer UVB laser, and five subjects were treated with a UVB light device. Six months after the final treatment, the biopsies were evaluated for both

standard and electron microscopic changes in melanocytes.

**RESULTS.** Analyses of biopsied skin after treatment with both the UVB laser and light source showed increased melanin content, hypertrophy of melanocytes, and an increase in the number of melanocytes in all patients.

**CONCLUSIONS.** Repigmentation of striae distensae with either a UVB laser or light source is due to an increase in melanin pigment, hypertrophy of melanocytes, and an increase in melanocytes.

DAVID J. GOLDBERG, MD, ELLEN S. MARMUR, MD, CHRYSALINE SCHMULTS, MD, MUSSARRAT HUSSAIN, MD, AND ROBERT PHELPS, MD, HAVE INDICATED NO SIGNIFICANT INTEREST WITH COMMERCIAL SUPPORTERS.

STRIAE DISTENSAE are scars with microscopic evidence of thinning and flattening of the epidermis, a normal or decreased number of melanocytes, and thinning and retraction of the dermal collagen and elastin. Clinically, striae appear as erythematous (striae rubra) or hypopigmented (striae alba), linear, dermal scars with epidermal atrophy. Causes of striae include pregnancy, obesity, high corticosteroid levels, weight loss, high potency topical corticosteroid application, protease inhibitor ingestion, endocrine disorders, and connective tissue disease.<sup>1</sup> The distribution of striae is variable but usually involves the abdomen, buttocks, and breasts. Extremities may also be involved, for example, in the bicipital or popliteal areas. Women develop striae more commonly than men (reportedly 90% of pregnant women, 70% of adolescent females, and 40% of adolescent males).<sup>2</sup>

Anecdotal treatments are numerous and unproven. *Centella asiatica* extract,  $\alpha$ -tocopherol collagen-elastin hydrolysates, eucalyptus tree oil, and tretinoin (all-trans retinoic acid) have been used with anecdotal success in reducing or improving the appearance of striae. In addition, laser treatments using the 585 nm flashlamp pumped

pulsed dye laser for striae rubra and alba have been used, with limited success.<sup>3,4</sup> New developments in laser technology use focal narrow-band UVB phototherapy for the treatment of striae alba.

The XeCl excimer laser emits monochromatic laser light at 308 nm, with a train of 30 ns pulses at a repetition rate of up to 250 Hz. Laser energy is delivered through a fused silica fiber to a handpiece with variable fluences between 100 and 2,100 mJ/cm<sup>2</sup>. A specialized handpiece delivers laser energy through an iris, with spot sizes varying between 0.2 × 0.2 cm and 1.8 × 1.8 cm. The XeCl excimer laser has been used in cardiology for transmural laser revascularization and in dentistry for the ablation of dentine.<sup>5,6</sup> In dermatology, the excimer laser was initially developed for the treatment of localized psoriasis to limit the adverse effects of chronic UVB exposure from conventional phototherapy.

UVB light sources are generally generated by a mercury vapor arc lamp. The therapeutic wavelength emission is 290 to 320 nm, with operational modes of continuous or single pulses and variable pulse widths. Those used for the treatment of leukoderma generally are used with treatment spots with an adjustable size and shape.

Following the successful treatment of plaque psoriasis, the uses of the excimer laser and the UVB light source have been expanded for treatment of various localized leukodermas, such as vitiligo, hypopigmented scars, and striae

Address correspondence and reprint requests to: David J. Goldberg, MD, 20 Prospect Ave., Suite 702, Hackensack, NJ 07601, or e-mail: drdavidgoldberg@skinandlasers.com.

alba. The excimer laser and the UVB light source have since been established as excellent, safe treatments for vitiligo.<sup>7</sup> Hypopigmented acne scars on the face improve considerably after treatment with either the 308 nm laser or the UVB light source.<sup>8</sup> Similar improvement has been noted after excimer laser treatment of leukoderma in striae distensae.<sup>9-11</sup> This study is the first histologic and ultrastructural analysis of changes in melanocytes after treatment with an UVB-emitting laser and light source.

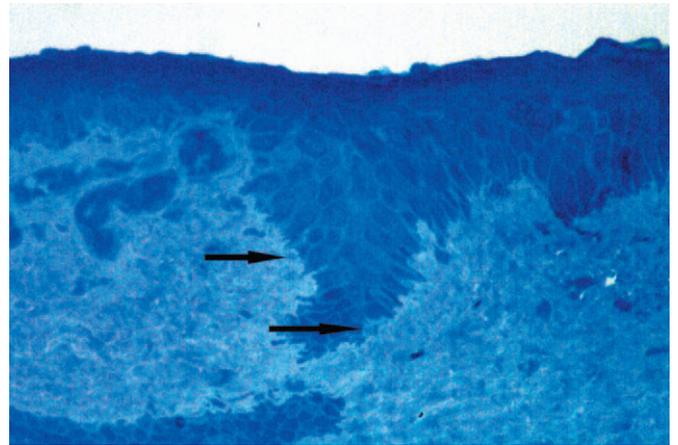
## Materials and Methods

Ten subjects between the ages of 20 and 45 years with hypopigmented striae, present for at least 2 years on the trunk or extremities, were selected. Subjects were Fitzpatrick skin phenotypes II to IV and had not had any previous treatment to their striae prior to the study.

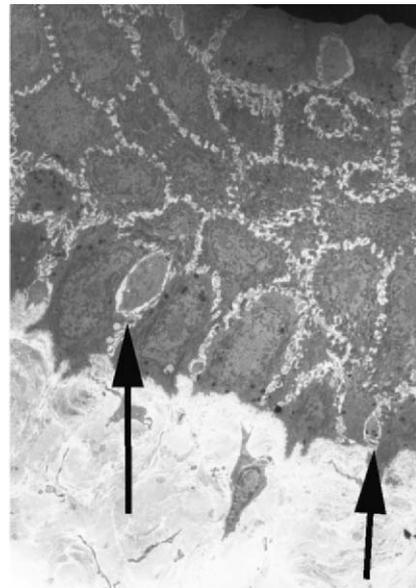
Five subjects were treated with an XeCl excimer laser (Xtrac, PhotoMedex, Radnor, PA, USA). The remaining five subjects were treated with a UVB light device (ReLume, Lumenis, Santa Clara, CA, USA). Minimal erythema dose was determined on all subjects prior to beginning treatments. Before treatment, a 3 mm punch biopsy was taken from the leukodermatous striae for standard histologic examination and electron microscopic analysis. The first treatment for each subject was started at their minimal erythema dose. The treatment dose was increased by 10% each treatment until post-treatment erythema was achieved. Treatments were continued on each subject until 10 treatments were completed with either full repigmentation or until the subject was noted to have a 75% or greater increase in pigment in the treatment area. Six months after treatment, biopsies were again taken for standard histologic examination and electron microscopic analysis. The biopsy results were analyzed for changes in melanocytes.

## Results

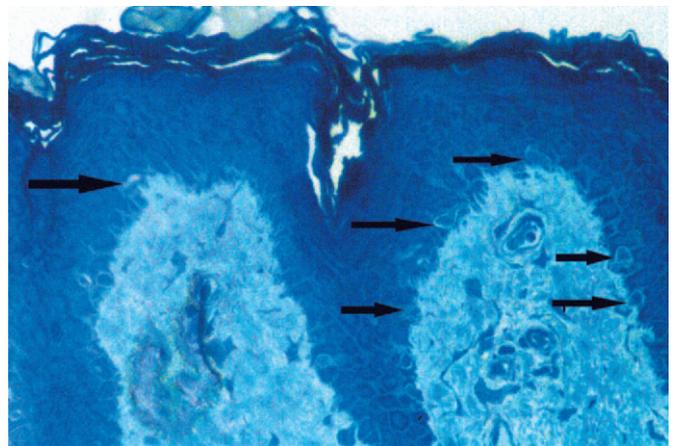
Both histologic and electron microscopic biopsies taken before treatment with a UVB laser and light source revealed a normal number of small melanocytes at a 1:10 ratio with respect to basal keratinocytes (Figures 1 and 2). Six months after the final UVB laser or light source treatment, all subjects showed clinical evidence of some persistence of clinically significant pigmentation. The clinical results were similar with both the UVB laser and light source. In addition, 6 months after the final UVB laser or light source treatment, all biopsies showed histologic evidence of both an increase in number and enlargement of melanocytes at the epidermal basal cell layer (Figure 3). The histologic results were similar with both the UVB laser and light source. There appeared to be no difference in the histologic findings based on treated skin phenotype. Six-month post-treatment electron microscopic biopsies con-



**Figure 1.** Standard histologic examination prior to treatment showing small melanocytes that are difficult to discern. (Arrows indicate melanocytes.) (Toluidine stain;  $\times 40$  original magnification)

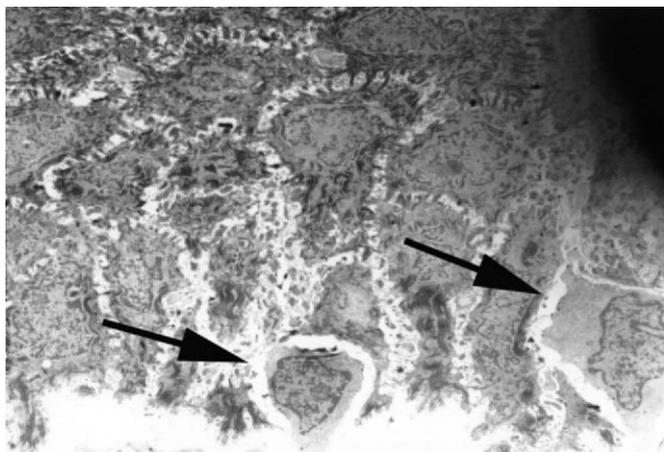


**Figure 2.** Electron microscopy prior to treatment showing small melanocytes. (Arrows indicate melanocytes.)



**Figure 3.** Standard microscopy 6 months after treatment showing an increase in the number and size of melanocytes. (Arrows indicate a subset of the most prominent melanocytes in this section.) (Toluidine stain;  $\times 40$  original magnification)

firmed the presence of enlarged melanocytes of varying sizes (Figure 4). This was associated with an increased number of melanosomes. The findings were identical after both laser and light source treatment. Such findings are consistent with that of a "chronic" suntan and correlated with the persistence of pigment at 6 months after treatment. Biopsies of random untreated leukoderma striae distensae in all study subjects did not show such changes.



**Figure 4.** Electron microscopy 6 months after treatment showing an increase in the number and size of melanocytes. (Arrows indicate a subset of the most prominent melanocytes in this section.)

## Discussion

High-dose targeted UVB laser or light systems, using fiberoptic-delivered light technology, have been used for the treatment of localized leukodermal skin conditions, such as striae distensae. Both the laser and nonlaser devices used in this study allow for customized treatments and significantly higher doses than those delivered from conventional ultraviolet light box therapy.

Traditional UVB phototherapy usually requires multiple treatments, with additional maintenance treatments. Similarly, targeted laser and light source phototherapy requires a number of treatments to achieve and maintain lasting repigmentation of leukodermal skin conditions. Initially, it was assumed that targeted UVB stimulates melanocytes to increase melanin production. On withdrawal of the light stimulus, these melanocytes would be expected to return to their baseline level of melanin production. However, our ultrastructural analysis showed both an increase in the number and size of melanocytes and an increase in the number of melanosomes. The increase in the number of melanocytes was an unexpected finding but may account for the long-term, albeit not permanent, improvement in pigmentation seen in this study.

Repeated ultraviolet exposure leads to an increase in the number of dopa-positive melanocytes and an increase in their size and associated production of melanin.<sup>11</sup> Presumably, repeated high-dose targeted UVB treatment leads

to the same increase in the population of melanocytes that is seen with repeated exposure to standard ultraviolet radiation. Anecdotal experience also suggests that patients who have successfully completed an initial treatment series for their leukoderma striae ultimately require fewer maintenance treatments at a later date. This may be due to the presence of either a greater quantity of epidermal melanocytes or melanocytes that are simply more reactive.

Targeted UVB phototherapy using monochromatic or polychromatic light devices is a safe and effective treatment for leukoderma in striae distensae. Although prior studies have shown an increase in collagen content in striae after pulsed-dye laser or intense pulsed light treatments, this is the first study to report an increase in both the melanin content and the number of melanocytes after laser or light treatment of striae distensae. Although a series of multiple treatments are required to obtain a satisfactory level of repigmentation, and treatments are tedious for both the physician and the patient, no other method has been shown to produce improvement in the loss of pigment seen with striae distensae. Our post-treatment histology and ultrastructural findings confirm the clinical finding that UVB-induced improvement in striae can be long-lasting, albeit not permanent. Future studies should evaluate a correlation between pigment persistence and quantitative melanocyte density.

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