Successful Treatment of Under-Eye Pigmentation in Skin Type IV With a Picosecond Alexandrite Laser With Diffractive Lens Array

Infraorbital dark circles are among the most common concerns of patients in an aesthetic dermatology practice. They result from a confluence of factors such as facial volume loss, skin laxity, excess subcutaneous vascularity, skin pigmentation, exogenous medication use, and fat pad herniation.[1] An optimal cosmetic outcome often requires a variety of treatment methods to address this multifactorial etiology. Pigmentation in this sensitive area can be difficult to treat, particularly in darker skin types, because of the increased risk of postinflammatory hyperpigmentation.

The picosecond 755-nm alexandrite laser (PicoSure; Cynosure, Inc., Westford, MA) was approved by the Food and Drug Administration (FDA) for the treatment of unwanted tattoos and pigmented lesions in 2012. A subsequently developed fractionated optic for the picosecond 755-nm alexandrite laser called the diffractive lens array (DLA) has been FDA-cleared for the treatment of wrinkles and acne scars in Fitzpatrick skin Types I through IV.[2] Studies have also demonstrated this device to be effective in addressing conditions such as photodamage, striae, and minocycline-induced skin pigmentation.[3–5] Thus far, the utility of this device in the treatment of under-eye pigmentation has not been described.

A 44-year-old, Fitzpatrick skin Type IV, Hispanic woman requested treatment for dark under-eye circles (Figure 1A). Whereas examination revealed that her complaint of under-eye circles could also be partially attributed to volume loss and subcutaneous vascularity, she had notable bilateral infraorbital hyperpigmentation. After a discussion of treatment options, the picosecond 755-nm alexandrite laser was selected to address the hyperpigmentation.

Pretreatment consisted of topical anesthetic with 23% lidocaine/7% tetracaine ointment applied 1 hour before the procedure. A single treatment session with the picosecond 755-nm alexandrite laser using a fixed focus DLA (550 ps, 6 mm, 0.57 J/cm^2, 1 Hz, 167 pulses) was administered. A total of 2 to 4 passes were performed to the bilateral undereyes until a clinical end point of mild greying of the excessive pigmentation was achieved with minimal erythema. The procedure was well tolerated. Triamcinolone 0.1% ointment and sunscreen were applied immediately after the procedure. The patient was instructed to continue daily gentle skin care and sun protection.

At a follow-up visit 3 months after procedure, the patient had near-complete clearance of under-eye pigmentation and significant improvement in the appearance of dark under-eye circles, with maintenance of pigment resolution at 5 months (Figure 1B). No adverse events such as postinflammatory hyperpigmentation or hypopigmentation were noted.

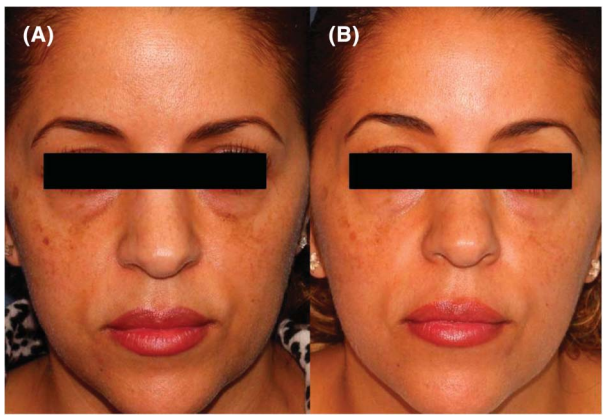

Figure 1. (A) Bilateral infraorbital pigmentation, prior to treatment (B) 3 months post-treatment with the picosecond 755-nm alexandrite laser with a fixed focus diffractive lens array.

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Discussion

Though our increasingly diverse society has inspired a growing body of literature exploring the safest methods of using laser and energy devices for the treatment of ethnic skin types, most of the published literature still provide data relevant to Fitzpatrick skin Types I through III. It is well established that the increased melanin content of darker skin types increases cutaneous absorption of laser energy, making these patients more prone to nonspecific thermal injury and, ultimately, scarring and dyspigmentation.[5]

In recent years, lasers have evolved to target melanosomes more selectively. Given that melanosomes have thermal relaxation times of approximately 0.5 to 1 μs, lasers with ultrashort pulse durations in the nanosecond and picosecond range are required to specifically target melanosomes with photothermal destruction without damaging surrounding tissues. Pulse durations shortened into the picosecond range also generate a greater degree of selective photoacoustic effect, producing greater tensile stress on pigmented structures than that produced by nanosecond pulse durations, resulting in more efficient destruction of the target. This increased efficiency allows for the use of lower fluences, decreasing the risk of epidermal injury.

It is believed that using the picosecond 755-nm alexandrite laser with the DLA further allows for the targeting of unwanted epidermal pigmentation while protecting the pigment of the dermoepidermal junction. The energy delivered through the DLA is absorbed by intraepidermal melanocytes in localized zones, where a cascade of electron activation creates "laser-induced optical breakdown" (LIOB). This LIOB absorbs the incoming 755-nm irradiation that would otherwise reach the dermis, creating a localized hot plasma ball within the epidermis. The hot plasma ball rapidly heats the surrounding tissues above boiling temperature, resulting in an intraepidermal vacuole.[2] Histologic studies by Tanghetti[2] suggest that this process remains isolated to the stratum spinosum, with keratinocyte necrosis limited to 1 to 2 cellular layers beyond the vacuoles.

When using the DLA, less than 10% of the treated skin is exposed to the peak fluence setting, whereas the remaining area is exposed to lower fluences.[2] Delivering the maximum laser energy to limited columns of tissue while sparing adjacent columns preserves treatment efficacy while minimizing the risk profile. Additionally, lower overall fluence also likely had a beneficial impact on adverse events by minimizing the 3-dimensional diffusion of photothermal energy. Overall, the adverse events associated with laser treatment of darker skin types because of the inadvertent heating of adjacent tissue were limited in this case because of the fractionated nature of the DLA optic, and the lower fluences required to reach treatment goals when using the shorter pulse durations of the picosecond 755-nm alexandrite laser.

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