Laser Therapy in Ethnic Populations

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ABSTRACT

Today, laser therapy is standard treatment for a wide variety of dermatologic complaints. From skin rejuvenation to the management of complex vascular malformations, laser treatment has proved to be an effective, innovative solution to once-challenging dilemmas. However, laser application in those with darker complexions remains a topic of great concern. Although contemporary devices may use longer-wavelength lasers and cooling devices to isolate target tissues within patients with high levels of epidermal melanin, significant risk remains. Today's laser surgeon must have a thorough understanding of patient concerns, lesion character and response to treatment, as well as the unique needs of those with darker skin. In this article, we discuss critical issues in patient assessment, proper evaluation of common skin complaints, and laser therapy use for a variety of lesions in the ethnic population.

KEYWORDS: Ethnic skin, Fitzpatrick type V skin, Fitzpatrick type VI skin, laser treatment for dyschromia, laser treatment for acne scars, postinflammatory hyperpigmentation, laser therapy, laser skin rejuvenation, nonsurgical facial rejuvenation, laser resurfacing, laser treatment for hypertrichosis

According to the 2000 Census, the proportion of non-Caucasian U.S. citizens is expected to rise from 29% to over 50% by 2056.¹ This growing sector of the population may certainly benefit from laser therapy for a variety of dermatologic concerns. However, much of the published literature is based on experience with patients of Fitzpatrick type I and II skin; questions regarding laser use on those with darker complexions remain. With respect to this increasing percentage of the population, the laser surgeon must be aware of the unique needs of those with darker skin, be able to exercise expert judgment in patient evaluation, and realize all risks and benefits of cutaneous laser procedures in this potentially challenging patient group. In this article, we discuss laser therapy in ethnic populations with darker skin tones.

BASIC SCIENCE

The biology of skin color differences is quite fascinating. Theories suggest that our common ancestors were light skinned with thick dark hair. As selective pressure caused us to lose our hair, our skin darkened to prevent ultraviolet-related injury to the cells.² With Northern migration, our skin lightened to increase capture of vitamin D.³ These tenets of human evolutionary theory may explain underlying reasons behind the differences in complexion between different races. These skin color differences between populations are not due to increased melanocyte number but are secondary to increased melanin production.⁴ Increased melanin production may also be a response to ultraviolet light (i.e., tanning).⁵ Categorization of skin color for medical purposes is by the Fitzpatrick scale⁶ (Table 1).

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Table 1 Fitzpatrick Skin Phototypes

Fitzpatrick Phototype	Response to Sunlight Exposure	Constitutive Color
I	Burns easily; never tans	White
II	Burns easily; tans minimally with difficulty	White
III	Burns moderately; tans moderately and uniformly	White
IV	Burns minimally; tans moderately and easily	Beige-olive, lightly tanned
V	Rarely burns; tans profusely	Moderate brown or tanned
VI	Never burns; tans profusely	Black

In addition to possessing a base of knowledge of the basic structural anatomy and physiology of the skin, today's laser surgeon needs to understand the relationship between melanin and wavelength, as melanin may interfere with specific target or chromophore absorption. Melanin absorbs light within a large spectrum, with greater absorption seen with smaller wavelengths and decreased absorption seen with larger wavelengths. With the greater absorption seen with shorter wavelengths, there is an increasing amount of heat generated.⁷ This leads to a greater risk of thermal injury in patients with large quantities of melanin in the epidermis, as seen in skin types V and VI.⁸ Because newer laser systems allow modification of cooling and pulse duration, they will be used to treat a wide variety of skin types. With this next generation of lasers, the risk of thermal injury should be reduced, leading to more consistent outcomes.⁹

THE INITIAL CONSULTATION

The preprocedure consultation is an opportunity not only to perform a thorough patient history and examination but also to discuss patient expectations. A detailed medical history should be taken, and specific attention should be paid to identification of any hereditary hemolytic diseases that may affect any postoperative healing. As with all potential patients, any history of isotretinoin use should be obtained before laser application.¹⁰ More specific to those of African American, Mediterranean, or Southeast Asian heritage, any history of sickle cell anemia, thalassemia, and glucose-6-phosphate dehydrogenase deficiency must be elicited. Patients must be made aware of and appreciate these possible complications with respect to their expected outcome. The possibility of staged procedures and time constraints related to postoperative recovery should be discussed.

After initial evaluation, test spots are advisable prior to formal laser application. Test spots should be performed in the same or similar area that treatment is to be performed. The performance of test spots is crucial to minimize patient dissatisfaction if a side effect occurs. Test spot parameters should start with the safest settings (lower fluences and longer pulse durations) and slowly progress to higher fluences and shorter pulse durations. Typically, two to four fluences are tested with a minimal

48-hour wait before determining the safe treatment fluence. This time frame is ideal because patients with darker skin types can have a 1- to 2-day delay in demonstrating cutaneous side effects. Based on the results from the test spots, the safest fluence parameter can be selected to use to initiate treatment.

DYSCHROMIA

Dyschromia, a site-specific difference in pigmentation, frequently prompts consultation by dark-skinned patients.¹¹ Two dyschromic disorders for which laser therapy is most commonly applied include melasma and postinflammatory hyperpigmentation. Melasma can be found in all ethnic groups, but African American and Hispanic women of fair complexion are more frequently affected.^{12,13} Patients who are prone to developing melasma are also prone to developing postinflammatory hyperpigmentation.¹⁴ Causative factors for both, such as oral contraceptives and photosensitizing drugs, must be identified and eliminated. In addition, use of daily broad-spectrum ultraviolet A and B sunscreens should be encouraged. Melasma should be differentiated from postinflammatory hyperpigmentation, which is the result of an inflammatory process.

One significant difference between melasma and postinflammatory hyperpigmentation is that once causative factors are eliminated, postinflammatory hyperpigmentation usually resolves spontaneously.¹⁴ Although the first-line treatment for melasma is chemical, the Q-switched neodymium:yttrium-aluminum-garnet (Nd:YAG) lasers may be useful for recalcitrant lesions.¹⁵ Fractional nonablative devices may also be used for pigment disorders in darker-skinned patients.

ACNE-RELATED SCARRING

African American patients often demonstrate a marked inflammatory response to acne, and postinflammatory hyperpigmentation with scarring is frequent.¹⁶ As a result, acne is one of the most common stimuli prompting those with darker skin to seek laser treatment.^{17,18} Given the probability of acne-related scarring in this population, early, aggressive treatment may be necessary to avoid dyschromia and scarring. Today's lasers provide

highly concentrated heat that causes collagen contraction and, therefore, a tightening effect. Compared with abraded injuries, however, burn injuries require a more lengthy recovery period, cause long-lasting dyschromia, and may leave some textural irregularity. Full-face resurfacing has traditionally been performed with the CO₂ or erbium:yttrium-aluminum-garnet (Er:YAG) lasers. These lasers are useful for acne scarring in Fitzpatrick type I to IV patients but may produce unacceptably high hyperpigmentation rates in Fitzpatrick type V to VI patients. Repeated superficial resurfacing may be helpful in these populations. In available nonablative laser resurfacing technologies, such as the Nd:YAG 1320 nm, 1450-nm diode, and 1540-nm Er:glass lasers, the laser beam harmlessly penetrates through the epidermis to induce remodeling within dermal collagen. Although the benefits of this procedure include minimal recovery time, the clinical results achieved are subtle and necessitate serial treatments; epidermal blistering and permanent dermal defects may occur.^{19,20} The nonablative wavelengths are thought to be "color blind" due to their minimal melanin absorption. These lasers are an ideal starting point for acne scarring in the darker-skinned population. Fractional lasers, which treat a small percentage of the skin surface at each session, may be used in darker-skinned patients. These devices are available in both nonablative and ablative wavelengths.

BENIGN CUTANEOUS TUMORS

Laser resurfacing is an effective treatment for smooth benign cutaneous tumors such as syringomas, dermatosis papulosa nigra, and acne keloidalis nuchae. Syringomas are relatively prevalent in ethnic populations. However, CO₂ laser alone or in combination with trichloroacetic acid have shown acceptable results.^{21,22} Because of depth limitations, complete lesion removal is unlikely. Instead, the goal of laser therapy when treating the syringoma is to flatten, smooth, or improve lesion appearance. Dermatitis papulosa nigra are benign flesh-colored papules found predominately on the face, neck, and trunk of African Americans.²³ Although treatment is unnecessary based on medical protocol, cosmetic concern frequently prompts consult. Dermatitis papulosa nigra is easily removed through a variety of means, including scissor excision, electrodesiccation, and laser ablation. When using ablative lasers, such as the CO₂, Er:YAG laser, or 532 diode,²⁴ one must be careful to apply a spot size approximating lesion diameter. Acne keloidalis nuchae occurs on the posterior scalp almost exclusively in African American men.²⁵ Although the exact pathophysiologic process remains debated, a robust foreign body reaction with subsequent keloid formation is thought to play a role.²⁶ A CO₂ laser in cutting mode can be used to excise the tumor below hair follicle level at the deep subcutaneous

tissue.²⁷ Facial telangiectasias, port wine stains (PWSs), hemangiomas, and leg veins may also prompt laser consult. However, epidermal melanin absorbs the same laser light intended for hemoglobin, the target chromophore when treating vascular lesions. Vascular lasers using longer wavelengths (e.g., Nd:YAG) offer the greatest potential to treat darker ethnic skin. In addition, the response rate of vascular lasers varies widely in the literature. In treating the PWS, published success ranges from 36.5 to 78.6% with more than 50% clearing.^{28,29}

SKIN REJUVENATION

The photoprotective nature of melanin protects those with darker complexions from many of the finer, sun-related aging signs that may be more apparent in Caucasians.³⁰ While those with dark skin still experience crow's-feet, lipstick lines, and fine perioral lines, these processes tend to occur much later.³¹ To date, very few articles have evaluated laser use for age-related skin resurfacing in darker populations. Available data demonstrates that the most frequent complication observed with darker skin was posttreatment hyperpigmentation. However, these reports used treatment in Asian and Hispanic groups with Fitzpatrick IV and V phototypes.³²⁻³⁵ In general, ablative lasers remain associated with an increased risk of hyperpigmentation. Newer fractional devices as discussed previously may be more useful in ethnic populations. Current research on these devices will determine whether nonablative or ablative wavelengths have better results and lower complication rates and clarify the role of other variables such as spot size, density, and depth of treatment.

HYPERTRICHOSIS

Laser therapy for hypertrichosis relies on melanin absorption within the hair bulge or bulb for follicle destruction. In those with darker complexions, however, effective follicle targeting can be complicated by competition from epidermal melanin. Lasers for hair removal come in a variety of wavelengths. Ruby lasers at 694 nm, alexandrite lasers at 755 nm, and pulsed light devices are better suited to lighter-skinned, nontanned individuals with dark hair. Diode lasers at 800 nm and 1064 nm Nd:YAG lasers are most useful in darker skin types. There is considerably less melanin absorption with these devices. Contemporary laser hair-removal devices incorporate longer pulse durations and a variety of cooling devices, all of which facilitates safer treatment of dark skin.³⁶ Jackson^{37,38} demonstrated that longer pulse durations of 40 milliseconds using the long-pulsed alexandrite laser⁴¹ (Cynosure, Chelmsford, MA) destroyed hair follicles while protecting epidermal melanin. Despite the use of cooling devices, patients with higher

melanin contents within their skin experience more pain with laser hair-removal procedures. This generally means that higher laser fluences should be avoided,³⁷ and treatment should be guided by more conservative parameters. With these modifications, laser hair removal can now be successfully applied for hypertrichosis and pseudofolliculitis barbae.

KELOIDS AND HYPERTROPHIC SCARS

Keloids and hypertrophic scars are common in the African American population and frequently prompt laser consultation due to displeasing appearance, continued pruritus, and pain. Although lesion vaporization with the CO₂ laser is discouraged due to high rates of recurrence, the pulsed dye laser (PDL) is effective in reducing erythema, decreasing symptomatology, decreasing size, and improving pliability.^{38,39} By selectively targeting the vascularity of the scar, there is decreased blood supply to the growing fibroblasts within keloidal tissue. More appropriate collagen remodeling can then progress to form a softer, less erythematous keloid or hypertrophic scar. In combination with intralesional steroids, Connell and Harland⁴⁰ noted a 60% improvement in lesion height; 40% improvement of erythema; and 75% improvement of symptoms with PDL treatment. This study suggests that pretreatment with PDL decreases scar edema, local tissue density, and thereby facilitates the steroid injection.⁴⁰ Manuskiatti et al⁴² demonstrated a mildly positive response with lower fluences although no statistically significant difference could be shown.

CONCLUSION

When performing laser procedures in patients with darker skin, today's surgeons must balance effective treatment with minimal risk to the patient. With the risk of high complications relative to lighter-skinned individuals, potential effects may be minimized with the use of conservative treatment parameters (i.e., longer wavelengths and lower energy settings). With appropriate patient selection and proper laser application based on lesion character, laser surgery is increasingly safe in patients of color. As our understanding of the use of lasers for aesthetic resurfacing in this patient group grows and new laser technologies come onto the scene, it may be found that these patients have the most predictable outcomes; because patients with darker skin are less apt to present with great amounts of sun damage relative to those with fair complexions, and unacceptable cosmetic results such as demarcation lines might be less frequent. With further evaluation of laser use in those with darker skin tone, expanded basic science and clinical research into technological development, laser therapy

will provide innovative solutions and improved outcomes for the challenges of tomorrow.

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