Fractional Photothermolysis for the Treatment of Postinflammatory Hyperpigmentation

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Postinflammatory hyperpigmentation (PIH) is an acquired hypermelanosis of the skin. Development of PIH can occur after any type of inflammation of the skin but is typically seen in association with acne, folliculitis, eczema, and trauma and as a complication of laser resurfacing. Other diseases that may produce this change are lichen planus, lichenoid drug reaction, lupus erythematosus, fixed drug reaction, pityriasis rosea, herpes zoster, insect bite reactions, contact dermatitis, and superficial burns.1 It is thought that inflammatory interruption of the epidermal–dermal junction is responsible for the development of PIH and that the degree of inflammation and disruption of the epidermal–dermal junction affects the severity of the PIH. Arachidonic acid metabolites and histamine, found in large amounts in inflamed skin, may play a role in the initiation of the development of PIH.2 Histopathology reveals high levels of epidermal melanin, with melanophages present in the superficial dermis.3 Lymphohistiocytes are variably present around superficial blood vessels in the dermal papillae.3 Clinically, lesions appear as irregularly shaped, darkly pigmented macules that coalesce and may persist for months or become permanent. PIH is more commonly seen in people with darker skin types and is found equally in men and women.

PIH can occur anywhere on the body and at any age. Resulting cosmetic disfigurement may lead to problems with self-esteem, social interactions and to distress. Treatments for PIH include topical agents such as retinoids, hydroquinone bleaching creams, corticosteroids, dermabrasion, and chemical peels.4–6 These treatment modalities have been used with varying success. Topical hydroquinones have been associated with undesirable depigmentation, irritant dermatitis, and ochronosis.6–9 Chemical peels and microdermabrasion may cause dyspigmentation and hypertrophic scarring.4 The Q-switched ruby laser has been used for the treatment of PIH with variable results and for postsclerotherapy hyperpigmentation.10,11 Owing to the success of fractional photothermolysis in treating epidermal and dermal pigmented lesions and conditions, it was conjectured that PIH could also be treated with this technology.12–18

Patient and Methods

A dermatologist referred a 50-year-old woman (Fitzpatrick skin type IV) with a 2-year history of an irregular brown patch on the left lateral neck. The lesion was clinically diagnosed as PIH. The patient did not recall a skin rash before developing the pigmentation, but she stated that this was where her automobile seatbelt rubbed against her skin. No
other relevant medical history was reported. Previous treatments for the PIH on the left lateral neck included an acid peel (unknown type) performed 3 months before presentation and a 2-month course of bleaching creams. These treatments were unsuccessful. The patient used a moisturizer with a sun protection factor (SPF) of 15 daily. Daily medications included multivitamins. Physical examination revealed a 6- × 4-cm brown and partly erythematous patch with irregular borders on the left lateral neck (Figure 1).

Although the patient had previously used a bleaching agent with no change in the PIH, PIH is a theoretical complication after treatment with fractional photothermolysis, which may be reduced with pre- or post-treatment regimens of hydroquinone or tretinoin. For this reason, our patient was concurrently started on Triluma (Triluma, Galderma Laboratories L.P., Fort Worth, Texas) 1 week after the first laser treatment.

Treatments were conducted with the 1,550-nm wavelength erbium-doped Fraxel SR 1500 laser (Reliant Technologies, Inc., Mountain View, CA). The treatment area was cleansed before the procedure using a mild soap (Cetaphil Gentle Skin Cleanser, Galderma Laboratories, L.P.). A topical triple anesthetic of 10% benzocaine, 6% lidocaine, and 4% tetracaine (New England Compounding Center, Framingham, MA) was applied under occlusion to the treatment area of the left lateral neck for 1 hour before treatment. An ointment (LipoThene Inc., Pacific Grove, CA) was applied so that the laser handpiece could glide smoothly over this area.

From November through February, the patient underwent three treatment sessions at 4- to 8-week intervals. Treatments were performed at an energy fluence of 15 mJ and a treatment level of 6 (manually selected on the laser device monitor), corresponding to 17% surface coverage. Final densities (determined according to treatment level) were 880 to 1,100 microscopic treatment zones per square centimeter (MTZ/cm²). Each treatment included eight to 10 passes at a density of 110 MTZs/cm² per pass. A cold-air cooling system (Cryo 5, Zimmer Medizin Systems, Irvine, CA) was used to cool the skin during the treatment and to minimize patient discomfort (fan power 4, 10–14 cm from the skin). The patient was advised to begin using a daily broad-spectrum sunscreen with ultraviolet (UV)A and UVB protection (minimum SPF 45) on the treated areas and to avoid sun exposure for 7 days after the treatment. During the treatment, the patient experienced mild pain and moderate postprocedural erythema and edema, which resolved in 24 to 48 hours.

Photographic documentation using identical camera settings, lighting, and patient positioning was
obtained at baseline, before each treatment, and at a 7-month follow-up visit the following September. The evaluating physician noted near-complete clearing of the PIH (>95%), with no post-procedural complications or recurrence, 7 months after her third treatment (Figure 2). The patient’s degree of satisfaction with the treatment paralleled the physician’s assessment of improvement of the lesion.

**Discussion**

Although there are many published reports on the use of fractional photothermolysis for the treatment of pigmentary dyschromias, this is the first reported case for PIH. Fractional photothermolysis is a new technology whereby thermal columns of injury in the dermis, known as MTZs, are created, surrounded by zones of undisturbed tissue. This allows for rapid healing of the treated area through epidermal cell migration from adjacent viable epidermis aided by the intact stratum corneum. The mechanism by which the melanin in this patient may have been eliminated involves the extrusion and transepidermal vacuolar elimination of dermal and epidermal content known as microscopic epidermal necrotic debris through a compromised dermal–epidermal junction. Fractional photothermolysis initiates this transport system.

Although PIH is more commonly seen as a side effect of ablative laser therapy (seen in 2.8% of 104 patients), it is a rare complication of fractional photothermolysis (found in 0.73% of 961 patients treated with fractional photothermolysis) and has been observed with greater frequency in darker skin. Chan and colleagues found that the risk of PIH after fractional photothermolysis is reduced by lowering treatment densities and using cooling in conjunction with laser treatments. Kono and colleagues found that greater density was more likely to produce swelling, redness, and hyperpigmentation than greater energy.

Most studies investigating the treatments of PIH have been conducted with patients with darker skin types, because PIH is a more common finding in this population. Common treatment modalities for PIH, such as peels, bleaching agents, and retinoids, have had variable results. Combination therapies have achieved greater success. Mequinol 2%, tretinoin 0.01%, and fluclonolone acetonide 0.01% combination therapy is efficacious, as is a combination of hydroquinone 4% and tretinoin 0.05%.

There are many reports on the use of ablative and nonablative lasers for the successful treatment of melasma, nevus of Ota-like macules, and lentigines. The treatment of postinflammatory dyspigmentations is more difficult. A study

![Figure 2. Seven months after the third treatment.](image-url)
on the Q-switched ruby laser for the treatment of PIH was inconclusive,\textsuperscript{10} although it yielded better results for the treatment of postsclerotherapy hyperpigmentation. Ninety-two percent of lesions studied were found to be lighter after treatment, with significant (75–100\%) resolution of hyperpigmentation in 58\% of treated areas.\textsuperscript{11} Recently, blue pigmentation due to minocycline treatment was treated with fractional photothermolysis at energy fluences up to 60 mJ.\textsuperscript{25}

Because of the inherent tendency of PIH to recur after sun exposure, follow-up was obtained after the summer months to confirm long-term improvement. We were able to successfully treat PIH in a patient with Fitzpatrick skin type IV using a fractionated device. After the completion of her series of laser treatments, the patient continued to apply Triluma cream twice a week for 6 months. Because the patient had used a bleaching agent before the laser treatments with no change in the dyspigmentation, we believe that the role of Triluma in this case was only in preventing recurrence, although we recognize this as a possible confounding factor. This case demonstrated marked improvement of PIH on the neck after a series of fractional photothermolysis treatments. Controlled studies are warranted to better understand the efficacy, longevity, and optimal laser settings for this indication.

References


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