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1927 nm Diode Laser for Infraorbital Hyperpigmentation in Skin of Color: Safe and Effective Approach

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ABSTRACT

Background: Infraorbital hyperpigmentation (IOH) is a common aesthetic concern with multifactorial pathogenesis, especially prevalent in patients with skin of color (SOC). Its management remains challenging due to the delicate anatomy of the periorbital area and the increased risk of post-inflammatory hyperpigmentation associated with many energy-based treatments.

Objective: To evaluate the clinical efficacy and safety of a 1927 nm non-ablative fractional diode laser in the treatment of IOH in patients with SOC.

Methods: We present a case series of 4 female patients with Fitzpatrick skin types III to IV and clinical diagnoses of IOH. All patients were treated at a single dermatologic practice using the 1927 nm Clear + Brilliant Permea® laser. Each patient received eight non-ablative fractional passes at a high treatment level. Most patients did not receive additional topical therapies. Clinical outcomes are evaluated based on physician observation and patient-reported satisfaction.

Results: All patients demonstrated progressive improvement in periorbital pigmentation, increased brightness, and enhanced skin texture. Results were noticeable within weeks of treatment and were maintained over time. No adverse effects, including post-inflammatory hyperpigmentation, were observed.

Conclusion: The 1927 nm diode laser appears to be a safe and effective option for the treatment of infraorbital hyperpigmentation in patients with SOC. Its favorable safety profile and gradual clinical improvement make it a promising tool for addressing pigmentary and structural components of IOH. Further controlled studies are needed to validate these findings.

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INTRODUCTION

Infraorbital hyperpigmentation (IOH), commonly referred to as "dark circles," is a prevalent and distressing cosmetic concern. Infraorbital hyperpigmentation is often societally associated with fatigue, stress, or sadness, and can be perceived as a visible marker of physical exhaustion and premature aging. These associations can consequently impact self-perception and quality of life for affected patients.

IOH can be observed across all ethnicities, sexes, and ages; however, its prevalence and severity are notably higher in females and skin of color (SOC).[1] The pathogenesis of IOH is complex and multifactorial, with several contributing intrinsic and extrinsic factors that interact in diverse ways. This condition is particularly challenging to treat due to its various presentations and underlying causes, which can often coexist within the same patient.

To facilitate diagnosis and guide treatment approaches, IOH has been classified in the literature into 4 subtypes: vascular, structural, pigmented, and mixed.[1] However, it is important to highlight that external factors such as environmental exposure and lifestyle habits significantly contribute to the onset and exacerbation of IOH, regardless of the primary subtype. External lifestyle factors such as inadequate sleep, psychological stress, and frequent eye rubbing can aggravate both pigmentary and vascular components of IOH by disturbing skin homeostasis.[7] Proposed mechanisms include activation of the hypothalamic-pituitary-adrenal (HPA) axis and stimulation of melanin production.[6] Recognizing these influences is essential for accurate assessment and individualized treatment planning.

In this review, we will cover classifications and etiologies of infraorbital pigmentation, differential diagnosis, and highlight treatment modalities. We will also present a case series demonstrating significant improvement in infraorbital hyperpigmentation among patients treated with the 1927 nm diode laser, with no adverse events reported.

Classification

Pigmented

Pigmentary IOH is primarily due to excessive melanin deposition in the infraorbital region. It may be constitutional, often with a familial predisposition, or acquired through post-inflammatory

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changes linked to chronic rubbing, eczema, or allergic reactions such as atopic dermatitis. Multispectral imaging in affected patients reveals a significantly higher melanin index compared with control subjects, confirming that pigment accumulation plays a central role.[3]

Vascular

The periorbital skin, particularly in the lower eyelid, is among the thinnest in the body, with a total thickness averaging approximately 1265 µm, making the underlying vasculature more visible.[19] Vascular IOH arises from increased visibility or dilation of vessels under the thin periorbital skin, resulting in a bluish or violaceous hue with or without periorbital puffiness.[5] This may be due to blood stasis, venous congestion, or vasodilation. Multispectral analysis and videocapillaroscopy have demonstrated elevated hemoglobin indices and capillary changes in affected individuals, supporting the hypothesis of vascular dilation as a key contributor to dark circles.[3] Inflammation further contributes by inducing vascular alterations and triggering secondary hyperpigmentation.[2,3]

Structural

The anatomy of the periorbital region strongly influences IOH. Structural IOH is influenced by orbital bone resorption, periocular fat resorption, and orbital fat collapse. These factors create shadows and exaggerate the appearance of darkness.

Thin Skin

Ultrasound studies have also shown that affected individuals have significantly thinner periorbital skin, making vascular and pigmentary changes more visible.[3] In addition to these effects, thinning of the dermis may also allow underlying muscle structures such as the orbicularis oculi to become more apparent. This muscle visibility can create a brownish or violaceous hue under the eyes, contributing to the appearance of IOH independent of pigment or vascular dilation.

Evaluation

The assessment of IOH begins with a comprehensive clinical history and physical examination, aiming to identify contributing factors such as lifestyle habits, systemic illnesses, and family history. Clinically, IOH appears as brownish to dark pigmentation surrounding the eyelids, often demonstrating a fatigued appearance. It is essential to differentiate true pigmentation from shadowing caused by anatomical features like the tear trough. Manual stretching of the lower eyelid can aid in this distinction: true pigmentation persists with stretching, whereas shadowing tends to diminish; a violaceous hue observed during this maneuver may indicate thin skin or increased vascularity in the lower eyelid.[5]

Clinical evaluation should include inspection under natural light, and if available, dermoscopy can help distinguish pigmentary from vascular causes. In a study of 200 patients, dermoscopy revealed light brown epidermal pigmentation in 39% of cases, dark brown to gray dermal pigmentation in 9%, and mixed patterns in 52%, with a reticular vascular pattern commonly seen in mixed types.[9] These findings assist in subtype identification and guide treatment selection.

Wood's lamp examination may also assist in distinguishing epidermal from dermal pigmentation, as epidermal pigment becomes more pronounced under this light, while dermal pigment changes are subtler.[5] A structured evaluation ensures accurate diagnosis and guides personalized treatment planning.

Systemic Conditions and Differential Diagnosis

Facial and periorbital hyperpigmentation may also be secondary to systemic diseases. A recent study found that individuals with diabetes and thyroid disorders had a significantly higher frequency of periorbital hyperpigmentation, indicating that metabolic and hormonal imbalances may contribute to its development.[4] Dermatomyositis, an idiopathic inflammatory myopathy, presents with characteristic cutaneous features including heliotrope rash and, in some cases, distinct hyperpigmented patterns on the face such as the "suntan sign." This finding is particularly notable in Hispanic patients and underscores the importance of a thorough clinical history in cases of facial hyperpigmentation in the periorbital area, as this may be a manifestation of an underlying systemic disease.[8] Additionally, anemia has been linked to IOH due to reduced hemoglobin levels and compensatory vasoconstriction in the skin, which together limit oxygen delivery to the periorbital region and contribute to a darker appearance accentuated by facial pallor.[4]

When evaluating IOH, it is important to consider other causes of periorbital pigmentation. These include melasma, erythema dichromicum perstans, nevus of Ota, cutaneous amyloidosis, fixed drug eruption, ecchymosis, and, less commonly, periorbital melanoma. A careful clinical assessment and, when necessary, histopathological or imaging studies can help differentiate IOH from these entities.

Treatment

The management of IOH requires a careful balance between efficacy and safety, particularly in patients with SOC, who have an increased risk of post-inflammatory hyperpigmentation (PIH) following energy-based procedures.

Multiple laser technologies have been explored for the treatment of IOH, each demonstrating variable outcomes depending on the predominant underlying mechanism, whether pigment deposition, vascular prominence, or dermal thinning. Among the most frequently studied are Q-switched lasers, including the 694 nm ruby laser and the 1064 nm Nd:YAG laser, both of which target melanin within the dermis. The ruby laser has shown pigment clearance greater than 50% in up to 88.9% of patients

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after 2 sessions, particularly in cases of dermal melanocytosis.[15] However, its use has been associated with adverse effects such as hypopigmentation and prolonged PIH.[16]

In contrast, the 1064 nm Q-switched Nd:YAG laser and its long-pulsed variant offer deeper tissue penetration with lower melanin absorption, making them safer for darker skin types.[17] These lasers have shown notable efficacy in vascular and mixed-type IOH, with high patient satisfaction and clinical improvement reported in multiple studies; however, outcomes remain variable, and recurrence is frequently observed in pigment-type IOH.[16]

Another available option for treating infraorbital pigmentation is the picosecond alexandrite laser 755 nm, which offers deeper dermal penetration while minimizing thermal damage. Clinical reports have shown marked improvement, including near-complete clearance of pigmentation, with sustained results observed up to 5 months after treatment. Notably, these lasers have demonstrated a favorable safety profile in individuals with Fitzpatrick skin type IV.[18]

Ablative lasers such as CO_2 and Er:YAG improve pigmentation and skin texture by inducing controlled dermal injury and stimulating collagen remodeling. However, their application is limited by longer downtime and a higher risk of PIH, particularly in individuals with SOC. Fractional CO_2 lasers, which deliver energy in a pixelated pattern while preserving surrounding tissue, have shown improved efficacy and a lower incidence of complications compared with traditional fully ablative devices.[17]

Given the limitations of currently available technologies, including variable efficacy, treatment recurrence, and the potential for adverse effects in darker skin types, there is increasing interest in safer, non-ablative fractional modalities.

The 1927 nm diode laser is a non-ablative fractional modality that offers a safe and effective approach to treating IOH, particularly in patients with SOC. Its wavelength is selectively absorbed by water in the epidermis and superficial dermis, inducing controlled thermal injury that stimulates keratinocyte turnover and dermal remodeling. This dual mechanism leads to gradual melanin reduction in the basal layer, neocollagenesis, and improvement in skin texture, contributing to the attenuation of both pigmentary and structural components of IOH.[11,13]

Additionally, the increased epidermal permeability observed post-treatment supports its use for laser-assisted drug delivery when combined with topical agents such as hydroquinone.[13] Importantly, this mechanism minimizes disruption of the skin barrier and reduces the risk of PIH, making it particularly appropriate for Fitzpatrick skin types III to VI.[10,13]

Clinical studies have demonstrated the safety and efficacy of the 1927 nm diode laser for facial hyperpigmentation. In a randomized trial involving 40 adults with skin types III to V, significant improvement was observed by week 4 and maintained through week 12, even in the absence of adjunctive hydroquinone. No cases of PIH or other adverse events were reported, and patient satisfaction was high.[13]

Compared with the 1927 nm thulium laser, which delivers up to 4 times higher energy per pulse and over 15 times the treatment density, the diode-based platform provides a gentler approach with reduced downtime and fewer pigmentary complications.[11,12,19]

Although specific data on its use in IOH remain limited, the encouraging outcomes in broader facial hyperpigmentation studies support the 1927 nm diode laser as a promising, well-tolerated treatment option for IOH in patients with SOC.[14] Further clinical trials are needed to establish optimal treatment parameters and compare their efficacy with other energy-based modalities.

Case Series

We present a series of 4 female patients with infraorbital hyperpigmentation (IOH) treated with the 1927 nm non-ablative fractional diode laser (Clear + Brilliant Permea, Solta®, Bothell, WA) at a single outpatient dermatology clinic. All patients were treated by 8 passes on a treatment level of high. The following cases illustrate clinical responses among patients with SOC.

Case 1

FIGURE 1. A 45-year-old female with Fitzpatrick skin type IV presented with infraorbital hyperpigmentation. She was treated with the 1927 nm diode laser to target pigmentary and textural irregularities in the periorbital area. No topical bleaching agents were used. The patient demonstrated a visible reduction in pigmentation, enhanced skin brightness, and improved overall quality of the under-eye skin.

FIGURE 1. Improvement of infraorbital hyperpigmentation after treatment with 1927 nm diode laser.

Case 2

FIGURE 2. A 42-year-old female with Fitzpatrick skin type IV presented with infraorbital pigmentation and mild periorbital

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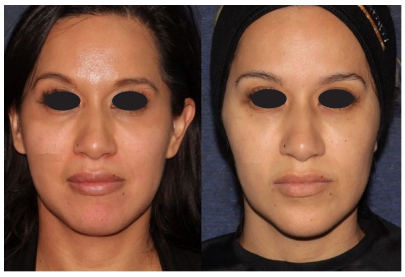
skin dullness. She underwent the 1927 nm diode laser as part of a maintenance protocol to improve skin radiance and reduce pigmentation in the under-eye area. Following a series of treatments, she showed progressive improvement in periorbital brightness and homogeneity of skin tone. No post-inflammatory hyperpigmentation or other adverse effects were reported.

FIGURE 2. Reduction in periorbital pigmentation following 1927 nm diode laser treatment.



Case 3

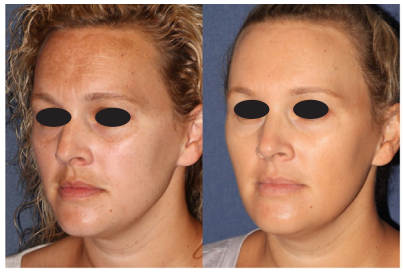
FIGURE 3. A 66-year-old female with Fitzpatrick skin type IV presented with periorbital hyperpigmentation and mild facial dullness. As part of an ongoing skin maintenance program, she received the 1927 nm diode laser to improve skin brightness and mitigate infraorbital pigmentation. Following treatment, the patient demonstrated notable improvement in under-eye luminosity, with a more refreshed and even-toned appearance. No adverse effects were observed, and treatment was well tolerated. Results were maintained over time with continued use of the laser.

FIGURE 3. Clinical improvement in infraorbital hyperpigmentation after 1927 nm diode laser treatment.

Case 4

FIGURE 4. A 37-year-old female with Fitzpatrick skin type III presented with melasma and diffuse infraorbital hyperpigmentation. She underwent a combination regimen including 4 sessions of the 1927 nm Clear + Brilliant diode laser and a customized topical treatment plan. The laser was used to reduce pigmentation and improve overall skin luminosity. After one year of follow-up, the patient demonstrated visible improvement in periorbital brightness, melasma control, and global skin radiance. No adverse effects were reported, and results were sustained with maintenance care. The laser was well tolerated, and the patient expressed high satisfaction with the outcome.

FIGURE 4. Improvement of melasma and infraorbital hyperpigmentation with combination treatment including 1927 nm diode laser.



DISCLOSURES

The authors have no conflicts of interest to disclose.

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