

Laser Surgery in Dark Skin

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Although challenging, effective laser surgery in patients with darker skin tones can be achieved despite a higher inherent risk of untoward side effects. While the incidence of undesirable postoperative sequelae has decreased with the development of advanced laser technology and individualized treatment parameters, these risks may never be eliminated completely. Consequently, thorough patient preoperative preparation and education regarding the risks of cutaneous laser therapy will remain an essential component of treatment in darkly pigmented patients. In the future, as more refined laser techniques evolve, the ability to safely and effectively treat these patients will improve. (SKINmed. 2003;2:80–85) ©2003 Le Jacq Communications, Inc.

The safe and effective laser treatment of patients with darker skin tones presents a challenge to the laser surgeon and is becoming more frequently encountered as the patient population continues to increase and become more ethnically diverse. Population statistics of the United States reveal dramatically shifting demographics in the past decade. Between 1990 and 2000, Hispanics and Asians accounted for 40% of the total growth of the US population, African Americans for 12%, and non-Hispanic Caucasians for slightly over 2%.¹ In 2000, the total number of individuals in the United States with skin of color was approximately 85 million.¹ Despite the increased demand for dermatologic laser surgery by Asians, Hispanics, and African Americans, most of the current literature remains devoted to examining laser procedures performed on individuals with fair skin tones (skin phototypes I–II) and protocols have largely been defined on the basis of the more extensive clinical experience that has accumulated surrounding these patients.

Due to its unusually wide absorption spectrum ranging from 250–1200 nm, all visible-

light and near-infrared dermatologic lasers currently in use can specifically target melanin. Nonspecific energy absorption by relatively large quantities of melanin in the basal layer of the epidermis can increase unintended nonspecific thermal injury and lead to a higher risk of untoward side effects including permanent dyspigmentation, textural changes, focal atrophy, and scarring in the darkly pigmented patient. Moreover, competitive absorption by epidermal melanin substantially decreases the total amount of energy reaching deeper dermal lesions, rendering it more difficult to achieve the degree of tissue destruction necessary to affect the desired clinical result. Treatment parameters, therefore, must be carefully considered when performing laser surgery on patients with darker skin phototypes.

Although difficult, effective laser therapy in patients with darker skin phototypes can be achieved,^{2–7} since the absorption coefficient of melanin decreases exponentially as wavelengths increase. Illustrating this principle, epidermal melanin absorbs approximately four times as much energy when irradiated by a 694 nm ruby laser as when exposed to the 1064 nm beam generated by the neodymium:yttrium-aluminum-garnet (Nd:YAG) laser, thus allowing greater penetration of the longer wavelength.⁸ Therefore laser systems generating wavelengths that are less efficiently absorbed by endogenous melanin can often provide a greater margin of safety while still allowing the laser surgeon to achieve satisfactory results.

When determining a treatment protocol for an individual patient, power level is at least as important as the laser wavelength chosen when treating darker skin, since highly melanized skin

absorbs electromagnetic energy much more efficiently than does fair skin. For example, skin phototype VI may absorb as much as 40% more energy when irradiated by a visible light laser than does class I or II skin when fluence levels and exposure duration remain constant.⁹ Thus, conservative power settings (the minimal threshold fluences necessary to produce the desired tissue effect in a given individual as determined through irradiation test spots) should be employed initially to minimize the extent of collateral tissue damage. Clearly, a prudent approach to treatment is far preferable to incurring the risk of irreparable tissue destruction resulting from excessive thermal injury, even if this may necessitate multiple laser treatments in order to achieve maximal clinical results.¹⁰

Pigment-Specific Lasers

Pigment-specific laser technology generates green, red, or near-infrared light to selectively target intracellular melanosomes or tattoo pigment. Pigment-specific lasers are also used to eradicate unwanted hair by damaging follicular structures in which melanin is heavily concentrated.

Q-switched systems generating nanosecond (ns) pulses, which are substantially shorter than the 10–100 ns thermal relaxation time of melanosomes, represent the safest means for treating pigmented lesions in dark skin. Q-switched systems currently available include the 532 nm frequency-doubled Nd:YAG, 694 nm ruby, 755 nm alexandrite, and 1064 nm Nd:YAG lasers. Although melanin absorbs energy throughout this range of wavelengths, its absorption peaks lie in the ultraviolet range, with decreased absorption capacity at the longest wavelengths. Thus, the far infrared wavelengths generated by the alexandrite and Nd:YAG laser systems are less efficiently absorbed by epidermal melanin, which limits the extent of unwanted thermal injury to nontargeted tissues of the epidermis and upper papillary dermis. This, in turn, allows for deeper dermal penetration, making the effective treatment of pigmented dermal lesions and hair follicles possible. Whether targeting superficial epidermal lesions such as lentigines, ephelides, café-au-lait macules, or lesions with a deep dermal component such as nevus of Ota, melanocytic nevi, or nevus spilus, treatment should be initiated at threshold fluences (the minimum fluence necessary to produce immediate lesional whitening signaling the destruction of intracellular melanosomes). If the clinical threshold is exceeded, epidermal exfolia-

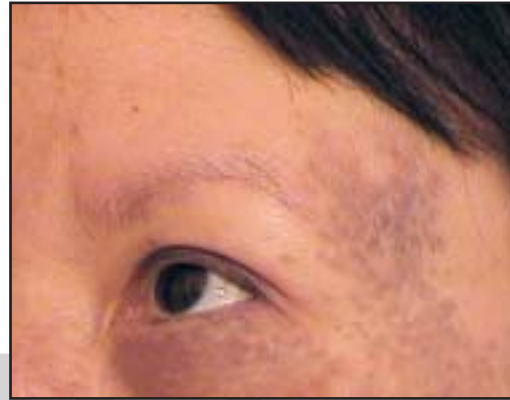


Figure 1A. Nevus of Ota in a patient with type III/IV skin



Figure 1B. Clearing noted after five Q-switched 755 nm alexandrite laser treatments

tion and pinpoint bleeding ensues, resulting in blistering, possible temporary or permanent hypopigmentation, and perhaps even skin textural changes or scarring.^{8,10}

Of the pigmented lesions that disproportionately affect ethnic groups with darker phototypes, nevi of Ota have proved especially amenable to treatment with Q-switched ruby, alexandrite, and Nd:YAG lasers.^{11–13} Of these systems, the alexandrite laser appears to offer distinct advantages over other modalities as its longer wavelength produces less epidermal damage than does the ruby laser and, since it requires lower fluences than does the Nd:YAG, less tissue splatter is produced intraoperatively.¹³ (Figures 1 A & B)

“Although difficult, effective laser therapy in patients with darker skin phototypes can be achieved.”

Because multiple different pigments may be present in a tattoo, effective treatment can require the use of wavelengths throughout the visible and near-infrared spectrum. Tattoos may respond unpredictably to laser treatment not only because their chemical compositions are

Figure 2A. Dark terminal hair on the chin in a patient with type V skin



Figure 2B. Reduced hair seen 6 months after third long-pulsed 1064 nm Nd:YAG laser treatment



highly variable, but also because they can be placed in the deep dermis. Treatment is more difficult and unpredictable in patients with darker skin phototypes because of the presence of significant amounts of epidermal melanin that absorbs the laser energy. As described previously, systems that generate energy characterized by longer wavelengths cause less collateral epidermal damage and penetrate more deeply, affording a safer and usually more effective form of treatment. Although the Q-switched 694 nm ruby laser is highly efficacious in removing black and blue tattoo pigments, its wavelength is strongly absorbed by epidermal melanin and its potential for inducing long-term dyspigmentation or other untoward side effects is relatively high in patients with darker skin tones. Thus, the Q-switched Nd:YAG (1064 nm) or alexandrite (755 nm) laser would be a better choice for treating blue and black tattoo pigments in darker skin since its energy is less well absorbed by epidermal melanin. Epidermal ablation with a resurfacing laser may enhance the safety and effectiveness of tattoo removal in patients with darker phototypes by eliminating the problem of competitive melanin absorption.¹⁴

The combination of longer wavelengths, active epidermal cooling, and longer pulse durations provided by the most advanced laser technology has decreased the side effects following

laser-assisted hair removal in patients with darker skin tones.^{15–23} Several pigment-specific laser systems with relatively long (millisecond) pulse durations have demonstrated safety and efficacy in darker skin phototypes, including the 755 nm alexandrite,^{17–19} 810 nm diode,^{20,21} and 1064 nm Nd:YAG.^{23,24} Intense pulsed-light treatment of hirsutism in patients with darker skin phototypes may also be possible; however, studies have been limited.²² One study²⁴ demonstrated significant long-term hair reduction after a series of 3 monthly long-pulsed 1064 Nd:YAG laser treatments in 20 women with skin phototypes IV–VI. (Figures 2 A & B) Adverse effects were limited to transient pigmentary alteration without fibrosis or scarring.²⁴ Pseudofolliculitis barbae, a condition with a high incidence in the African American population, has also been shown to respond favorably to laser-assisted hair removal with minimal untoward sequelae.^{20,21}

Vascular-Specific Lasers

Vascular-specific laser systems include a wide array of Q-switched, pulsed, and quasicontinuous wave lasers generating green or yellow light with wavelengths ranging from 532–600 nm. Since 577 nm represents a major absorption peak of oxyhemoglobin, the 585 nm flashlamp-pumped pulsed dye laser (PDL) has proved to be the most vascular-specific. For the treatment of port-wine stains, hemangiomas, and facial telangiectasias, the 585 PDL has garnered the best clinical track record for both effectiveness and safety, regardless of patient skin phototype. This system has also proved effective in the treatment of hypertrophic scars and keloids which occur more frequently among individuals with darker skin tones.²⁵ (Figures 3 A & B) Transient postinflammatory hyperpigmentation is the most common side effect of PDL treatment. Although patients with darker skin phototypes are more prone than those with fair skin of developing pigmentary changes after PDL treatment,²⁶ skin cooling techniques can reduce the risk of dyspigmentation.²⁷ Hyperpigmentation often resolves within 2–3 months, as does transient hypopigmentation. Permanent hypopigmentation and scarring are rare. The side effect profiles for the frequency-doubled Nd:YAG and potassium titanyl phosphate (KTP) lasers are similar, but side effects resulting from nonspecific epidermal injury in darker skinned patients are generally more common.²⁸ Investigators found that while the 578 nm copper vapor laser could improve port-wine stains in patients with skin

phototypes III–IV, a significant degree of epidermal injury resulted from laser treatment.^{2,3}

In 1998, long-pulsed (millisecond) 1064 nm lasers were introduced in an effort to target violaceous leg telangiectasia and large caliber subcutaneous reticular veins.²⁹ The benefit of this wavelength is deep penetration of its energy due to relatively low absorption by melanin, thus effecting safe treatment in patients with darker skin tones. These millisecond-domain 1064 nm lasers may offer a viable treatment option for vascular birthmarks in patients with darker skin phototypes in the future.³⁰

Ablative and Nonablative Laser Skin Resurfacing

Cutaneous laser resurfacing can provide an effective means for improving the appearance of diffuse dyschromia, photoinduced rhytides, and atrophic scarring in patients with darker skin phototypes. Several reports document the long-term safety of the high-energy, pulsed and scanned carbon dioxide (CO₂) and short- and long-pulsed erbium:YAG for the treatment of more darkly pigmented patients.^{31–35} Although the degree of cosmetic improvement possible following ablative laser skin resurfacing in patients with skin phototypes I and II may not be attainable in patients with darker skin tones, studies have reported a high rate of satisfaction in this population.^{4,5} Preoperative skin preparation and meticulous postoperative care are essential for success when treating patients with darker skin phototypes. Effective patient education and comprehensive information about the most commonly experienced side effects, especially postinflammatory hyperpigmentation, is crucial in the management of patients with darker skin tones. While transient hyperpigmentation is the most commonly experienced side effect after laser skin resurfacing (affecting approximately one third of all patients), the incidence rises to 68%–100% among patients with skin phototypes greater than type III.^{33–35} (Figures 4 A & B)

Of particular importance for individuals with darker complexions, especially those living in regions where ultraviolet radiation is most intense, is the strict avoidance of excessive sun exposure and the consistent use of full-spectrum sunscreens both before and after

laser treatment. Ideally, individuals with darker complexions should follow pretreatment regimens that include consistent sun-



Figure 3A. Hypertrophic scar before treatment



Figure 3B. Improvement in scar color and bulk after four 585 nm pulsed dye laser treatments



Figure 4A. Hyperpigmentation apparent 4 weeks after carbon dioxide laser resurfacing for acne scars in a patient with skin phototype IV



Figure 4B. Resolution of hyperpigmentation 10 weeks after daily use of topical hydroquinone and glycolic acid creams

screen use for longer periods than is necessary for those with fair skin tones. Sunscreen use (sun protection factor ≥ 30) should be initiated at least 3–4 months before surgery and reinstated as soon as possible postoperatively.³⁶ Although they do not diminish [AU: WORD ALTERED. DIMINATE NOT A WORD] the risk of postinflammatory hyperpigmentation in patients with darker skin phototypes, some presurgical topical treatments may enhance the eventual postoperative results. Investigators³⁷ have found that, contrary to the assumptions of many clinicians, pretreatment with hydroquinone, tretinoin, or glycolic acid does not decrease the incidence of hyperpigmentation following ablative laser resurfacing in any skin phototype. But pretreatment with retinoic acid does appear to speed re-epithelialization rates and it can also reduce rates of melanin production after being reinstated

after the initial stage of healing is completed and the skin has regained its tolerance.^{38,39} Thus, even if it does not decrease the actual incidence of post-treatment hyperpigmentation, retinoic acid may still reduce its severity and duration, factors of critical importance for patients with darker skin tones.

Newer dermal collagen remodeling options including nonablative lasers may prove a more satisfactory compromise between efficacy and safety in patients with darker skin tones. A cooling device protects the epidermis at the same time as laser energy is absorbed in the upper dermis. While nonablative lasers have not yet accrued a long history of clinical use in darker-complected patients, it is reasonable to anticipate that they may offer benefit to patients who desire clinical improvement with decreased risk of postoperative dyspigmentation.

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PROOF



New Therapy Update

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COMMUNICATIONS

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BenzaClin Topical Gel (clindamycin-benzoyl peroxide gel)

BenzaClin Topical Gel (Dermik Laboratories), a combination treatment containing clindamycin phosphate and benzoyl peroxide, is used for the topical treatment of acne vulgaris. Individually, each component has been shown to be active against *Propionibacterium acnes*, an anaerobe found in sebaceous follicles and comedones. The antibacterial action of benzoyl peroxide is believed to be due to the release of active oxygen. Benzoyl peroxide may also have keratolytic, desquamative, and antiseborrheic effects. The antimicrobial activity of clindamycin may help in reducing inflammatory lesions.

In two well-controlled studies, clindamycin-benzoyl peroxide gel was significantly more effective than

vehicle in the treatment of moderate to moderately severe facial acne vulgaris.

The most common adverse reactions and side effects experienced by patients applying clindamycin-benzoyl peroxide gel is dry skin, occurring in approximately 12% of patients. Other local adverse events include application site reaction (3%), pruritus (2%), peeling (2%), erythema (1%), and sunburn (1%). Adverse events that have been infrequently reported with the use of topical and systemic clindamycin include diarrhea, bloody diarrhea, and colitis (rarely including pseudomembranous colitis).

For therapeutic efficacy, the recommended regimen is twice daily applications. A convenient characteristic of this gel is that it may be stored at room temperature up to 25°C (77°F) for 2 months following mixing. It is available in 25 and 50 g sizes.