

Nonablative Laser Surgery for Pigmented Skin

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BACKGROUND. Nonablative laser surgery has been proven to improve early photodamaged skin and acne scars. These techniques include treatments with lasers, light sources, and/or radiofrequency devices.

OBJECTIVES. To review the history of nonablative technology and its applicability to darker skin types and to provide an objective

look at the various published studies documenting the efficacy of nonablative technology.

CONCLUSION. Nonablative laser surgery can improve skin quality and acne scars in all skin types. Complications are rare but can occur. Future studies are required to compare the efficacy of the various nonablative technologies.

DAVID J. GOLDBERG, MD, HAS INDICATED NO SIGNIFICANT INTEREST WITH COMMERCIAL SUPPORTERS.

THE UNIQUE characteristics of skin color affect the clinical response of pigmented skin to treatment with most laser and light source technology. People of color include a wide variety of racial and ethnic populations. Individuals with pigmented skin are often classified as having Fitzpatrick skin phenotypes IV through VI.¹ According to the 2000 US census, 29% of the US population is not white. By 2056, according to projections, more than 50% of the American population will not be white. In 2000, the US Census Bureau estimated that the total resident US population includes 33 million Hispanic Americans (12%), 34 million African Americans (13%), 11 million Asians and Pacific Islanders (4%), and 2 million Native Americans, Eskimos, and Aleuts (1%).² Statistical projections show that among nonwhite groups in the United States, Hispanics will have the most significant growth rate. Everyday clinical evaluations show that ethnic skin shows less photoaging than is generally seen with Caucasians. However, signs of photoaging can be seen in this group. Interesting differences are found in perceptions of wrinkling among women of various skin colors. A recent study evaluated concern about wrinkles in darker skin types compared with the same concerns from an age-matched population of white women.³ The mean age of the white comparison group was 43 years. Sixty-five percent of the women of color—versus only 20% of the white women—reported that their skin was not wrinkled. Only 2% of the women of color—versus 20% of the white women—considered their skin moderately wrinkled.⁴ These results show a marked difference in perceived photoaging between women of color and white women. Despite these differ-

ences, recent data from the American Society of Plastic and Reconstructive Surgery revealed that cosmetic procedures among minority patients increased from 12% of all cosmetically treated patients in 1992 to 20% in 1998. Of those, 6% were African American (up from 4%), 8% were Hispanic (up from 5%), and 4% were Asian (up from 3%).⁴ Similarly, the popularity of cosmetic laser procedures is increasing in dermatologic surgery.⁵ This increased interest has been seen across the country and with all skin types. To understand how laser and light technology affects pigmented skin, one must understand the basics of lasers and laserlike technology. Simply put, can these procedures be used safely when treating skin of color?

Hemoglobin, melanin, and water are the major absorbing chromophores in human skin. Each chromophore has specific peak absorption wavelengths in the electromagnetic spectrum.⁶ The broad melanin absorption spectrum and the increased melanin content of darker skin create an obvious challenge for the laser surgeon. The highly melanized epidermis of pigmented skin absorbs and/or interferes with absorption of laser energy that is intended for other deeper targets. Thus, the distinct characteristics of pigmented skin must be considered when selecting laser and laserlike treatment parameters.

Because melanin, by its very nature, provides photoprotection from ultraviolet damage, the fine periorbital and perioral rhytids often seen as early as age 20 years in light-complected individuals tend to occur much later, if at all, in most darker skin types. This ethnic difference in rhytids accounts for the lack of articles on laser resurfacing in darker skin types.⁷⁻⁹ The most frequent complication occurring after laser treatment of darker skin is post-treatment hyperpigmentation.¹⁰ Despite the relative lack of sun damage seen in darker skin types, these individuals still seek laser treatments to improve the quality of their skin (Figure 1).

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Figure 1. Individual with Fitzpatrick skin type VI presenting for non-ablative treatment.

In addition to mild photodamage in ethnic skin, one commonly sees acne and its scarring sequelae in these darker skin types. In particular, acne in African American patients has a marked inflammatory component. This commonly leads to postinflammatory hyperpigmentation, worsening of the melasma commonly seen in darker skin types, and scarring.¹¹ Although Asians are less likely than African Americans to develop these problems, it is not unusual for Asians to present seeking treatment for acne scarring and melasma.

One would expect, in accordance with the theory of selective photothermolysis, that lasers that selectively target and destroy epidermal pigment should be efficacious in the treatment of the commonly seen dyschromias in darker skin. Laser-emitted light from 510 to 755 nm falls within the peak absorption spectrum of melanin. Logically, these wavelengths should be effective in the treatment of a wide range of pigmented anomalies, including melasma and postinflammatory hyperpigmentation.¹² However, most studies of these conditions were not undertaken in darker skin types. In addition, the predominance of melasma in patients with darker skin types makes postinflammatory hyperpigmentation with any laser therapy a potential and frequent complication in this group.

Initial attempts at laser treatment of photodamage and acne scars were undertaken with ablative lasers that removed the epidermis. Erbium:yttrium-aluminum-garnet (Er:YAG) lasers can solely ablate the skin or can ablate and also promote a thermal wound with thermal tighten-

ing of the treated dermis. Carbon dioxide lasers ablate the skin and also promote a thermal wound, with resultant thermal tightening of the treated dermis. All ablative lasers, by definition, vaporize skin and lead to the potential risks associated with laser resurfacing. These include infection, prolonged erythema, hyperpigmentation, and delayed hypopigmentation. The ethnic disparity in rhytids accounts for the few published articles discussing laser resurfacing in nonwhite patients. However, the most frequent complication observed with laser-treated darker skin was post-treatment hyperpigmentation.⁷⁻⁹ This laser-induced postinflammatory hyperpigmentation occurs in approximately 35 to 40% of treated patients with Fitzpatrick skin types I to III and virtually 100% of those with darker skin phototypes (Fitzpatrick skin types IV-VI).¹³⁻¹⁶ Hyperpigmentation usually manifests within the first month following treatment and generally spontaneously resolves during the next several months to a year.

Nonablative technology has been suggested as an alternative to ablative techniques for promoting new collagen formation and lessening ablative laser-associated complications.

Published studies using this technology show promise with the possibility of a decreased incidence of complications in darker skin phenotypes. These nonablative techniques all share the elements of a minimal recovery time, the requirement of multiple treatments, and the presence of subtle clinical results.

Ablative resurfacing improves photodamaged skin, in part because of the post-laser-induced dermal wound. However, if a dermal wound and new collagen formation are the primary mechanisms behind the improvement seen after laser resurfacing, techniques that induce a dermal wound without epidermal ablation and without significant thermal effect should theoretically lead to cosmetic improvement of dermal photodamage. Because there is no epidermal disruption, one would expect that such technologies would be safer in darker skin types.

In one of the first studies evaluating a nonablative approach to dermal remodeling, a 1,064 nm Q-switched neodymium-yttrium-aluminum-garnet (Nd:YAG) laser was used in an attempt to improve rhytids.¹⁷ In 6 of 11 patients (3 with perioral rhytids, 3 with periorbital rhytids), clinical improvement was noted but was not thought to be as significant as that seen with an ablative laser system. No pigmentary changes or scarring was noted in any of the treated subjects.

The aforementioned study was expanded when the nonablative, dermal remodeling effects of a Q-switched Nd:YAG laser were potentiated by the use of a topical car-

bon-assisted solution.¹⁸ Further studies have also been performed with a non-Q-switched millisecond Nd:YAG laser.¹⁹ All of these studies were performed on lighter skin types. However, because the 1,064 nm Nd:YAG laser wavelength is so poorly absorbed by melanin, one would expect that this wavelength could be used in darker skin types.

Other nonablative systems, such as the pulsed dye laser and intense pulsed light sources, have also been shown to improve dermal collagen.²⁰⁻²² Since these technologies emit wavelengths well absorbed by melanin, they would not be expected to be as safe in the treatment of darker skin types compared with the aforementioned 1,064 nm wavelength. However, several reports have documented the safety and efficacy of intense pulsed light treatments in Asian skin.²³⁻²⁷ Negishi and colleagues were among the first to investigate the use of intense pulsed light in Asians.²³ Using this nonlaser light source, they studied skin rejuvenation in 97 Japanese patients. They observed that 90% experienced a reduction in pigmentation, 83% showed improvement in telangiectasia, and 65% were noted to have improvement in skin texture after three treatment sessions. There were no reports of postinflammatory hyperpigmentation. More recently, Huang and colleagues used the same device in the treatment of 36 Chinese patients with ephelides. They observed good to excellent results after a mean of 1.4 treatment sessions.²⁴

In another study, Negishi and colleagues used an intense pulsed light to treat 73 Japanese photoaged subjects.²⁵ After the fifth treatment, a combined rating of greater than 60% improvement was observed in more than 80% of patients with increased pigmentation, telangiectasia, and roughened skin texture. Furthermore,

histologic evaluations showed strong staining of type I and type III collagen

The first specifically nonablative laser to be solely marketed to the physician community is the 1,320 nm Nd:YAG laser.²⁸ The goal of this system, similar to that of the previously described systems, is improvement of rhytids without the creation of a wound. The 1,320 nm wavelength is advantageous in its high scattering coefficient. Thus, the laser irradiation scatters heat throughout the treated dermis after nonspecific absorption by dermal water.

Patients are usually treated at 2- to 4-week intervals and can be expected to show improvement in early photo-damaged skin and acne scars (Figures 2 and 3).²⁹⁻³¹ Consistent with the noted clinical improvement is the histologic replacement of the irregular collagen bands with organized new collagen fibrils. A 1,450 nm diode laser produces results similar to those seen with the 1,320 nm Nd:YAG laser³ (Figures 4 and 5).^{32,33} Finally, a new nonablative radiofrequency source may produce similar results.³⁴ Because these technologies all cool the epidermis, epidermal ablation would not be expected. However, if too much cooling is delivered, one would expect cryogen or contact cooling-induced postinflammatory pigmentary changes in all skin types, especially darker-skinned ethnic groups (Figure 6).

Nonablative technology does play a role in the treatment of early photodamage and acne scarring in darker skin types. Although postlaser complications are less than would be seen when these skin types are treated with ablative lasers, they still do exist. Future studies are likely to continue to show the value of nonablative treatment in all skin types.



Figure 2. Acne and acne scars before treatment with the 1,320 nm Nd:YAG laser.



Figure 3. Improvement in acne and acne scars after treatment with the 1,320 nm Nd:YAG laser.



Figure 4. Acne and acne scar before treatment with the 1,450 nm diode laser.



Figure 5. Improvement in acne and acne scars after treatment with the 1,450 nm diode laser.



Figure 6. Cryogen-induced postinflammatory hyperpigmentation seen after treatment with the 1,450 nm diode laser.

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