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Skin of Color Laser Primer

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Introduction

Laser devices have been used to treat patients for various medical and cosmetic concerns for years. While several early studies explored the treatment of concerns such as acne scarring, laser hair removal and fine lines in Fitzpatrick I, II, and III patients, there weren't as many studies that included darker skin type patients as subjects. In recent years, the number of studies which explore treatment outcomes in a more diverse patient population has grown and in fact, some recent studies have been focused solely on treatment outcomes in darker skinned individuals. One of the goals of this primer is to summarize the major findings in the more recent literature and studies that include skin of color patients.

The risk of hyperpigmentation and scarring by some laser procedures are often concerns shared by both patients and physicians. These potential adverse outcomes can be barriers for patients with darker skin types (Fitzpatrick IV, V, VI) in seeking treatment for scars, dyspigmentation, etc. While there certainly are limitations to the types of lasers and settings used to treat skin of color patients, there is limited literature on this topic targeted towards residents and fellows in training. Due to time constraints and limited availability of laser devices at many training programs and academic centers, residents and trainees have limited exposure to these devices in residency. In many areas, trainees may not get much exposure to treating skin of color patients with laser devices. Thus, another goal of this primer is to educate residents on safe use of lasers in diverse patient populations.

Acne Scars

Scarring is a complication of acne that can be bothersome to patients even years after the acne lesions have cleared. They can impact psychosocial well-being and a reason why many patients seek treatment. Lasers are frequently used to treat redness, pigmentary concerns, and textural changes associated with these scars. It is extremely important to consider the types of scars and goals of treatment since different laser devices may be more suitable for treating certain types of scars.

Nonablative Fractional Laser

Nonablative fractional lasers can help improve the appearance of mild to moderate atrophic acne scarring. Laser resurfacing for acne scars has been widely studied and used in patients with skin types I-III; however, only recently has this treatment modality been studied and used in patients with darker skin types IV-VI. Over the past ten years, there have been an increasing number of randomized control trials assessing safety and efficacy of nonablative fractional lasers in patients with darker skin types. Furthermore, some studies have sought to compare the efficacy and side effect profile of laser treatments with alternative treatment modalities.

Nonablative fractional lasers have been used to safely and effectively treat acne scarring in skin types IV to VI with self-limited post-inflammatory hyperpigmentation as the main side effect¹. Furthermore, some data has shown no statistically significant difference in appearance of scars when comparing high and low density treated groups². In that study, patients underwent treatment with a 1550-nm erbium-doped fractionated nonablative laser (Fraxel Re:Store Dual 1550nm:Solta Medical) in a split-face approach. One side of the face was treated with a lower density setting (200 microthermal zones of injury per square centimeter or MTZ/cm²) and the other side was treated with a higher density setting (393 MTZ/ cm²) while maintaining constant energy of 40mJ for both sides. Forced air cooling (Zimmer) was used during this procedure as well. In this cohort, there was no evidence to suggest variation in efficacy when comparing the high and low density treatment sides; however there was increased procedural pain reported with higher density treatments. Moreover, increased procedural pain did correlate with darker skin type.

¹ Alexis AF, Coley MK, Nijhawan RI, et al. Nonablative Fractional Laser Resurfacing for Acne Scarring in Patients With Fitzpatrick Skin Phototypes IV-VI. *Dermatol Surg*. 2016;42(3):392-402. doi:10.1097/DSS.0000000000000640

² Mahmoud BH, Srivastava D, Janiga JJ, Yang JJ, Lim HW, Ozog DM. . *Dermatologic Surgery*. 2010; 36 (5): 602-609. doi: 10.1111/j.1524-4725.2010.01513.x.

Furthermore, in another study treating Asian acne scar patients with nonablative fractional resurfacing, the researchers found that reducing total treatment density actually reduced the risk of post-inflammatory hyperpigmentation as well.³ In that retrospective study, 47 acne scarring patients were treated with a 1,550nm erbium-doped fiber fractional laser (Fraxel SR laser system: Solta Medical) with either eight passes (considered full treatment with 442.5MTZ/cm²) or four passes (considered “mini” treatment with 210.5MTZ/cm²). Patients who underwent the treatment with fewer passes underwent double the number of treatment sessions. Photographic image comparison of baseline and post-treatment images assessed for improvements in skin texture, acne scarring, pore size and pigment irregularities. There was a statistically significant difference between incidence of post-inflammatory hyperpigmentation in full treatment patients (18.2%) compared with “mini” treatment patients (6.0%). The findings from this study suggest that acne scarring can be treated with similar efficacy but fewer adverse outcomes by reducing the number of passes during treatment sessions and increasing the total number of treatment sessions needed.

One study compared efficacy and safety of nonablative fractional Erbium laser treatments with microneedling for the treatment of acne scars⁴. This was a randomized control trial in which patients with facial acne scars were separated into two treatment groups one with nonablative fractional Erbium laser 1,340nm and the other with microneedling. Both groups showed significant improvement with no statistically significant difference in results; however, the microneedling group experienced fewer side effects (compared to mild post-inflammatory erythema and hyperpigmentation seen in laser treated patients) and lower down time.

Another study has explored successful treatment of skin types III to V patients with moderate to severe atrophic acne scarring with a combination of radiofrequency microneedling and fractional Erbium: Glass 1565nm laser treatments⁵. In that study population, patients were treated with an 8 month course of radiofrequency microneedling (4 sessions total) alternating with laser treatment (4 sessions total). Photograph comparison showed statistically significant improvement in the appearance of scars. Three out of the twenty study patients developed post-inflammatory hyperpigmentation following laser treatments which was treated with vitamin C, kojic acid, and arbutin.

Fractional picosecond lasers have also been used to treat atrophic acne scars in patients with skin types III to V⁶. Patients underwent split face treatments with fractionated picosecond 1064nm laser to one half and fractionated CO₂ to the other side. The study compared efficacy using subjective (patient and physician scores) and objective (histological measurements of collagen density, elastic density and elastic elongation) criteria. The treatments did not show a statistically significant difference in efficacy; however, there was an increased risk of mild post-inflammatory hyperpigmentation on the side treated with the fractionated CO₂ device.

Ablative Laser

Fractional ablative laser treatments can help improve the appearance of deeper scars such as boxcar or icepick scars. Given the high risk of post-inflammatory hyperpigmentation seen in skin type V and VI patients, most of the literature studying ablative lasers to treat skin of color patients has focused predominantly on skin type III and IV patients.

³ Chan NP, Ho SG, Yeung CK, Shek SY, Chan HH. The use of non-ablative fractional resurfacing in Asian acne scar patients. *Lasers Surg Med*. 2010;42(10):710-715. doi:10.1002/lsm.20976

⁴ Cachafeiro T, Escobar G, Maldonado G, Cestari T, Corleta O. Comparison of Nonablative Fractional Erbium Laser 1,340 nm and Microneedling for the Treatment of Atrophic Acne Scars. *Dermatologic Surgery*. 2016; 42 (2): 232-241. doi: 10.1097/DSS.0000000000000597.

⁵ Sharad J. Evaluation of the cumulative effect of Radiofrequency Microneedling and fractional Erbium: Glass 1565 laser in moderate to severe acne scars in skin of color. *J Cosmet Dermatol*. 2022;21(3):991-997. doi:10.1111/jocd.14741

⁶ Sirithanabadeekul, P., Tantrapornpong, P., Rattakul, B., Sutthipisal, N., & Thanasarnaksorn, W. (2021). Comparison of Fractional Picosecond 1064-nm Laser and Fractional Carbon Dioxide Laser for Treating Atrophic Acne Scars: A Randomized Split-Face Trial. *Dermatologic Surgery*, 47(2), E58–E65. <https://doi.org/10.1097/DSS.0000000000002572>

Erbium 1550-nm fractional laser has used to treat acne scars in Fitzpatrick types IV to VI⁷. In this study there was an overall improvement in acne scarring after patients underwent five sessions of treatment with Erbium-Doped Yttrium Aluminum Garnet fractionated laser. The authors did mention a higher incidence of pain and post-inflammatory hyperpigmentation compared to other modalities.

Another study focused on treatment of atrophic acne scarring in Asian patients⁸. Thirteen skin type IV subjects were selected to undergo treatment with a 15W CO₂ laser. The subjects underwent three treatments each spaced apart on average by 7 weeks. Analysis was done up until 6 months following the final treatment session. Objective measurements showed improvements in surface smoothness and scar volume at just one month following treatments. Patients noted at least 50% improvement in appearance of scars. Most of the patients in this study did experience mild to moderate post-inflammatory hyperpigmentation which was subsequently treated with hydroquinone.

Radiofrequency and Radiofrequency Microneedling

Radiofrequency produces heat through conversion of electrical energy into thermal energy thus improving collagen production in the dermis and resulting in skin tightening. Radiofrequency microneedling creates small channels in the skin using needles to achieve a similar goal but optimizes the heat delivery to different levels of the dermis. These treatments can both be used in darker skin types (Fitzpatrick III to VI) to treat acne scarring, rhytides and striae. A systematic literature review was done on the usage, safety and efficacy of radiofrequency and radiofrequency microneedling in skin of color patients⁹. Collectively, these studies found these treatments have a low risk of scarring or hyperpigmentation in skin of color patients, particularly with radiofrequency microneedling due to the method by which heat is distributed.

Capsule summary

Non-ablative fractional resurfacing can be used to safely treat acne scars in all skin types. The use of lower density settings can reduce the associated risks of post-inflammatory hyperpigmentation and procedural pain without compromising treatment efficacy. Additionally, reducing the number of passes in individual treatment sessions and increasing the total number of treatments can result in similar clinical improvement in acne scarring with a lower risk of post-inflammatory hyperpigmentation. Ablative fractional resurfacing should be used more cautiously in skin of color patients due to the higher risk of post-inflammatory hyperpigmentation. It is especially important to understand the goals of a patient and set expectations so that they understand limitations of different laser devices (i.e. types of scars treated) and can weigh the risks and benefits of treatment.

Laser Hair Reduction and Pseudofolliculitis Barbae

Laser therapy is commonly used in the treatment of unwanted body and facial hair. Patients with darker skin types will have more melanin in the skin surrounding hair follicles making it more difficult to target hair follicles with the laser and more likely that they will experience side effects. Thus, it is extremely important to consider the safety profile of various laser devices when treating patients with darker skin types. In reviewing the literature, the predominantly used laser devices used for treatment of unwanted hair in Fitzpatrick III-VI are Diode lasers and long-pulse Nd:YAG.

⁷ Mahmoud, B. H. , Srivastava, D. , Janiga, J. J. , Yang, J. J. , Lim, H. W. & Ozog, D. M. (2010). *Dermatologic Surgery*, 36 (5), 602-609. doi: 10.1111/j.1524-4725.2010.01513.x.

⁸ Manuskiatti W, Triwongwaranat D, Varothai S, Eimpunth S, Wanitphakdeedecha R. Efficacy and safety of a carbon-dioxide ablative fractional resurfacing device for treatment of atrophic acne scars in Asians. *J Am Acad Dermatol*. 2010;63(2):274-283. doi:10.1016/j.jaad.2009.08.051

⁹ Syder, N. , Chen, A. & Elbuluk, N. (2023). Radiofrequency and Radiofrequency Microneedling in Skin of Color: A Review of Usage, Safety, and Efficacy. *Dermatologic Surgery*, 49 (5), 489-493. doi: 10.1097/DSS.0000000000003733.

Diode Lasers

Diode lasers have been used safely and effectively to remove unwanted hair in skin types V and VI. In one study the 800-nm diode laser was used to treat darker skin type patients¹⁰. This study examined the efficacy of treating facial, neck and axillary skin with an 800nm diode laser (Lightsheer: Coherent Medical). The study found that increasing the fluence from 30ms to 100ms allowed for significant reduction in hair removal with only minimal and well-tolerated post-operative side effects (mild crusting and transient hyperpigmentation).

In another study with eight Fitzpatrick type V-VI patients with unwanted facial hair (half of whom presented with pseudofolliculitis barbae), patients were treated with an 810-nm diode laser (Lightsheer: Coherent Medical)¹¹. Patients underwent 7-10 treatment cycles in 4-6 week intervals with 75-90% reduction in hair. The study researchers advocated for increased number of treatments with more conservative laser settings to reduce the risk of adverse effects. Patients who underwent more treatment cycles did have a higher percentage of hair reduction; however, all patients who presented with pseudofolliculitis barbae demonstrated resolution after their treatments. Patients who presented with pseudofolliculitis barbae noted significant improvement after just one treatment cycle. Side effects included post-treatment hyper and hypopigmentation and blistering, which all resolved within 2 months of treatment.

Nd:YAG lasers

Due to the higher wavelengths at which treatment occurs with Nd:YAG lasers, there is decreased melanin absorption. As a result, higher fluence is required to cause damage to the hair follicle. Decreased melanin absorption does make this laser safer to use in darker skin type patients.

It is especially important to counsel patients on the use of sunscreen before and after treatments. In some instances, using a bleaching cream like hydroquinone may be considered for 2 weeks prior to treatment to reduce the risk of post-inflammatory hyperpigmentation.

Like all laser treatments, parameters should be tailored to the patient with the goal endpoint being perifollicular erythema and edema lasting no more than a few hours.¹² In one study, patients of all skin types were treated with a 1064nm laser (Coolglide: Altus Medical Inc.) for 3 consecutive treatments in 4-6 week intervals with reduction of hair¹³. Patients with skin types III-VI were assessed at one, three, and six months post-treatment. Although peak hair reduction was noted one month following treatment, percentage of hair reduction at the six month post-treatment assessment was still impressive (ranging from 44-46% on the face and 48-53% on the body).

Capsule Summary

Lasers can be used to treat both pseudofolliculitis barbae and for hair reduction in patients with skin types III to VI. Diode lasers and Nd:YAG lasers are the preferred devices to treat skin of color patients with darker hair due to the longer wavelengths that are targeted. Increasing fluence and frequency of treatments can help with increased hair reduction. There is some increased risk of thermal burns when treating patients with darker skin types due to greater melanin content in the surrounding skin. For this reason, it is extremely important to pay close attention to the clinical endpoints (perifollicular erythema) and use good technique (appropriate contact between the device and skin, cooling time, etc).

¹⁰ Adrian RM, Shay KP. 800 nanometer diode laser hair removal in African American patients: a clinical and histologic study. *J Cutan Laser Ther.* 2000;2(4):183-190. doi:10.1080/146288300750163754

¹¹ Greppi I. Diode laser hair removal of the black patient. *Lasers Surg Med.* 2001;28(2):150-155. doi:10.1002/lsm.1031

¹² Alam, Murad, et al. *Cosmetic Dermatology for Skin of Color*, McGraw-Hill Professional Publishing, 2009. *ProQuest Ebook Central*, <https://ebookcentral.proquest.com/lib/umn/detail.action?docID=4657446>.

¹³ Tanzi EL, Alster TS. Long-Pulsed 1064-nm Nd: YAG Laser-Assisted Hair Removal in All Skin Types. *Dermatologic surgery.* 2004;30(1):13-17. doi:10.1097/00042728-200401000-00004

Melasma

Melasma is a condition that disproportionately affects women with darker skin types. Its chronic course can prove challenging to treat, with patients and clinicians frustrated with a dearth of effective treatments. First line therapies include diligent sun protection, bleaching creams, and chemical peels, although some clinicians and researchers have used lasers to treat refractory cases. A few research studies have compared topical treatments to laser treatments in split-face studies with lackluster evidence to support laser therapies as a first line option.

One split-face study compared the 1550 nonablative laser with triple combination cream (hydroquinone 5%, tretinoin 0.05%, triamcinolone acetonide 0.1%)¹⁴. In that study, one side of the patient's face was treated with 4-5 nonablative fractional laser therapy sessions (15mj/microbeam, 14-20% coverage) and the other half with triple combination cream once daily for 15 weeks. Both patient and physician assessments of the melasma showed improved response on the triple combination cream treated side when compared to the laser treated side. More importantly, about one-third of patients developed post-inflammatory hyperpigmentation following laser treatment.

Another study compared nonablative fractional laser with triple combination cream in a randomized control trial. Both treatments showed similar efficacy with neither having lasting results¹⁵. In another split face study, researchers sought to compare 1550 Erbium nonablative fractional laser with 15% TCA peel in a study population of skin type III and IV patients¹⁶. Results showed similar results with both treatments, neither of which had long-lasting results. Overall the evidence does not suggest that nonablative fractional laser is a significantly better treatment modality than topical treatments (triple combination cream) or chemical peels in the treatment of melasma.

Although laser treatments are by no means a first line treatment for melasma, there has been some evidence to support the use of picosecond lasers in treating refractory melasma. One group based in Hong Kong recruited twenty subjects with skin types III and IV¹⁷. All subjects were rated with a baseline and posttreatment modified Melasma Area Severity Index (mMASI) score. They underwent treatment with a fractionated nonablative 1064nm Nd:YAG picosecond laser (PicoWay; Candela, resolve handpiece) in 4-6 week intervals for nine sessions each. Moderate improvement was noted in about 70% of patients 6 weeks post-treatment without any major side effects. Perhaps most importantly, none of the patients experienced worsening post-inflammatory hyperpigmentation following the study.

Capsule Summary

First line treatment for melasma includes diligent sun protection, bleaching agents (i.e. hydroquinone), and chemical peels. While these aforementioned methods are the mainstay of treatment for melasma, picosecond lasers have shown some promise in refractory cases. Due to the short pulse duration seen with picosecond lasers, it is possible to achieve targeted treatment of melasma (with less heat diffusion to surrounding normal tissue).

¹⁴ Wind BS, Kroon MW, Meesters AA, et al. Non-ablative 1,550 nm fractional laser therapy versus triple topical therapy for the treatment of melasma: a randomized controlled split-face study. *Lasers Surg Med*. 2010;42(7):607-612. doi:10.1002/lsm.20937

¹⁵ Kroon MW, Wind BS, Beek JF, et al. Nonablative 1550-nm fractional laser therapy versus triple topical therapy for the treatment of melasma: a randomized controlled pilot study. *J Am Acad Dermatol*. 2011;64(3):516-523. doi:10.1016/j.jaad.2010.01.048

¹⁶ Hong SP, Han SS, Choi SJ, et al. Split-face comparative study of 1550 nm fractional photothermolysis and trichloroacetic acid 15% chemical peeling for facial melasma in Asian skin. *J Cosmet Laser Ther*. 2012;14(2):81-86. doi:10.3109/14764172.2012.655287

¹⁷ Wong CSM, Chan MWM, Shek SYN, Yeung CK, Chan HHL. Fractional 1064 nm Picosecond Laser in Treatment of Melasma and Skin Rejuvenation in Asians, A Prospective Study. *Lasers Surg Med*. 2021;53(8):1032-1042. doi:10.1002/lsm.23382

Solar Lentigines and Ephelides

Solar lentigines and ephelides are benign skin lesions that patients commonly seek cosmetic treatment for. Although these lesions tend to occur less commonly in darker skin type patients, when they do occur these lesions can be somewhat difficult to treat due to the risk of post-inflammatory hyperpigmentation. In lighter skin types, Q-switched lasers are the mainstay of treatment. Studies have shown that in Asian patient populations, Q-switched Nd:YAG 532 lasers are associated with increased risk of hyperpigmentation compared to long pulsed Nd:YAG 532 lasers and intense pulsed light source devices.^{18,19}

The authors of one study (which focused on treatment of Asian patients) propose treating several test areas with different laser devices and proceeding with treatment to the full face with the laser that provides the desired outcome while minimizing post-inflammatory hyperpigmentation²⁰. The desired clinical endpoint for a 532 nm QS Nd:YAG and QS alex lasers is an immediate whitening of the solar lentigo. For the long-pulsed 532nm Nd:YAG laser, the desired endpoint is a slate gray appearance. If either of these spot sites results in a desirable result with minimal post-inflammatory hyperpigmentation, it would be reasonable to proceed with treatment of the entire area. Patients may require more than one treatment session, typically around two sessions to achieve noticeable improvement. As an alternative, intense pulsed light (IPL) treatment can be substituted with mild erythema as the clinical endpoint. The downside of this treatment is that more sessions are typically required to achieve results; however, there is a lower risk of post-inflammatory hyperpigmentation.

Another prospective cohort study demonstrated successful treatment of solar lentigines in Asian patients (Fitzpatrick skin type III and IV)²¹. In the study a total of 89 lesions were treated on 20 patients with a 532-nm picosecond Nd:YAG laser and 18 of these patients showed improvement based on a physician global assessment rating scale. Post-inflammatory hyperpigmentation occurred after 10.2% of sessions and hypopigmentation was noted in one patient. Additionally, picosecond lasers can sometimes be used to treat lentigines and other pigmentary disorders in darker skin types at longer wavelengths (i.e. 755nm, and 1064nm)²².

Capsule Summary

When treating solar lentigines with QS or long-pulsed lasers in Asian patients, it is important to perform test sites to assess for risk of post-inflammatory hyperpigmentation. Intense pulsed light treatment can also be used as an alternative treatment with a lower risk of post-inflammatory hyperpigmentation.

Dermatosis Papulosa Nigra

Dermatosis Papulosa Nigra are hyperpigmented benign epidermal lesions that are more commonly seen in patients with skin types III to VI.

Potassium-Titanyl-Phosphate (KTP) laser has been used to successfully treat Dermatitis Papulosa Nigra (DPN) in skin of color patients. One split-face study compared treatment of DPN lesions with electrodesiccation versus with

¹⁸ Chan HH, Fung WK, Ying SY, Kono T. An in vivo trial comparing the use of different types of 532 nm Nd:YAG lasers in the treatment of facial lentigines in Oriental patients. *Dermatol Surg*. 2000;26(8):743-749.

¹⁹ Wang CC, Sue YM, Yang CH, Chen CK. A comparison of Q-switched alexandrite laser and intense pulsed light for the treatment of freckles and lentigines in Asian persons: a randomized, physician-blinded, split-face comparative trial. *J Am Acad Dermatol*. 2006;54(5):804-810.

²⁰ Chan HH, Alam M, Kono T, Dover JS. Clinical Application of Lasers in Asians. *Dermatologic Surgery*. 2002; 28 (7): 556-563.

²¹ Chan MWM, Shek SY, Yeung CK, Chan HH. A Prospective Study in the Treatment of Lentigines in Asian Skin Using 532 nm Picosecond Nd:YAG Laser. *Lasers Surg Med*. 2019;51(9):767-773. doi:10.1002/lsm.23103

²² Jakus J, Kailas A. Picosecond Lasers: A New and Emerging Therapy for Skin of Color, Minocycline-induced Pigmentation, and Tattoo Removal. *J Clin Aesthet Dermatol*. 2017;10(3):14-15.

KTP laser treatment²³. Fifteen subjects (skin types IV to VI) underwent treatment with two KTP laser treatments (4 weeks apart) to lesions on one side of the face using an Aura KTP laser (Laserscope) and electrodesiccation (0.8W low setting) using a Hyfrecator 2000 (ConMed Corporation) to the lesions on the contralateral side of the face. The study found no statistical difference between appearance of the laser treated side and the electrodesiccation treated side so the outcome was comparable; however, patients did note increased discomfort with the electrodesiccation procedure compared with the laser procedure itself. Other clinicians have reported case studies or case series of successful treatment of DPNs using the Nd:YAG laser²⁴, 532-nm diode laser²⁵, and CO₂ laser²⁶.

Capsule Summary

Laser devices (i.e. KTP) have been used to successfully treat dermatosis papulosa nigra, which is more common in darker skinned patients; however, in clinically settings where access to lasers may be limited, electrodesiccation has shown to have similar clinical outcomes.

²³ Kundu RV, Joshi SS, Suh KY, et al. Comparison of electrodesiccation and potassium-titanyl-phosphate laser for treatment of dermatosis papulosa nigra. *Dermatol Surg.* 2009;35(7):1079-1083. doi:10.1111/j.1524-4725.2009.01186.x

²⁴ Schweiger ES, Kwasniak L, Aires DJ. Treatment of dermatosis papulosa nigra with a 1064 nm Nd:YAG laser: report of two cases. *J Cosmet Laser Ther.* 2008;10(2):120-122. doi:10.1080/14764170801950070

²⁵ Spoor T. Treatment of dermatosis papulosis nigra with the 532 nm diode laser. *Cosmet Dermatol* 2001;14:21-3.

²⁶ Furukawa F, Mizawa M, Shimizu T. Treatment of dermatosis papulosa nigra using a carbon dioxide laser. *J Cosmet Dermatol.* 2020;19(10):2572-2575. doi:10.1111/jocd.13309