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CASE REPORT

Layer-Targeted Multimodal Treatment for Melasma with Concurrent Skin Laxity and Infraorbital Eyebags: A 3-Year Case Report

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ABSTRACT: Melasma is a chronic acquired hypermelanosis that predominantly affects Asian women with Fitzpatrick skin types III–IV. Its multifactorial pathogenesis and high recurrence rate make long-term management challenging, particularly in patients with concurrent facial aging concerns. This study evaluated a layer-targeted multimodal treatment strategy addressing both pigmentation and skin aging. A 46-year-old Asian woman (Fitzpatrick skin type IV) with a history of melasma exceeding 10 years, accompanied by midface laxity and infraorbital eyebags, underwent a sequential treatment protocol. This included 25 sessions of low-fluence 1064-nm and 595-nm Q-switched Nd:YAG (QSNY) laser, 7 sessions of high-intensity focused ultrasound (HIFU), 2 sessions of calcium hydroxyapatite (CaHA), and 4 sessions of pulsed-wave radiofrequency (RF) microneedling. Clinical outcomes were assessed using the modified Melasma Area and Severity Index (mMASI) and the Global Aesthetic Improvement Scale (GAIS). The mMASI score improved from 4.5 at baseline to 0.6 at final follow-up, with visible improvement in skin laxity and infraorbital contour. The final GAIS rating was Grade 1 (very much improved). No adverse events, including post-inflammatory hyperpigmentation, were observed over a 3-year follow-up period. This case suggests that a layer-targeted multimodal approach integrating pigment modulation, structural support, and dermal remodelling may achieve sustained improvement in chronic melasma while concurrently addressing facial aging in patients with darker skin types.

Keywords: Melasma, Multimodal therapy, Q-switched Nd:YAG, HIFU, Calcium hydroxyapatite, RF microneedling, Fitzpatrick IV, Asian skin

INTRODUCTION

Melasma is an acquired hyperpigmentation disorder characterized by symmetric, irregular brown macules and patches that predominantly affect the malar regions and forehead. It occurs more frequently in women and individuals with darker skin types [1,2] and is associated with significant emotional and psychosocial burden [2,3]. Despite the availability of topical agents, oral therapies, and energy-based devices, long-term disease control remains challenging due to its multifactorial pathogenesis, which involves ultraviolet (UV) exposure, hormonal influences, and genetic predisposition [1]. In addition, melasma pathogenesis is associated with structural alterations involving the epidermis, basement membrane, and dermis, including vascular changes, solar elastosis, mast cell activation, and fibroblast senescence [4]. These factors are believed to contribute to treatment resistance and disease recurrence. Consequently, single-modality

therapies often provide suboptimal outcomes, highlighting the potential benefit of a multimodal treatment approach for melasma management [3].

This case report describes a layer-targeted, sequential multimodal treatment strategy combining low-fluence Q-switched Nd:YAG (QSNY) laser toning, high-intensity focused ultrasound (HIFU), calcium hydroxyapatite (CaHA), and pulsed-wave radiofrequency (RF) microneedling over a 3-year period to improve chronic melasma while concurrently addressing skin laxity and infraorbital eyebags in a patient with Fitzpatrick skin type IV.

CASE PRESENTATION

A 46-year-old Asian woman with Fitzpatrick skin type IV presented with melasma of more than 10 years' duration, progressive midface skin laxity, and prominent infraorbital eyebags. She reported worsening facial pigmentation following her second pregnancy 12 years earlier. She had no prior dermatological or aesthetic procedures. Her menstrual cycles were regular, and she denied any significant medical history or hormonal therapy. She worked at a morning market with daily UV exposure and did not practice routine photoprotection. She reported increasing self-consciousness due to progressive facial pigmentation and age-related changes.

Clinical examination revealed diffuse brown hyperpigmented patches with irregular borders over both malar regions. A diagnosis of melasma was made based on clinical and photographic evaluation, with concurrent midface skin laxity and prominent infraorbital eyebags. Baseline melasma severity, assessed using the modified Melasma Area and Severity Index (mMASI), was 4.5, indicating moderate severity.

MANAGEMENT AND OUTCOME

A structured, sequential multimodal protocol was implemented between 2023 and 2025. The protocol included repeated low-fluence QSNY laser sessions, HIFU for structural tightening, CaHA biostimulation for dermal remodelling, and RF microneedling for additional dermal modulation. Photoprotection was emphasized throughout the treatment period. The treatment modalities, device specifications, parameters, and clinical targets are summarized in **Table 1**, while the overall treatment timeline is illustrated in **Figures 1** to **3**. Written informed consent was obtained from the patient for publication of this case report and the accompanying clinical photographs. All identifying information was removed to ensure patient confidentiality.

Following the multimodal treatment regimen, the patient demonstrated progressive improvement in pigmentation and overall skin quality. Melasma improved compared with baseline, with the mMASI score decreasing from 4.5 to 0.6 at final follow-up, three months after the last intervention. Clinical photographic assessments demonstrated improvement in midface and lower-face laxity, as well as reduction in infraorbital eyebags with improved periorbital contour. These improvements are shown in **Figures 4** to **5**.

Patient outcomes were further evaluated using the Global Aesthetic Improvement Scale (GAIS), which employs a 5-point scale ranging from 1 (very much improved) to 5 (worse) to rate overall cosmetic improvement. The final GAIS score was 1 (very much improved). No adverse events, including PIH, prolonged erythema, blistering, scarring, or prolonged downtime, were observed throughout the 3-year treatment period.

Table 1. Summary of the layer-targeted multimodal treatment regimen, including treatment modality, indication, schedule, and key procedural parameters.

Modality (Brand)	Details
Low-fluence Q-switched Nd:YAG laser *(Spectra XT; Lutronic, Goyang, South Korea)*	• Performed from January 2023 to October 2025 at 1–2-month intervals (25 sessions) without adjunctive oral or topical depigmenting agents. • Used primarily for melasma. • Parameters: 1064-nm at 0.55–0.65 J/cm^2, 8 mm, 10 Hz, pulse-to-pulse (PTP) mode; 595-nm at 0.17–0.22 J/cm^2, 5 mm, 5 Hz. (Both wavelengths were used in the same session)
High-intensity focused ultrasound (HIFU) *(Ultraformer; Classys Inc., Seoul, South Korea)*	• Performed in August 2023, October 2023, February 2024, June 2024, October 2024, April 2025, and October 2025 (7 sessions). • Used primarily for skin laxity, midface descent, and infraorbital eyebags. • Parameters: 4.5 mm at 0.6 J, 100 shots; 3.0 mm at 0.4–0.5 J, 150 shots; 2.0 mm at 0.2 J, 150 shots.

	• Intensive phase: the first two sessions were performed at 2-month intervals, followed by three sessions at 4-month intervals to achieve initial structural correction. • Maintenance phase: subsequent 6-monthly sessions used to preserve treatment effect.
Calcium hydroxyapatite (CaHA) biostimulation *(Radiesse; Merz Aesthetics, Frankfurt, Germany)*	• Performed in November 2023 and December 2023 (2 sessions). • Used primarily for dermal remodeling and midface support. • Each session used 1.5 mL, diluted 1:1, injected in the subdermal plane using a 25G, 50 mm cannula across the anterior medial cheek and submalar region.
Radiofrequency (RF) microneedling *(Sylfirm X; Viol Co., Seongnam, South Korea)*	• Performed in March 2025, May 2025, July 2025, and September 2025 (4 sessions). • Introduced after mild melasma fluctuation was observed despite prior improvement. Each session conducted separately from Q-switched Nd:YAG laser. • Used primarily for melasma stabilization. • Parameters: pulsed-wave 2 (PW2) mode, 0.3 mm depth, power 3, 200–250 shots.
Photoprotection	• Continuous throughout treatment. • Broad-spectrum sunscreen, sun protection factor (SPF) ≥ 50 daily. • Used for maintenance and relapse prevention.

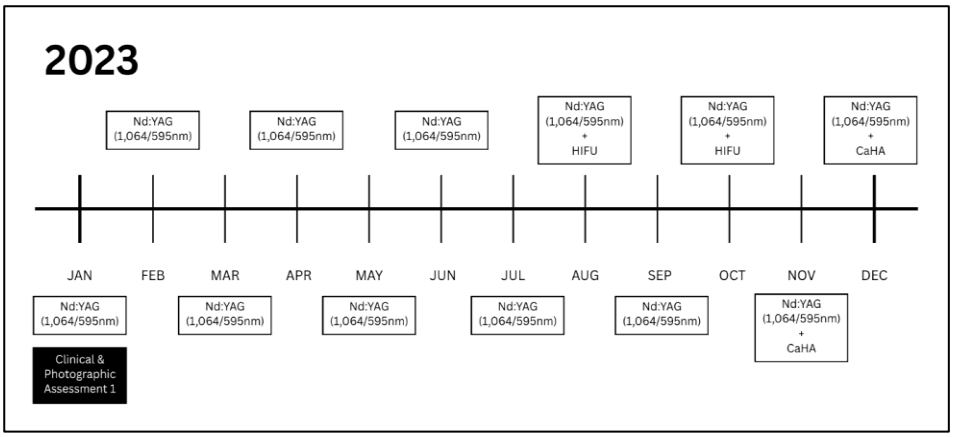

Figure 1. Layer-targeted multimodal treatment course conducted in 2023, consisting of serial low-fluence QSNY (1064/595-nm) laser sessions with adjunctive HIFU and CaHA administered at selected time points following baseline clinical and photographic assessment.

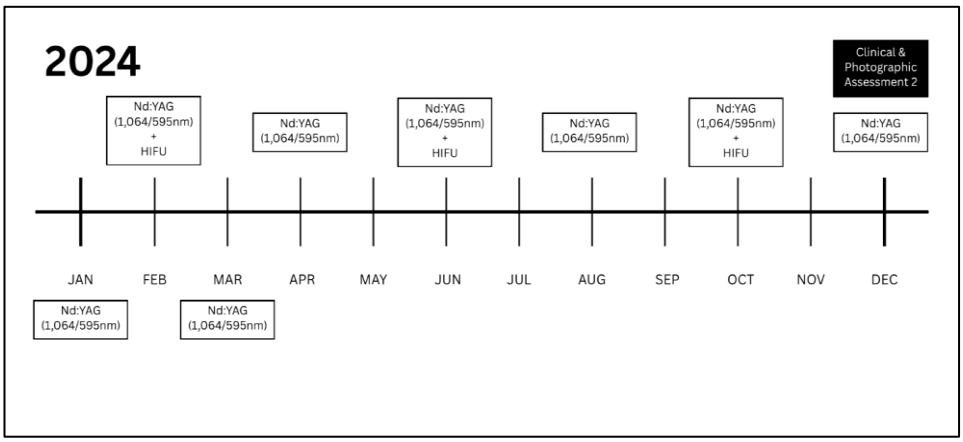

Figure 2. Layer-targeted multimodal treatment course conducted in 2024, consisting of serial low-fluence QSNY (1064/595-nm) laser sessions with adjunctive HIFU administered at 4-month intervals, followed by a second clinical and photographic assessment at the end of the year.

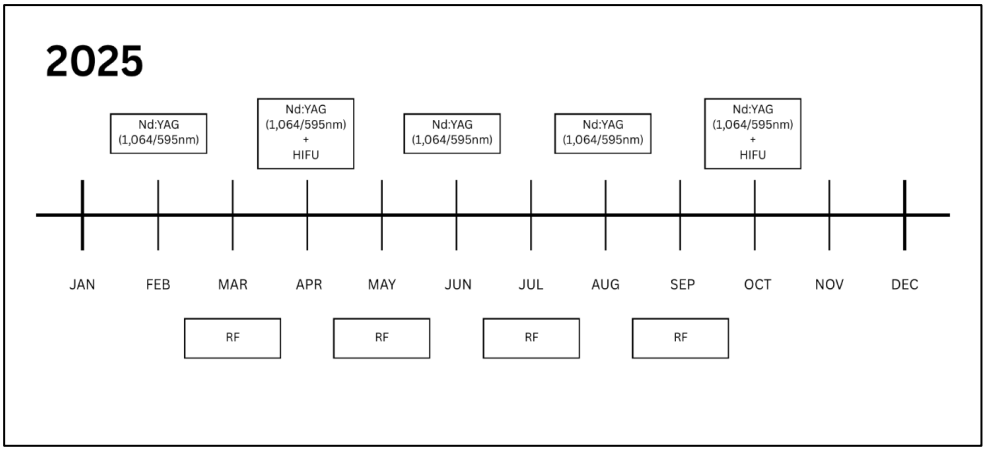

Figure 3. Layer-targeted multimodal treatment course conducted in 2025, consisting of low-fluence QSNY (1064/595-nm) laser sessions, HIFU administered at 6-month intervals, and additional RF microneedling treatments performed every 2 months as maintenance therapy.

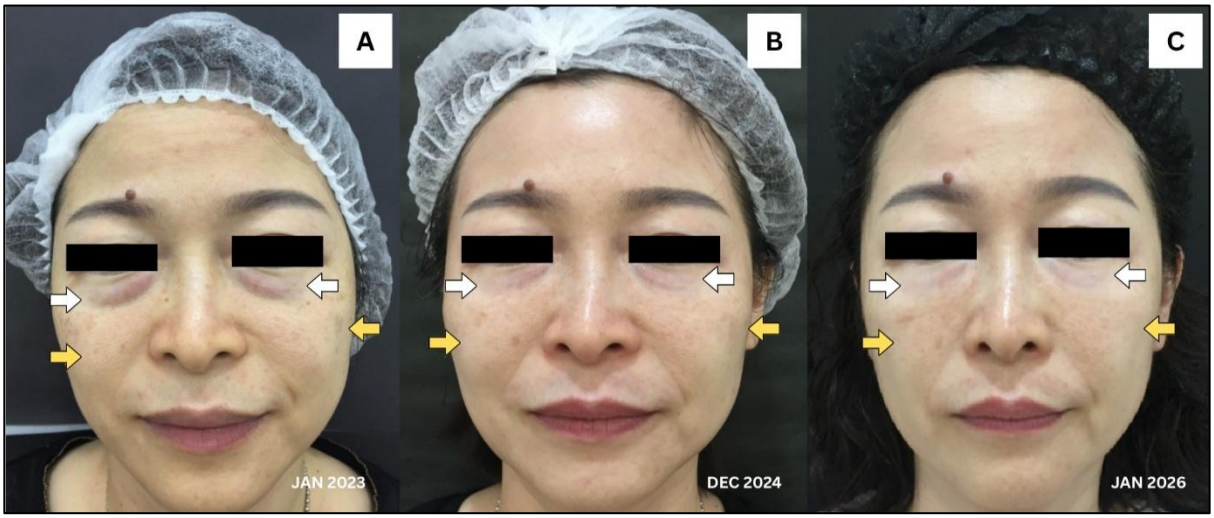

Figure 4. Clinical photographs of the patient in right oblique view at baseline **(A)**, follow-up in December 2024 **(B)**, and three months after the last intervention **(C)**, demonstrating progressive improvement in infraorbital eyebag prominence and periorbital hyperpigmentation (white arrows), with concurrent reduction in malar hyperpigmentation and improvement in overall skin quality (yellow arrows) over the treatment course.

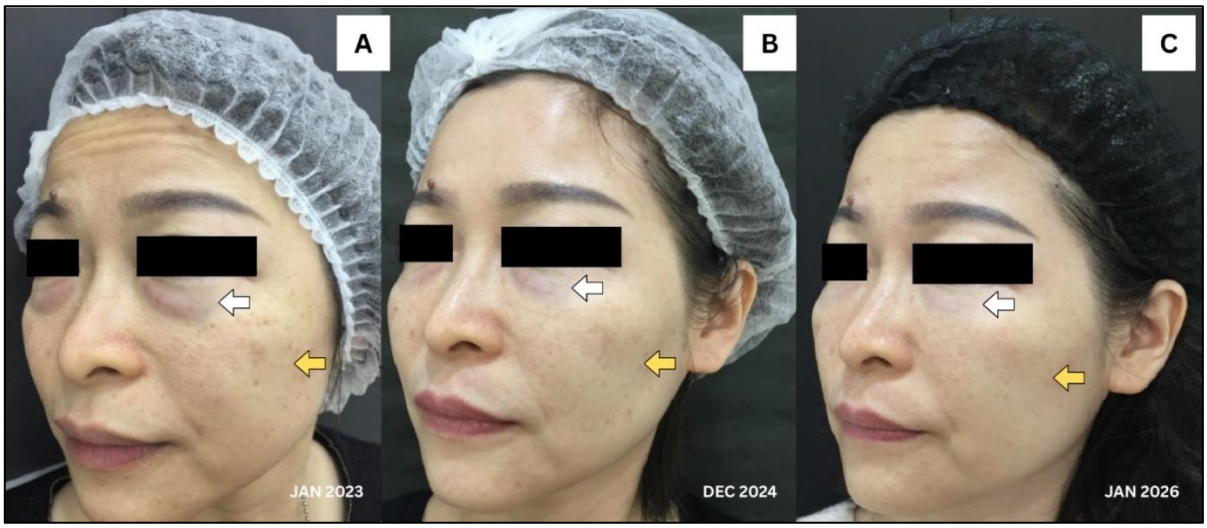

Figure 5. Clinical photographs of the patient in left oblique view at baseline **(A)**, follow-up in December 2024 **(B)**, and three months after the last intervention **(C)**, demonstrating progressive improvement in infraorbital eyebag prominence and periorbital hyperpigmentation (white arrows), with concurrent reduction in malar hyperpigmentation and improvement in overall skin quality (yellow arrows) over the treatment course.

DISCUSSION

The pathogenesis of melasma is multifactorial and involves not only UV exposure and hormonal influences, but also dermal, vascular, and photoaging-related alterations, including basement membrane disruption, increased vascularity, and fibroblast senescence [4]. These factors may contribute to disease chronicity, treatment resistance, and recurrence. As a result, pigment-targeted monotherapies often provide only partial or temporary improvement because they do not adequately address the underlying dermal microenvironment. Therefore, a stepwise multimodal approach targeting different pathogenic components has been recommended for the long-term management of melasma [3].

In this case, treatment was structured according to a layer-targeted rationale. Initial therapy focused on pigment reduction using low-fluence QSNY laser, followed by structural remodeling with HIFU and CaHA to address concurrent facial aging concerns. Adjunctive RF microneedling was later incorporated as maintenance therapy. This sequential approach may be described as a "break-and-build" strategy.

Low-fluence 1064-nm QSNY laser was used as the initial "break" phase to achieve gradual pigment reduction before introducing deeper structural modalities. This approach is supported by its established efficacy in melasma, particularly among Asian patients [5,6]. In this patient, a conservative serial low-fluence protocol using PTP mode was adopted. By delivering two closely spaced low-energy pulses within a single Q-switched cycle, PTP enhances photoacoustic disruption of melanosomes while minimizing thermal injury, making it suitable for gradual pigment reduction in darker skin types. Previous studies have demonstrated that low-fluence 1064-nm QSNY laser with PTP mode is both safe and effective for melasma, with significant clinical improvement reported after repeated sessions in Asian populations [7]. Additionally, the 595-nm wavelength was incorporated within the same session as an adjunct vascular-targeted modality, given the recognized role of vascular components in melasma pathophysiology [4].

Following initial pigment control, HIFU was introduced primarily to address concurrent midface laxity and infraorbital eyebags. This represented the structural "build" phase, aiming to improve tissue support across multiple layers, including the superficial musculoaponeurotic system (SMAS), deep dermis, and upper dermis. HIFU is well established in facial rejuvenation due to its ability to target deeper tissue layers without epidermal disruption [8]. Although not primarily intended for melasma management, it may have provided additional adjunctive benefit for the patient's pigmentation. Studies have suggested that HIFU may improve melasma outcomes when used alongside QSNY therapy, with acceptable safety profiles [9,10]. One proposed mechanism is that ultrasound-induced vibration and friction exert mechanical destructive effects that facilitate the elimination of melanin and pigmented debris from the epidermis and upper dermis [11].

Diluted CaHA was subsequently administered as a biostimulatory agent to improve dermal quality and structural integrity through neocollagenesis and extracellular matrix remodeling. Previous studies have demonstrated that diluted or hyperdiluted CaHA improves skin laxity and quality through collagen remodeling, particularly in the mid- and lower face [12]. In addition, CaHA microspheres have been shown to directly stimulate fibroblast activity, promoting collagen production [13].

Although progressive improvement was observed, mild fluctuations occurred during follow-up, likely related to ongoing UV exposure and the chronic relapsing nature of melasma. Therefore, RF microneedling with pulsed-wave delivery at a shallow depth of 0.3 mm was incorporated as a superficial dermal maintenance strategy to enhance treatment stability. Evidence from a prospective split-face study demonstrated that the addition of 0.3-mm fractional microneedling RF following QSNY laser toning produced synergistic effects, resulting in greater improvement in pigmentation indices compared with QSNY monotherapy [14]. Similarly, Kwon et al. reported superior efficacy of combination therapy with fractional microneedling RF compared with conventional QSNY monotherapy in melasma treatment [15]. Jung et al. further demonstrated that combination therapy using microneedling RF and low-fluence 1064-nm QSNY laser was safe and effective for melasma treatment, with additional improvement in periocular wrinkles and no serious adverse effects [16]. Maintenance therapy using RF microneedling has also been shown to sustain clinical improvement following conventional melasma treatment, supporting its role as a stabilizing adjunct [17]. Collectively, these findings

suggest that superficial RF microneedling may be particularly useful in patients with recurrent or fluctuating melasma.

Overall, this case suggests that melasma in patients with concurrent facial aging may benefit from a multimodal, layer-targeted approach rather than pigment-focused monotherapy alone. By combining pigment modulation, vascular-targeted treatment, dermal regeneration, and structural support, sustained clinical improvement can be achieved with a favorable safety profile.

CONCLUSION

These findings suggest that a layer-targeted, multimodal treatment strategy may be associated with improvement in both pigmentation and structural aging features in this patient. The combination of low-fluence QSNY laser therapy, HIFU, CaHA biostimulation, and RF microneedling may address multiple components of melasma, including pigmentary, dermal, vascular, and structural alterations. However, given the inherent limitations of a single case report, the level of evidence remains low. Therefore, larger, well-designed controlled studies are required to further validate this multimodal layer-targeted approach in individuals with melasma and concomitant skin aging concerns.

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CONFLICT OF INTEREST

The author declares no conflict of interest. No sponsorship or financial support was received for this case report.

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