A Novel Multilight Approach to Nonablative Rejuvenation of Photodamaged Skin: The 3-Dimensional Strategy

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We report on 2 cases of photodamaged skin rejuvenation using a novel strategy that combines multiple wavelengths of coherent and incoherent lights. These lights are targeted to 3 different depths of the skin and can correct some of the clinical signs of photoaging in a nonablative manner. The lights can be delivered singly or cumulatively during a single treatment session, and treatment can be repeated at close intervals since little to no postoperative recovery time is required.

Solar UV irradiation, aging, and some environmental factors (eg, smoking and gravity) induce aesthetically adverse changes in the skin's color, texture, and structural integrity. Aging processes occur in the epidermal, dermal, and subcutaneous layers of skin, resulting in rhytides, overt skin laxity, telangiectasias, and dyschromia (various forms of hyperpigmentation). The skin's surface may develop a coarse, leathery texture, lose clarity and brilliance, and appear dull, with little or no reflection of natural sunlight.

Multiple ablative, nonablative, and surgical procedures, as well as topical treatments, such as peeling agents and retinoids, are available for the restoration of photodamaged skin, but, unfortunately, no single treatment option can fully address all the underlying causes. Thus, physicians currently rely upon a combination of modalities to correct photodamage, an approach that presents logistical and technical difficulties since procedure time, number of procedures, and recovery time between procedures may vary. Moreover, multiple devices and technologies may be required.

The approach used in the current patients may be described as 3-dimensional (3-D). This approach utilizes 3 nonablative, light-emitting technologies with different wavelengths designed to correct defects in 3 distinct layers of the epidermal and dermal skin. The devices may be used independently or cumulatively and are available as a new, all-encompassing machine. Because the technologies are nonablative and nonsurgical, they may be used repeatedly and at close intervals. We present 2 case studies demonstrating how these technologies may be collectively used to address the individual needs of patients seeking cosmetic improvements in facial skin.

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TECHNOLOGIES

The 3 light-based technologies used were intense pulsed light (IPL) therapy at 560 to 1200 nm, long-pulsed Nd:YAG laser therapy at 1064 nm, and a broad-spectrum infrared light–emitting handpiece at 1100 to 1800 nm (Table 1).[1] Each technology penetrates a different layer of skin, addressing a particular component of photodamage.

Table Not Available Online

There is no downside to using all 3 light-based technologies during one treatment session.

In the uppermost skin layer, superficial discolorations, such as solar lentigines and telangiectasias in the epidermis and papillary dermis, may be lightened using the IPL component. Although the exact mechanisms remain elusive, clinical studies suggest that IPL therapy stimulates the migration and shedding of melanosomes, the primary producers of melanin, in the basal (deepest) layer of the epidermis.[2]

The long-pulsed Nd:YAG laser system targets the midlayer of the skin, the papillary dermis, and stimulates collagen production.[3] Collagen is the main protein of connective tissue and is responsible for maintaining the skin's strength and elasticity. When degraded, wrinkles result. Restoration of collagen strengthens the skin's integrity, smoothes fine lines and cobblestoning, and may reduce pore size.

Lax skin may be tightened using the 1100- to 1800-nm broad-spectrum infrared light handpiece, which targets the reticular dermis—the deepest layer of the skin composed of connective tissue (collagen and elastin). The infrared light is absorbed by water, resulting in an even heating of the deep dermis. This deep dermal heating damages collagen fibrils, which immediately recoil, causing the collagen to contract and the skin to tighten.[4] Simultaneously, new collagen production is stimulated, improving the skin's strength and elasticity over time. The broad-spectrum device, when used at low fluences, was also reported to produce immediate and near painless skin contraction.[5] Immediate thermocontraction after treatment with this infrared device was later corroborated by Zelickson et al.[6]

CASE STUDIES

Case 1

A 75-year-old woman presented with advanced photoaging, spotty hyperpigmentation, a dull complexion that would not reflect light, rhytides, and lax facial and neck skin (Figure 1A). A comprehensive 4-session treatment plan was developed and executed utilizing the 3-D approach and the all-encompassing device (Table 2). Treatment sessions were conducted at approximately 2-week intervals. Because the patient had a wedding in the

Table 2

Treatment Course for a 75-Year-Old Woman With Photoaging, Hyperpigmentation, Dull Complexion, Rhytides, and Lax Facial and Neck Skin*

First Session	Second Session	Third Session	Fourth Session
1100- to 1800-nm infrared light Left neck: 30 J/cm^2, 91 pulses Right neck: 30 J/cm^2, 60 pulses Left cheek: 36 J/cm^2, 28 pulses, followed by 32 J/cm^2, 31 pulses Right cheek: 30 J/cm^2, 61 pulses Forehead: 65 J/cm^2, 9 pulses	560- to 1200-nm IPL 16 J/cm^2, 90 pulses evenly distributed across the face	560- to 1200-nm IPL 16 J/cm^2, 94 pulses evenly distributed across the face	560- to 1200-nm IPL Face: 16 J/cm^2 39 pulses evenly distributed across the face Neck: 12 J/cm^2, 36 pulses evenly distributed across the neck
	Long-pulsed 1064-nm Nd:YAG laser 14 J/cm^2, 2003 pulses total across the face, 5 mm, 0.3 ms, 5 Hz	Long-pulsed 1064-nm Nd:YAG laser 14 J/cm^2, 3000 pulses total across the face, 5 mm, 0.3 ms, 10 Hz	Long-pulsed 1064-nm Nd:YAG laser 15 J/cm^2, 3038 pulses total across the face, 5 mm, 0.3 ms, 10 Hz

*IPL indicates intense pulsed light.

family planned for 2 months after the initial treatment session and wanted to look her best, the decision was made to accelerate the treatment sessions, shortening the total procedure time of all treatments from 6 months to only 6 weeks.

Skin laxity was addressed during the first treatment session using the 1100- to 1800-nm infrared handpiece. Because this device targets the deepest layer of skin, we used it to initiate treatment. Pulses and joules used during the procedure varied by anatomic region and are described in Table 2. Only one infrared procedure was performed on this patient owing to budget considerations, as she was a paying patient.

The 3 subsequent treatment sessions with the long-pulsed Nd:YAG laser and IPL were devoted to correction of fine lines, wrinkles, and hyperpigmentation (Table 2). All treatments were well tolerated and required little to no recovery time. A follow-up visit at 10 days and again 7 weeks after the last treatment revealed a noticeable improvement in skin quality, as well as in the smoothness and tightness of the skin (Figure 1, B and C)

A second infrared treatment was performed 19 months later. At that session, a photograph of the patient was taken in the office showing the duration of the benefit from her earlier treatments (Figure 1D). No additional treatments had been performed in the interim.

Case 2

A 57-year-old woman presented with melasma, rhytides, and facial laxity (Figure 2A). A comprehensive treatment plan using all 3 procedures was developed and executed over the course of 6 weeks (one treatment session per week), as shown in Table 3. During the first treatment session, the patient received an 1100- to 1800-nm infrared light treatment, followed by long-pulsed 1064-nm Nd:YAG therapy, followed by 560- to 1200-nm IPL therapy. During the second and third sessions, the patient received long-pulsed 1064-nm Nd:YAG therapy only. During session 4, the patient received an 1100- to 1800-nm infrared light treatment followed by long-pulsed 1064-nm Nd:YAG, followed by 560- to 1200-nm IPL. During the fifth session, the patient received long-pulsed 1064-nm Nd:YAG only. At the sixth session, the patient received an 1100- to 1800-nm infrared light treatment followed by long-pulsed 1064-nm Nd:YAG.

Our rationale for using this treatment protocol is the belief that it is best to initially treat the deeper layers of the skin with heat, working up to the most superficial layers. Otherwise, too much heat may be concentrated in the superficial layers of the skin. Gravity changes in the structure of the face must be addressed first to lift the deeper structures of skin. Therefore, the first treatment employs the 1100- to 1800-nm infrared handpiece

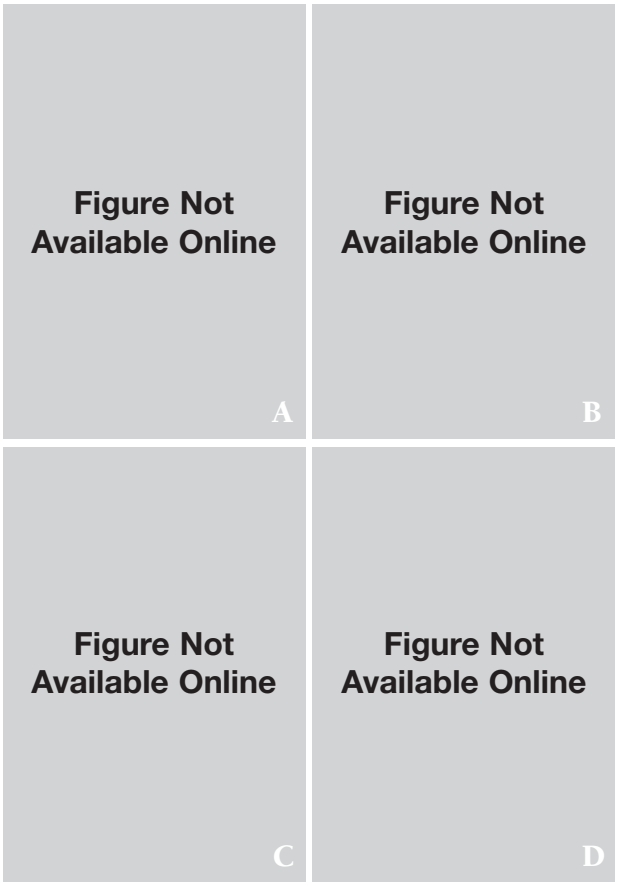

Figure 1. A 75-year-old woman before (A) and 10 days (B), 7 weeks (C), and 19 months (D) after four 3-dimensional facial rejuvenation sessions.

because it delivers penetrating heat into the reticular dermis. The next treatment employs the long-pulsed 1064-nm Nd:YAG laser, which stimulates collagen production in the papillary dermis. The last treatment employs the 560- to 1200-nm IPL wand, which removes the redness and solar lentigines on the most superficial layer of the epidermis and papillary dermis. This combination of treatments can be compared to building a house from the ground up, with the infrared component constituting the foundation of the house, the long-pulsed Nd:YAG component the first floor, and the IPL component the topmost floor.

All treatments were well tolerated by this patient. Mild, transient erythema was noted after several sessions with the long-pulsed Nd:YAG laser. Final follow-up and evaluation were conducted approximately 6 weeks after the last treatment session. Notable smoothing and tightening of the neck and facial skin were achieved, and the skin was evenly pigmented (Figure 2B).

DISCUSSION

We refer to this combination of lights used in sequence and at regular intervals as a 3-D approach to the restoration of photodamaged skin, offering the physician a cumulative and customizable treatment strategy. The combination of procedures and the intensity of the individual treatments may be tailored to the specific needs of each patient, allowing physicians to address multiple manifestations of aging. Moreover, because they are nonablative, 1 to 3 procedures may be performed during a single treatment session, making combination therapy an efficient approach to rejuvenation, an approach that produces rapid, visible improvements, as was observed in our patients. For clinical improvement, we recommend that patients receive three 1100- to 1800-nm infrared treatments, 6 long-pulsed 1064-nm Nd:YAG treatments, and two 560- to 1200-nm IPL treatments. Virtually no recovery time is required, which is appealing to patients. There is no downside to performing all 3 procedures or a combination of procedures during each treatment session.

The efficacy of individual laser therapies in the rejuvenation of facial skin is well established.[3-5,7] Although the 3-D strategy is a relatively new addition to the armamentarium, several clinical studies have been performed. Negishi and colleagues[8] studied 21 Asian women aged 31 to 59 years with Fitzpatrick skin types III and IV. Laxity was measured objectively pretreatment and posttreatment using 3-D software that measured skin surface, wrinkle and scar volume, and roughness. One-month follow-up was performed in 15 patients, and 3-month follow-up was performed in 12 patients. The infrared procedure was performed with a 10×15 spot size, and each patient received 3 treatments of 32 to 38 J/cm^2 on the forehead and cheeks. At 1-month follow-up, nasolabial fold depth was reduced in 14 of the 15 patients (93%), and the difference between pretreatment and posttreatment measurements achieved statistical significance ($P<.01$). At 3 months, 9 of the 12 patients analyzed (75%) showed improvement. No anesthesia was used during the procedure, and 90% (19 of 21) of patients reported that the gain of treatment exceeded the discomfort experienced during the procedure.

Likewise, Taub et al[4] reported positive outcomes in 42 patients with lax skin treated with the device. These investigators noted visible improvements in more than 90% of patients after 2 treatments and 3 months of follow-up. Continuous improvement and tightening were observed for up to 8 months. The technology was safe and well tolerated, and no complications were reported.

Similar results were reported by Ruiz-Esparza.[5] In this 25-patient study, immediate skin contraction was seen in 22 patients and persisted for up to 12 months following the procedure. Topical anesthesia was used during the first treatment in 5 patients. No anesthesia was used during

TABLE 3

Treatment Course for a 57-Year-Old Woman With Melasma, Rhytides, and Facial Laxity*

First Session	Second Session	Third Session	Fourth Session	Fifth Session	Sixth Session
1100- to 1800-nm infrared light	Long-pulsed 1064-nm Nd:YAG laser	Long-pulsed 1064-nm Nd:YAG laser	1100- to 1800-nm infrared light	Long-pulsed 1064-nm Nd:YAG laser	1100- to 1800-nm infrared light Left face: 40 J/cm^2, 228 pulses Right face: 40 J/cm^2, 228 pulses Forehead: 36 J/cm^2, 38 pulses
Left face: 40 J/cm^2, 132 pulses	18 J/cm^2, 2000 pulses each on left cheek, right cheek, forehead, and perioral region, 5 mm, 0.3 ms, 5 Hz	18 J/cm^2, 2000 pulses each on left cheek, right cheek, forehead, and perioral, region, 5 mm, 0.3 ms, 5 Hz	Left face: 40 J/cm^2, 228 pulses	18 J/cm^2, 2000 pulses each on left cheek, right cheek, forehead, and perioral region, 5 mm, 0.3 ms, 5 Hz	Long-pulsed 1064-nm Nd:YAG laser
Right face: 40 J/cm^2, 132 pulses			Right face: 40 J/cm^2, 228 pulses		18 J/cm^2, 2000 pulses each on left cheek, right cheek, forehead, and perioral region, 5 mm, 0.3 ms, 5 Hz
Forehead: 36 J/cm^2, 38 pulses			Forehead: 36 J/cm^2, 38 pulses		
Long-pulsed 1064-nm Nd:YAG laser			Long-pulsed 1064-nm Nd:YAG laser		
18 J/cm^2, 2000 pulses each on left cheek, right cheek, forehead, and perioral region, 5 mm, 0.3 ms, 5 Hz			18 J/cm^2, 2000 pulses each on left cheek, right cheek, forehead, and perioral region, 5 mm, 0.3 ms, 5 Hz		
560- to 1200-nm IPL			560- to 1200-nm IPL		
18 J/cm^2, 84 pulses each on left cheek, right cheek, forehead, perioral region, and each side of the neck			18 J/cm^2, 96 pulses each on left cheek, right cheek, forehead, perioral region, and each side of the neck		

*IPL indicates intense pulsed light.

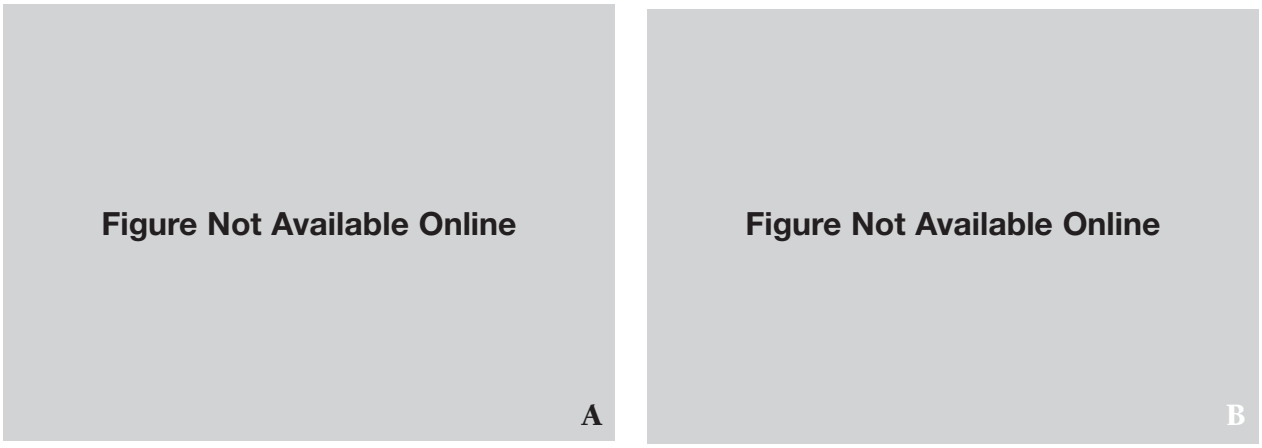

Figure 2. A 57-year-old woman before (A) and 6 weeks after (B) six 3-dimensional facial rejuvenation sessions.

subsequent procedures because of the level of the fluences used. No pain was reported at levels less than 30 J/cm^2.

COMMENT

This new 3-D approach of combined light therapy used repeatedly and at close intervals induces a combination of both gradual and rapid improvements in photoaged skin. The treatments are remarkable for patient comfort—they are virtually painless with little to no recovery time. Patients may continue normal daily activities before and after treatment sessions, and no preoperative or postoperative care is required.

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