

Laser and Light Therapies in Skin of Color: Special Considerations

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Nonsurgical cosmetic procedures are very popular and are performed by dermatologists all over the world. The use of laser and light devices has made these procedures easier, safer, and more affordable. Most of these procedures do not require anesthesia, hospitalization, or downtime, and the recovery period, if any, is short. The relative ease of nonsurgical cosmetic procedures and the minimal pain and discomfort associated with them have made them very compatible with the busy lifestyles of most people.

Most of the patients treated with nonsurgical cosmetic procedures in the United States and the rest of the western hemisphere are white (ie, Fitzpatrick skin type I–III). A relatively low number of dark-skinned patients in the United States, mostly in large metropolitan areas, undergo these procedures. Yet, despite these low numbers, nonsurgical cosmetic procedures are desired by the black and Hispanic populations in the United States and by a large number of people in Asian countries.

DIFFERENCES BETWEEN LIGHT AND DARK SKIN

It was formerly believed that nonsurgical cosmetic procedures would not be safe for dark-skinned patients because of the high risk of adverse effects. This belief was grounded in the science of lasers and in the differences between light and dark skin. When laser and light energy passes through the epidermis to target its chromophore, the energy has to go through the melanocytes in the epidermis. These melanocytes and the melanin within

them can act as competing chromophores and absorb this energy, resulting in an increased risk of complications. However, if the parameters are adjusted in a way that suits dark skin, these complications can be minimized or avoided.

There are some fundamental differences in the pathophysiology of light and dark skin.^{1,2} When compared with light skin, dark skin has a higher melanin content in the epidermis and larger and more melanized melanosomes.³ Degradation of melanosomes in the keratinocytes of dark skin is slower than in white skin. The melanocytes and mesenchyma are more prone to trauma and inflammatory conditions in dark skin.⁴ The dermis is thicker in dark skin than in light skin, and dark skin also absorbs and scatters more energy. The thicker dermis and larger melanosomes lead to better photoprotection, which, in turn, lowers the risk of skin cancers. They also protect against long-term photodamage and lead to less visible signs of aging, such as wrinkles and solar lentigines. Mesenchymal activity is increased in dark skin, resulting in a greater risk of keloid and hypertrophic scar formation.

CONSIDERING ETHNICITY AND SKIN COLOR WHEN TREATING WITH LASERS

When it comes to treating cutaneous signs of photoaging, we as dermatologists have come to realize that even though patients may appear white, their ethnic background must be considered. For example, many patients of Mediterranean heritage appear white, but their skin behaves as dark skin when treated with laser devices.

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The author reports no conflict of interest in relation to the article.

Presented in part at the fifth meeting of the American Society of Cosmetic Dermatology & Aesthetic Surgery, Las Vegas, Nevada, December 2, 2006.

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This is also true for patients whose parents are of 2 different races.

We must consider all of these factors when treating dark-skinned patients to achieve the most effective therapeutic outcome with minimal adverse effects. In addition to the usual adverse effects that patients may experience as a result of laser and light-based procedures, dark-skinned patients have a higher risk of pigmentary alterations (hypopigmentation, hyperpigmentation, and depigmentation).

If we choose the correct wavelength with the correct parameters, we can safely and effectively treat dark-skinned patients. These patients comprise a very large market worldwide that was initially ignored. It was erroneously assumed that laser and light-based procedures were simply not appropriate for dark-skinned patients. However, the sizeable demand for these procedures by dark-skinned patients encouraged clinicians, scientists, and industry groups to design studies that led to the development of new technologies and parameters that can be safely used for this group of patients. We are still working to develop even better parameters, but at the present time there are several procedures that are used

safely and effectively throughout the world in dark-skinned patients. The availability of such procedures has increased the level of confidence of dark-skinned patients and of the dermatologists who treat them.

SAFELY AND EFFECTIVELY TREATING DARK-SKINNED PATIENTS

The most fundamental way to achieve optimal results with minimum risk of complications in dark-skinned patients is to protect the epidermis and prevent injury and energy absorption by the melanin. There are many ways to achieve this goal. Some major considerations are the selection of the correct wavelength and pulse duration and effective cooling of the epidermis.

Devices with longer wavelengths are relatively safer to use on dark skin than devices with shorter wavelengths.^{5,6} For example, for hair removal, the ruby laser with a wavelength of 694 nm is known to cause pigmentary problems and scarring in dark-skinned patients, whereas an Nd:YAG laser with a wavelength of 1064 nm is better in terms of its safety profile. This is because the longer wavelength of the Nd:YAG laser is absorbed less by melanin than the shorter wavelength of the ruby laser (Figure 1).

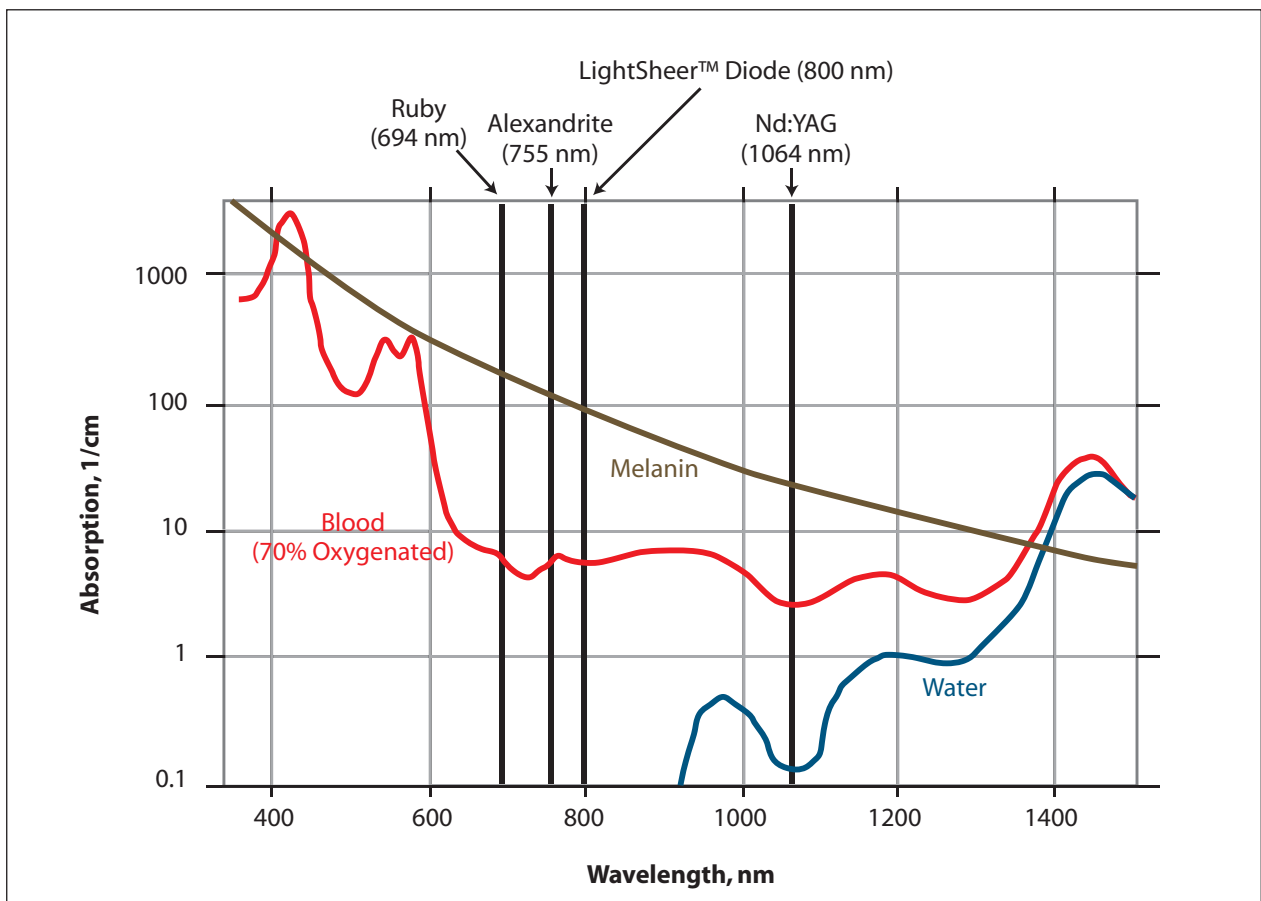


Figure 1. Laser absorption spectrum.



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Figure 2. A patient with Fitzpatrick skin type V 2 days after laser hair removal treatment at 30 J/cm². Patient's right side was treated with a 30-ms pulse, and the left side was treated with a 100-ms pulse. Photograph courtesy of Wellman Laboratories of Photomedicine, Massachusetts General Hospital, Boston.

Similarly, the wider spectrum of intense pulsed light with the correct parameters is safer in dark-skinned patients than in light-skinned patients.

Selecting the correct pulse duration is very important for achieving successful hair removal without causing any epidermal damage.⁷ It has been shown that for hair removal, longer pulse width is better for dark-skinned patients to prevent complications (Figure 2). We can deposit the same amount of energy in the skin or chromophore with either a short or a long pulse. To illustrate this concept, an appropriate analogy would be putting water into a bathtub either by slowly pouring a gallon of water into the tub over a period of few minutes or dumping the same amount of water in just a few seconds. The end result is the same: we are depositing 1 gallon of water in a bathtub. Another analogy would be heating a gallon of water in 2 similar containers, with one container left on the stove at low heat and the other left at high heat. Water in both containers will eventually boil, but the water in the container on high heat

would boil sooner. Again, the end result is the same: boiling water. When we deposit energy in a "slow" mode (long pulse), the skin loses heat at the same time as we deposit it. This prevents the skin from overheating. Hence, we choose longer pulse durations when treating dark-skinned patients for hair removal.

The vascular lesions in dark-skinned patients can also be treated if the correct parameters are chosen. Increased epidermal melanin competes with oxyhemoglobin and can act as a barrier to vascular lasers and intense pulsed light.⁸ The higher epidermal melanin is the main limitation to the final outcome of vascular laser treatment in clinical and histologic studies.⁹⁻¹² It has been shown that patients with Fitzpatrick skin type IV or V respond slowly and require more treatment sessions when their port-wine stains are treated with a pulsed dye laser.¹³ The more recently developed longer-wavelength Nd:YAG laser with long pulse duration and epidermal cooling has become the laser of choice to treat vascular lesions in dark-skinned patients.¹⁴

It is even more challenging to treat pigmented lesions in dark-skinned patients, as the target chromophore is melanin, but we must avoid or minimize injury to "non-target" melanin. In dark-skinned patients, pulsed lasers with appropriate energy settings provide more selective absorption by the target chromophore, resulting in a lower risk of pigmentary alteration and scarring than continuous-wave lasers.¹⁵ Benign epidermal pigmented lesions have been treated with the 488- and 525-nm argon laser,¹⁶ the 510-nm pulsed dye laser,¹⁷ the 511-nm copper vapor continuous-wave laser,¹⁸ the Q-switched frequency-doubled 532-nm Nd:YAG laser,¹⁹ and the Q-switched 694-nm ruby laser.^{16,20-22} The successful treatment of deep dermal lesions, such as nevi of Ota, with the use of Q-switched lasers is well documented.²³⁻²⁹ The results of treatment of mixed epidermal and dermal pigmented problems, such as melasma and postinflammatory hyperpigmentation, have been variable.^{23,30,31} The recent development of fractional technology has shown promise in the treatment of melasma, but long-term data are not yet available.

Both CO₂ and erbium:YAG laser resurfacing are used to treat the effects of photoaging and acne scars in dark-skinned patients.³² The risk of postinflammatory hyperpigmentation with laser skin resurfacing is higher in this group of patients.³³

Cooling the epidermis can minimize the absorption of energy by the epidermal melanocytes and decrease the risk of complications. Epidermal cooling enhances clinical efficacy and minimizes the epidermal damage that is caused by laser and light treatments.³⁴⁻⁴⁰ It protects the epidermis, extracts heat, and allows the use of higher fluence. Cooling helps reduce the intensity and duration



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Figure 3. The different responses of skin to laser treatment without (left) and with (right) cooling when the same parameters are used. Photograph courtesy of Wellman Laboratories, Massachusetts General Hospital, Boston.

of erythema, edema, and discomfort (Figure 3). We can effectively cool the treatment site by “bulk” cooling of the entire treatment area. We can also either cool the treatment site pretreatment or posttreatment, or cool the skin during treatment (ie, parallel cooling). However, the best way to maximize the effect of cooling is a combination of pretreatment, parallel, and posttreatment cooling. This allows cooling of the treatment site before, during, and after treatment. There are many ways to achieve the goal of cooling. Using ice cubes is the simplest way to cool the skin. Many physicians use a cold gel or a “roller” that is kept in the freezer for frequent use. A cold liquid (cryogen) spray and cold airflow are also used for this purpose. Several devices are equipped with a glass chamber and a sapphire window to cool the skin.

In addition to the previously mentioned factors that must be taken into account when treating dark-skinned patients, it is also important to stress to these patients the importance of avoiding sun exposure and indoor tanning and applying sunblock and bleaching agents before and after the treatment.

SUMMARY

We must educate ourselves to accommodate the changes that we need to make when treating dark-skinned patients. Our approach must begin at the first encounter with a patient (ie, during the initial consultation). We must educate these patients about the differences in skin types and advise them that there is an increased risk of complications in people with dark skin. We must inform them that we have changed the laser and light devices



Figure 4. Hyperpigmentation in a patient with Fitzpatrick skin type V after pulsed dye laser treatment without cryogen spray cooling.



Figure 5. Dermatitis papulosa nigra before (A) and 6 months after (B) an erbium:YAG laser ablation in a patient with Fitzpatrick skin type IV.



Figure 6. Patient with Fitzpatrick skin type IV before (A) and 3 months after (B) intense pulsed light hair removal.

and adjusted the parameters to prevent complications. Patients should be made aware of their responsibility to use bleaching agents and avoid sun damage.

In applying these measures, we as physicians should experience a great sense of satisfaction after treating *all* types of patients, including those with dark skin (Figures 4–6).

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