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REVIEW

Cosmetic Considerations in Dark-Skinned Patients

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Abstract: For dermatologists, diversities of human races result in an opportunity to encounter patients with various skin types. Cosmetic procedures have gained more popularity and become more accessible over the past decades. Thus, the selection of appropriate treatment protocol for each patient becomes inevitable. This review will focus on basic knowledge and key points in performing safe cosmetic-related procedures in patients with dark-complexioned skin. In terms of structure and function of the skin, people of color have equal epidermal thickness, corneocyte size and melanocyte number. However, they have more stratum corneum compaction, melanosome dispersion and melanocyte activity than fair skin individuals. Data regarding drug penetration and cutaneous irritation showed conflicting results. Superficial chemical peels and microdermabrasion can be done safely in dark-skinned patients. Medium-depth peel should be used with extreme caution. While deep-depth peel should be avoided at all times due to pigmentary and textural complications. Prolonged treatment interval, use of priming agents and sun protection are recommended. Injectable materials including botulinum toxin and soft tissue augmentation by hyaluronic acid filler can be done harmlessly in dark-skinned patients. Lasers and energy-based devices should be done with caution. Higher melanin dispersion and melanocyte activity acts as competitive chromophore. Pigmentary or textural changes can occur after aggressive treatment protocol. High energy setting, pulse stacking, short wavelength lasers and short treatment interval should be avoided in dark-skinned patients.

Keywords: complications, dark skin, energy-based devices, injectables, laser, skin of color

Introduction

Immigration of people with various racial profiles to different regions across the world leads to the surge of both racial and cultural diversity. This brings an enormous impact on medical practice across all medical specialties. Clinicians, including dermatologists, now have more opportunities to treat people with diversely-mixed shades of skin color from light to dark skin tone. Proper treatment regarding patient's skin color has now gained more interest.

Profound basic research and advance technology in cosmetic field has led to developments of novel treatments for various dermatological conditions. Cosmetic-related procedures include treatments with varying degree of invasiveness such as topical medications, chemical peels, microdermabrasion, injectables, lasers, and light-based devices, etc. Due to different mechanisms behind each treatment, clinicians should be able to choose appropriate treatment for each individual patient. Patient's skin condition, age or skin type are among factors to be considered. Moreover, clinical expertise is also crucial to achieve satisfactory results.

The difference between patients with light and dark skin tone is the amount of melanin dispersion in basal layer of the epidermis. Patients with skin of color have higher melanin content. This increases the risk of developing non-specific thermal injury. Though Caucasian patients may develop side effects after cosmetic procedures, side-effects in dark-skinned patients are found more frequently including hyperpigmentation, hypopigmentation, permanent depigmentation, textural change, hypertrophic scar and keloid.

Concerning the mixture of races, dermatologists should be aware of treating patients with different skin types to avoid preventable side-effects. Our review will focus on basic knowledge about how to perform cosmetic-related procedures safely in people of color including topical medications, chemical peels, microdermabrasion, injectable materials, lasers and light-based devices, and important patients' education.

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Topical Medications

Concerning the epidermal thickness, Freeman et al and Thomson ML demonstrated that dark-skinned patients have equal thickness compared to fair-skinned patients.[1,2] Wiegand et al conducted the study in 1974 comparing stratum corneum compaction between dark and fair skinned patients. They found that dark-skinned patients require more tape stripping to remove stratum corneum than fair skinned patients (average 16.6 (8–25) vs 10.3 (6–15) strips).[3] Reed et al also found that patients with Fitzpatrick skin type (FPT) V to VI require more tape stripping than patients with FPT II to III.[4]

Rienertson et al conducted a study about chemical composition of human epidermal lipids in 1959. They found that dark-skinned patients have more lipid content in stratum corneum than fair-skinned patients.[5] According to a study by Sugino et al, dark-skinned patients had lower ceramide level, compared to fair-skinned. Ceramide level was inversely correlated to transepidermal water loss (TEWL) but directly correlated to water content in epidermis. Moreover, in-vitro study also confirmed previous study results regarding TEWL. Incubated cells of dark-skinned patients showed a statistically significant difference in terms of TEWL more than cells from fair-skinned patients.[6]

According to previously mentioned studies, dark-skinned patients have more stratum corneum compaction. However, the issue of dark-skinned patients having less drug penetration than fair-skinned patients is still controversial. Wedig et al and Berardesca et al reported that African Americans have lower percutaneous absorption of dipyrithione, nicotinates and fluocinolone acetonide than patients with lighter skin types.[7,8] On the contrary, Wickrema-Sinha et al found no difference in percutaneous absorption of methyl nicotinate and diflorasone diacetate between dark- and faired-skin patients.[9] In conclusion, study results regarding drug absorption are controversial. The lower percutaneous penetration in certain medications may result from their specific absorption property or experimental error.

There were few researches about skin irritation. The results showed that patients of color have less susceptibility to skin irritation than fair-skinned patients. While objective measurement was done by measuring TEWL and microcirculation in the study by Berardesca et al and Wilson et al.[10,11] They found that dark-skinned patients had higher susceptibility to skin irritation than lighter skin types. According to previous studies, concern about people of color having higher chance of developing skin irritation is still equivocal. Furthermore, studies reported dark-skinned patients tend to be more resistant to irritation than in fairer patients.

Patients with skin of color have a higher chance of developing certain skin reactions after using products. Plewig et al conducted a study in 753 dark-skinned patients. The study found that prolonged habitual use of hair pomade in people of color increases risk of pomade acne up to 70%. Pomade is composed of mineral oil and petrolatum jelly which are considered comedogenic substances.[12]

Kaidbey and Kligman found that dark-skinned patients have different cutaneous reaction after using topical coal tar. Fair-skinned patients had inflammatory reaction as papules of papulopustules occurs within a few weeks after exposure. Meanwhile, dark-skinned patients developed comedogenic eruption within 2 weeks without coexisting inflammation. People of color react to comedogenic compound by inducing hyperkeratosis more than disintegration of hair follicle.[13]

In conclusion, people of color are not different from people with lighter skin types in terms of epidermal thickness. However, stratum corneum compaction, certain lipid content, and spontaneous desquamation seem to be more pronounced than in white skin. Percutaneous absorption in dark skin type patient remains inconclusive. The structures and functions of epidermis are summarized in Table 1.

Chemical Peels

Chemical peel works as an exfoliating agent that ablates partial skin thickness. Superficial chemical peel removes stratum corneum down to papillary dermis. Medium depth chemical peel exfoliates from papillary dermis to upper reticular dermis. The strongest one is deep depth chemical peel which penetrates from superficial epidermis to mid-reticular dermis.[14–16] Regarding previously mentioned studies on skin irritation, objective measurement found that people with dark skin are prone to have more skin irritation than fair skin patients. As a consequence, dark-skinned patients are prone to have postinflammatory hyperpigmentation, hypopigmentation or scarring after performing chemical peel that occur more frequently in medium to deep-depth chemical peels.[15,17,18]

Table 1 Overview of Structure and Function of Epidermis in People of Color

Structural and Functional Issues	Difference (Compared to Fair Skin People)
Structures	
Epidermal thickness	Equal
Corneocyte size	Equal
Stratum corneum compaction	Increased
Melanocyte number	Equal
Melanosome	Increased dispersion
Functions	
Lipid content	Increased
Desquamation	Increased
Ceramide level	Decreased
Transepidermal water loss	Increased
Drug absorption	Conflicting Data
Cutaneous irritation	Conflicting Data

Glycolic acid (GA) is the most commonly used chemical peel. It requires neutralizing agent to stop the peel from functioning. Clinical endpoint for GA peel is mild erythema. Blistering, vesiculation, blanching or excessive patient discomfort are the undesirable signs that clinician should monitor carefully. Burns et al demonstrated the additional benefit of 10% GA to a topical regimen of hydroquinone and tretinoin in the treatment of postinflammatory hyperpigmentation. Patients with FPT IV–VI receiving the glycolic peels had more rapid improvement, compared to hydroquinone and tretinoin alone.[19] In the treatment of acne vulgaris, Wang et al reported that 35% and 50% GA peels significantly reduce comedones, papules and pustules and also decrease pore size. Only small numbers of patients (5.6%) had cutaneous adverse effects including postinflammatory hyperpigmentation, skin irritation and herpes reactivation.[20] Sarkar et al conducted a study in Indian patients with melasma. They compared topical Kligman formula with concomitant use of 30–40% GA peel with topical Kligman formula. The study result showed that combination group has faster MASI reduction that topical treatment alone.[21] Trichloroacetic acid (TCA) is the combination of acetic acid and chlorine. It functions as self-neutralizing peel and causes coagulation of epidermal proteins and keratinocytes thereby creating frosting that cannot be wiped off as in salicylic acid (pseudofrost). Clinical endpoint for TCA peel is mild to moderate erythema or faint white frosting with patchy erythema. Moreover, Kalla et al conducted a study comparing 55–75% GA peel with 10–15% TCA peel in Indian patients with melasma (n = 100). They found that TCA group show greater improvement than GA group. On the other hand, TCA group also produced more side effects in TCA group.[22] Kumari et al also conducted a split face study in 100 Indian patients with melasma by comparing 20–35% GA peel with 10–20% TCA peel on the contralateral side. They found that both groups show equal improvement rates. However, TCA group experienced more erythema and scaling more than GA side (35%).[23]

Salicylic acid (SA) peel is a self-neutralizing peel. It has lipophilic property that can dissolve in sebum and penetrate into pilosebaceous unit. Clinical endpoint is mild erythema with white powdery residue (pseudofrost). The study regarding the use of salicylic acid peels in patient of color was conducted by Grimes PE. They studied the efficacy of 20–30% SA peel in dark-skinned patients (FPT V to VI) with melasma, acne and PIH. Results showed that pigmentary complications were found in a number of patients (16%). Hypopigmentation occurred within 7 days after procedure in one patient (4%). Hyperpigmentation occurred within 7–14 days in 3 patients (12%).[24] While in Asian skin, 30% SA was safe and effective for patients with FPT III–IV. Bae et al compared 30% SA to Jessner's peel (SA+ lactic acid + resorcinol) for acne treatment. Both treatments showed promising results in reducing acne lesions with mild adverse reactions. There was no postinflammatory hyperpigmentation or scarring reported in the study.[25] Concurrently, Dayal et al proved that 30% SA was more effective and safer in the treatment of acne vulgaris compared to Jessner's peel. Postinflammatory hyperpigmentation was reported in 5% of patients treated with SA, compared to 20% rate in Jessner's group.[26]

Lactic acid (LA) peel is considered a peel with hydrating property. It forms lactate after application and acts as humectants on the skin. The split-face study compared the efficacy of 92% lactic acid peels and Jessner's peel for the treatment of melasma. Result showed no difference in terms of efficacy and side-effects between the two study groups. Sarkar et al summarized level of evidence and strength of recommendation for the use of chemical peeling agents in ethnic skin. GA peel is the only strength A. LA, SA, TCA, Jessner's peel is considered strength B. Phytic acid and pyruvic acid is strength C.[17] Other than type of chemical peeling agents used, concentration is also the crucial determining factor of the depth of penetration. The higher the depth of penetration is, the more risks of developing side effects are.

Garg et al conducted the study in Indian patients with melasma (FPT IV–V). It demonstrated that the use of priming agents such as hydroquinone cream or retinoic acid cream before chemical peeling help to improve MASI score, prevent relapse, and decrease incidence of PIH after procedure more than groups without priming agents.[27]

In conclusion, a superficial chemical peel such as glycolic acid is safe for patients with skin of color. The peeling should be started with low concentration and slowly titrated between visits. Medium-depth chemical peel should be avoided as much as possible while deep depth chemical peels should be avoided at all times. The recommendation toward chemical peeling in skin of color is shown in Table 2. Moreover, concomitant uses of priming agents like hydroquinone or tretinoin cream 2 weeks before procedure help improve the efficacy of chemical peel and decrease risk of developing PIH. Lastly, appropriate post-treatment care, sun avoidance, and adequate sunscreen application also play important roles in preventing side-effects in patients with dark skin tone.

Microdermabrasion

Microdermabrasion (MD) is a closed loop system using abrasive stimulus such as aluminum oxide or sodium chloride to ablate a superficial layer of the skin. Abrasive spent crystals and skin debris will be suctioned back by vacuum system.[28] Possible side effects from MD can occur in patients who have thin fragile skin, photodamaged skin, or patients who take antiplatelet agents. The common side effects are erythema, mild pain, minor abrasion and petechiae. The study concerning side effects of MD in dark skinned patients is limited. However, dark patients can do MD as frequent as fair skin patients with selective use of low power setting to avoid possible side effects.[29]

Injectable Materials

Skin aging occurs from both intrinsic and extrinsic factors. Intrinsic aging occurs in all structures underneath the skin including soft tissues and bones. On the other hand, extrinsic aging results from chronic sun exposure. The study found that patients with dark skin type have slower onset of photodamage up to 10–20 years and less severity than fair skin patients. Aging change in patients of color usually manifests as facial aging more than photodamaged skin.[30]

However, cosmetic-procedures that help improve aging process are the same between dark and fair-skinned patients. Botulinum toxin is still the first desirable option for wrinkle reduction. Filler injection will be the best option to correct

Table 2 Summary of Chemical Peels in Ethnic Skin

Peeling Agents	Superficial-Depth	Medium-Depth	Deep-Depth
Salicylic acid (SA)	SA 20–30%	N/A	N/A
Pyruvic acid (PA)	PA 40–70%	N/A	N/A
Lactic acid (LA)	LA 10–30%	N/A	N/A
Glycolic acid (GA)	GA 30–70%	GA 70% + 35% TCA	N/A
Jessner's solution	Jessner's solution	Jessner's solution + 35% TCA	N/A
Trichloroacetic acid (TCA)	TCA < 30%	TCA 35–50%	TCA >50%
Recommendation	Safe	Use with caution	Avoid

Abbreviation: N/A, not available.

facial volume loss. This review will particularly focus on the use of botulinum toxin and hyaluronic acid filler injection in dark skin complexion.

Botulinum Toxin

Botulinum toxin A (BT-A) and B (BT-B) are commercially available for cosmetic and therapeutic indications.[31] However, BT-A is mainly used for cosmetic purposes which can be classified into onabotulinumtoxin A (onaBT-A), abobotulinumtoxin A (aboBT-A), incobotulinumtoxin A (incoBT-A), letibotulinumtoxin A (letiBT-A), daxibotulinumtoxin A (daxiBT-A), prabotulinum toxin A (proBT-A) or rimabotulinum toxin B (rimaBT-B). Both onaBT-A, aboBT-A, incoBT-A, daxiBT-A and praBT-A are approved for moderate to severe glabellar lines. Meanwhile onaBT-A has additional indication for axillary hyperhidrosis.[30] Botulinum toxin B has shorter action than BT-A. It was approved for the treatment of cervical dystonia.[32,33] Botulinum toxin binds selectively and irreversibly to cholinergic nerve receptor and blocks the release of acetylcholine at neuromuscular junction. The blockage of nerve impulse prevents the targeted muscle from contraction. Treatment effects can be seen clinically after 5 to 7 days after onaBT-A injection and 2 to 3 days after aboBT-A. Duration of both agents typically lasts 3–6 months.[34]

Facial wrinkles can be classified as static, dynamic or mixed. Static wrinkles are apparent even when the facial muscles are relaxed. Dynamic wrinkles are caused or aggravated by muscle contraction which are similar for all skin types. However, there are notable differences in skin physiology between patients with skin of color and patients with fair skin. These differences lead to greater tolerability to extrinsic aging factors, leading to delay and lesser degree in wrinkles development in people of color.[35] Dark skin patients develop facial lines at upper face more than perioral area. Moreover, patients with darker skin also develop brow ptosis and crow's feet later than fair skin type patients.[36,37] Masseter hypertrophy becomes one of the major concerns especially in Asian patients who favor slim "V-shaped" facial structure.[38,39] Glabellar lines pattern is different in Asian, compared to westerners, described by smaller mass, narrower and shorter corrugator muscles.[40,41] Clinician should provide individualized treatment regimen that suits for each patient, based on patterns and severity of wrinkles.

Concerning the safety and efficacy of botulinum toxin A. Multiple studies have been done regarding the use of onaBT-A in Chinese, Japanese, African-American, Brazilian, Iranian and Korean populations. Results showed that there was no statistically significant difference in terms of efficacy and side effects between patients with different ethnicities.[42] Moreover, there was no difference in the duration of action and dosage of toxin required for Asian skin despite more dermal thickness and collagen content in Asian skin.[43]

Kane et al studied the efficacy of aboBT-A for glabellar line reduction in African American patients (20% of total study population). They found that this group of patients responded to aboBT-A better than general study population. After subgroup analysis, they also found that median duration of action was longer (117 days) compared to all study participants (109 days). However, there was greater incidence of aboBT-A-related ocular adverse events (6% vs 4%) but lower rate of injection site reaction (3% vs 5%) in African American patients than other ethnic groups.[44] Brandt et al also conducted a study by using aboBT A for glabellar injection in non-white patients. They also found that dark skinned patients had better response than fair skin patients.[45] In terms of ocular adverse reactions, Brin et al conducted meta-analysis reporting that ocular adverse reactions including eyelid sensor disorder and eyelid edema were more common in Asian (Japanese and Chinese) than non-Hispanic white.[46] Additionally, prabotulinumtoxin A (praBT-A) is the new FDA-approved toxin for moderate to severe glabellar lines. Taylor et al reported the post-hoc analyses of the efficacy and safety regarding the color of the skin. Investigators grouped patients into skin of color (SOC, FPT IV–VI) and without SOC (FPT I–III). They further stratified patients into self-identified black and white patients. The results re-affirmed that efficacy, response rate and tolerability are similar between patients with SOC and without SOC. Dose adjustment is unnecessary for dark skin individuals.[35]

Fillers

Soft tissue augmentation by filler is currently available worldwide for correcting of atrophic scarring, wrinkles, volume loss and contour defects. Internal sources of filling agents are autologous fat transfer or human collagen. Currently, numerous filling agents are commercialized. These include bacterial-derived hyaluronic acid (HA) filler, bovine, porcine collagen, calcium hydroxyapatite (CaHA), poly-L-lactic acid (PLLA), polynucleotide, etc. Currently, the most commonly used filler is HA derivatives.[30]

Important factors to be considered in soft tissue augmentation are appropriate selection of filler type, depth of filler placement and techniques of filler injection. Smaller gel particles are suitable for superficial placement (mid to deep dermis) for the correction of static wrinkles and folds. Larger gel particles can be used to treat deeper, more severe areas by injecting into deep dermis to superficial subcutaneous tissue. However, it should be avoided in the lip area. Various injection techniques have been used such as linear threading, fan technique, cross hatching, towering technique, serial puncture, serial threading, etc.[47]

Considering aging process other than facial wrinkles, volume loss can be troublesome in aging population. The most strikingly aging change of upper face region is volume loss especially in temporal area. Midfacial region changes are due to loss of elasticity, subcutaneous tissue, remodeling of cartilaginous and osseous structures beneath the skin. As a result, change of facial contour and laxity, including tear trough loss, mid-cheek hollowness, develops. Aging change of lower face, both muscle hyperactivity and volumetric loss of the mandibular region and adipose tissue play important roles to aging in this particular area. Volume loss in this area is obviously seen as pre-jowl hollowness and marionette lines.[37,48]

In dark skin population, midfacial aging remains a common problem especially infraorbital hollowness, tear trough deformity and deepening of nasolabial folds. Skeletal morphology may contribute to this problem, both from infraorbital maxillary hypoplasia which can be found in African, Hispanic and Asian ancestry and also bone resorption due to aging process. Furthermore, sagging is more pronounced in dark-skin patients due to greater gravitational descent of facial soft tissue from the combination of heavy subcutis and weaker skeletal support. However, in dark skin patients, lips and perioral rhytids are less prominent. As African descents develop wrinkles mostly in the body of the lip below the vermillion border which occurs in response to volume depletion of the upper lip. On the other hand, the lower lip remains its same appearance.[37,49] However, with more advanced age, skin of color patients (particularly African descent) have lip augmentation from age-associated volume loss more than patients without skin of color. For Asian population, lips are fuller than white population. Nevertheless, trend toward lips augmentation and reshaping increased significantly through recent years.

Patients with darker skin tend to have better stimulation of collagen production after filler procedures. Furthermore, they also demonstrate less thinning of collagen bundles and elastic tissue after treatment, as evaluated from histological study. Thereby, people of color might require fewer sessions of treatment than fair skin patients.[50]

Filler injection in patients of color can be done efficaciously and safely according to the appropriate selection of filler type, injection techniques, and the plane of filler placement. Decreasing number of punctures, use of linear threading and mid dermal placement of HA filler are recommended to avoid disruption of dermo-epidermal junction, in order to decrease risk of possible complications.[51,52] Glogau et al studied filler injection in patients of color. They found that 20% of dark-skinned patients had increased incidence of local adverse events including postinflammatory hyperpigmentation or bruising due to aggressive approach. This lead to penetration of dermo-epidermal junction (DEJ). Fan technique, rapid injection, high volume injection were listed as the possible causes.[53]

Ethnic skin patients are considered to be 3 to 18 times more vulnerable to the development of keloidal formation.[52] Hence, FDA approved 9 dermal fillers since 2003. These fillers had post-approval studies conducted specifically in patients with dark skin types (FPT IV to VI) in order to assess safety issues of dermal fillers. These included of keloid formation, dyschromia, hypertrophic scarring and hypersensitivity. The studies had been conducted by using HA and CaHA fillers. They showed similar rate of dyschromia between Caucasian and non-Caucasian population. There was no report of keloidal formation in the studies. However, one case developed symptomatic positive serum IgG antibody titer and mild hypertrophic scarring with HA fillers.[54,55] Marmur et al conducted the study using CaHA for nasolabial fold correction in FPT IV to VI. They found no increased risk of developing hypertrophic scar, keloid or dyspigmentation after CaHA. Moreover, Lin YJ et al and Narins et al conducted studies of using PLLA for periorbital area (FPT II to III) and nasolabial fold correction (FPT I to VI), respectively. They also found no increased risk of hypertrophic scar, keloid or dyspigmentation as well.[54,56,57]

Laser and Light-Based Devices

Since laser manufacturers are increasing in number, lasers and light-based devices are becoming more approachable to medical practitioners. Market shares and decrease in production costs make the price of laser treatment per session more

affordable to patients. There are many types of lasers and energy-based devices such as ablative lasers, fractional lasers, pigment-specific lasers, vascular-specific lasers, hair removal lasers etc.[58]

People of color have higher melanin content and dispersion than people with lighter skin. Melanin has peak absorption range around 250–1200 nm which covers the range of visible light and near infrared spectrum. Patients with FPT VI absorb visible light more than patients with lighter skin (FPT I or II) up to 40% when use the same fluence and pulse duration. Therefore, patients with darker skin tone tend to have more non-specific thermal injury to epidermis. Common side effects after performing lasers and light-based devices in dark-skinned patients compose of postinflammatory hyperpigmentation (PIH), postinflammatory hypopigmentation, permanent depigmentation, textural change, focal atrophy of scarring.[59]

Regarding general principle of treating dark-skinned patients, the lowest possible fluence to achieve target endpoint for each laser should be applied. Longer wavelength laser and larger spot size should be used to penetrate more deeply into the dermis and to avoid competitive absorption by endogenous melanin.

Ablative Resurfacing Lasers

Laser resurfacing technology improves several skin conditions in patients with all skin phototypes. However, several clinical studies demonstrated that carbon dioxide laser (CO_2) and erbium: yttrium-aluminum-garnet (Er:YAG) lasers can be used safely in dark skin complexions. However, general precaution should be applied to prevent possible complications.

Carbon dioxide laser has carbon dioxide gas as a medium which emits energy at 10,600 nm. The only chromophore is water. The water-containing tissue has thermal relaxation time around 1 millisecond. The laser can be emitted as a continuous wave and gated wave. Chopped wave CO_2 can be classified into superpulsed and ultrapulsed mode which develop less charring than continuous wave form.[60,61]

Erbium:YAG emits energy at 2940 nm which shares the same chromophore (water) as CO_2 laser. However, Er:YAG laser is absorbed more superficially comparing to CO_2 laser. The clinician has to irradiate multiple passes to achieve similar depth as one pass of the CO_2 laser.[61]

Complications after performing ablative lasers include post-laser erythema, acne exacerbation, milia formation, post-treatment hyperpigmentation or hypopigmentation, Herpes reactivation or even scarring. Patients with dark skin phototype have higher risk of developing dyspigmentation or scarring after ablative lasers.[62] Nanni et al reported incidence of post-laser hyperpigmentation after ablative CO_2 resurfacing at 37%. Majority of the PIH group were patients with darker skin tone. Hyperpigmentation was usually observed four weeks after the procedure and gradually resolved within months. Moreover, in some studies transient hyperpigmentation incidence was up to 68% to 100% among patients with the darkest skin phototypes (FPT III–VI).[63]

Irradiating techniques and lasers parameters also play important roles in the development of post-operative complications. The use of high-energy pulsed CO_2 lasers (superpulsed or ultrapulse mode) produces single short pulses (less than 1 ms) thereby they create less tissue charring. Removal of desiccated tissue between laser passes is also crucial in order to decrease heat accumulation at the treatment site.[62]

Proper pre- and post-treatment care should be applied to treatment plan especially in dark skin patients. Pretreatment with topical retinoic acid can help fasten re-epithelialization rates and reduce rates of melanin production after procedure. Moreover, it also helps reduce severity and duration of hyperpigmentation in darker skin tones. Strict sun avoidance and daily application of sunscreen should be initiated before and after procedures.[64]

Fractional Lasers

The use of ablative laser skin resurfacing technology in facial rejuvenation and acne scar gives satisfactory results. However, prolonged down time and risk of potential side effects have led to decreased utilization of ablative laser resurfacing. The idea of fractional photothermolysis has become a new hope that provides efficacious clinical results and reduces post-treatment recovery period and possible side effects. Fractional lasers create columns of thermally denatured skin called microthermal treatment zones (MTZs) in the dermis with varying depths and widths. The healing process is

faster than conventional full ablative lasers due to migration of reservoir viable keratinocytes around islands of MTZ columns, creating rapid reepithelialization and faster recovery period.[65]

Fractional resurfacing technology has been adapted to many types of lasers and energy-based devices to treat several skin conditions such as Er:YAG, CO_2, YSGG, Er:Glass or radiofrequency technology. Possible side effects of fractional lasers include prolonged erythema, wound infection, acne, milia, pigmentary change and scarring.[66]

Patients of color have a high chance of developing postinflammatory hyperpigmentation (PIH) after lasers, especially ablative laser resurfacing. However, fractional laser resurfacing produced lower rate of PIH. According the study of Chan et al in 2007, overall PIH rate was 11.1% after fractional resurfacing 1540 nm erbium glass laser (Fraxel SR™, Reliant technology, Palo Alto, CA, USA). PIH rate was lower in patients who underwent high energy with lower density for acne scar condition. However, PIH rate was higher in patients who underwent the same density but with higher energy setting. To summarize, both energy setting and density of the treatment determine the risk of developing PIH after fractional resurfacing laser. Appropriate external cooling also plays important role in preventing PIH especially in small anatomical area such as perioral region.[67]

Emmy et al found that patients with darker skin type experienced more pigmentary complications than fair skin type after fractional treatment. Patients with FPT II had 0.26% incidence of PIH, meanwhile patients with FPT III, IV and V had 2.6, 11.6 and 33% incidence of PIH respectively.[68] The study of Manuskiatti et al in 2009 found up to 92% incidence of transient hyperpigmentation after fractional carbon dioxide lasers in Thai subjects with FPT IV. The hyperpigmentation was completely resolved within 5 weeks.[69] While, the study of Wattanakrai et al in 2011 demonstrated side effects and complications of fractional 1550 nm erbium fiber laser (Finescan™; TNC Medditron Co., Ltd., Thailand) in Thai patients with FPT III–V. The study found that PIH was the most common side effect, at 2.2%, which mostly occurred after first treatment and progressively subsided with topical hydroquinone cream.[70]

In conclusion, fractional laser resurfacing has lower rate of post-procedure complications than conventional ablative lasers. However, in patients with skin of color, physicians should use lower energy setting, fewer passes or treatment density, and appropriate skin cooling to prevent postinflammatory hyperpigmentation.

Pigment-Specific Lasers

The laser treatment of pigmented lesions is based on selective photothermolysis concept and the use of "Quality-switch, QS" technology to shatter pigments into small particles by photoacoustic mechanism within nanosecond range. Subsequent phagocytosis and lymphatic drainage occur. QS lasers used for pigmentary conditions include QS ruby (694 nm), QS alexandrite (755 nm) and QS Nd:YAG (532, 1064 nm). Other energy-based devices are long pulsed laser (ruby, alexandrite), intense pulsed light (IPL) or diode lasers. While, newly introduced picosecond lasers have faster rate of laser irradiation which cause pigment break down into smaller pieces and better results.[62]

Pigment-specific lasers can be used to treat multiple pigmentary conditions. Pigmentary disorders can be classified into epidermal, dermal pigmentation or mixed conditions. Melasma is one of the most common pigmentary disorders among dark skin complexion, particularly in female patients. Energy-based devices that have been used to treat melasma are low fluence Q-switch Nd:YAG (1064 nm), IPL or even pulsed dye laser. Apart from pigmentary disease, tattoo removal is also a challenging and frequently-encountered problem in cosmetic practice. It requires multiple treatment sessions to achieve satisfactory result which often leads to various complications. Therapeutic endpoint of pigment-specific laser is immediate lesional whitening. Clinicians should sufficiently select fluence that cause such endpoint for the treated lesion without causing epidermal disruption, petechiae or pinpoint bleeding. Possible side-effects include hyperpigmentation, hypopigmentation or blistering which can occur exclusively in patients with skin of color (Figure 1). In this particular group of patients, clinicians should use fluence as low as possible to create optimal endpoint.[71] Postlaser depigmentation can possibly occur, as presented in Figure 2.

Low fluence Q-switch 1064 nm Nd:YAG (LFQS) laser has been used to treat melasma. The exact mechanism is unclear however subcellular selective photothermolysis (SSP) theory may play an important role in fragmenting cytoplasmic melanin without disrupting cells. The histological assessment of facial melasma after LFQS showed decrease in melanin deposition in all layers of epidermis 1 week after laser irradiation.[72] Considering the use of LFQS 1064 nm Nd:YAG or "laser toning" to treat melasma in patients with skin of color, pigmentary complication such as mottled hypopigmentation can occur after several sessions. The histologic study of hypopigmented area demonstrated

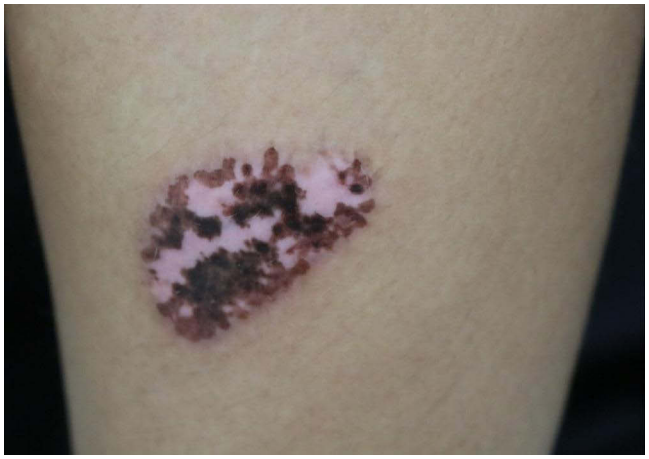

Figure 1 Segmental lentigines in patient with Fitzpatrick skin type IV after single session of Q-switch neodymium-doped yttrium aluminum garnet (532 nm) on lower part of the lesion, notice the postinflammatory hyperpigmentation that occur on the lower half of the lesion.

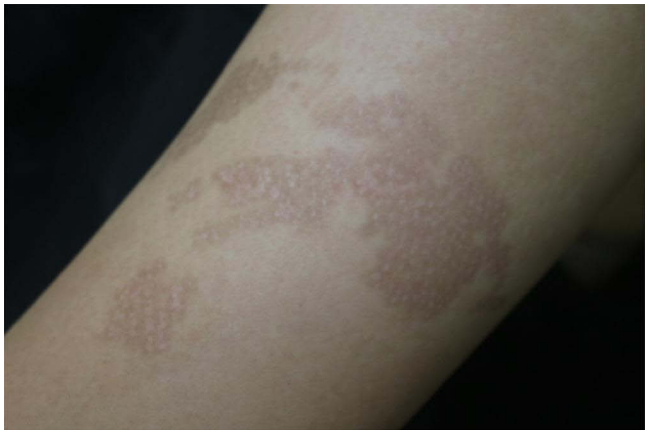

Figure 2 Congenital melanocytic nevus in patient with Fitzpatrick skin type IV with permanent depigmentation after several sessions of Q-switch alexandrite laser (755 nm).

depletion in melanin content without the decrease in melanocyte number. Conflicting histological results were seen in the case series which showed that both melanocyte number and melanin were decreased in hypopigmented area.[73]

In the study of Wattanakrai et al, mottled hypopigmentation was seen in 13.6% of patients after receiving 11 weekly sessions of LFQS 1064 nm Nd:YAG for melasma. All patients with mottled hypopigmentation in this study were FPT V.[74] Figure 3 shows patient with melasma developed this complication after several sessions of LFQS treatment. In order to avoid possible pigmentary complications in dark skin patients, clinicians should avoid excessive (more than 5, up to 10 treatments), too frequent (every week) or too high fluence LFQS procedure.[75]

Tattoo is the placement of ink in the upper dermis. Dye content varies depending on the color of the tattoo. Removal of tattoo by laser can be done by nanosecond Q-switch lasers including QS ruby (694 nm), QS alexandrite (755 nm) or QS Nd:YAG (532, 1064 nm). Selection of laser is based on the color of tattoo. Multiple treatment sessions are usually required to achieve satisfactory results. Immediate erythema is not uncommon. After multiple sessions, long-term side effects such as hyper or hypopigmentation can occur, especially in dark skin patients (Figure 4).[71]

Nowadays, picosecond lasers can achieve faster satisfactory result compared to traditional nanosecond lasers. There were six clinical trials reporting local pigmentary change after picosecond laser irradiation. Post-treatment complications after 755 nm picosecond laser included both hyperpigmentation (2/12; 16.7%) and hypopigmentation (3/12, 25%). While, treatment with 1064 picosecond laser was found to have hypopigmentation (6.25%).[76] For other pigmentary conditions, picosecond laser showed trend toward decreased risk of developing postinflammatory hyperpigmentation,

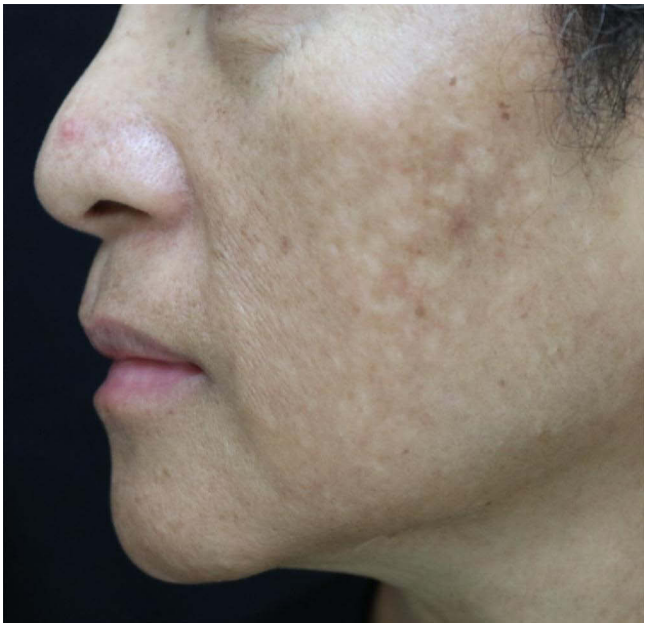

Figure 3 Melasma in patient with Fitzpatrick skin type III with guttate hypopigmentation after multiple sessions of low fluence Q-switch neodymium-doped yttrium aluminum garnet (1064 nm).

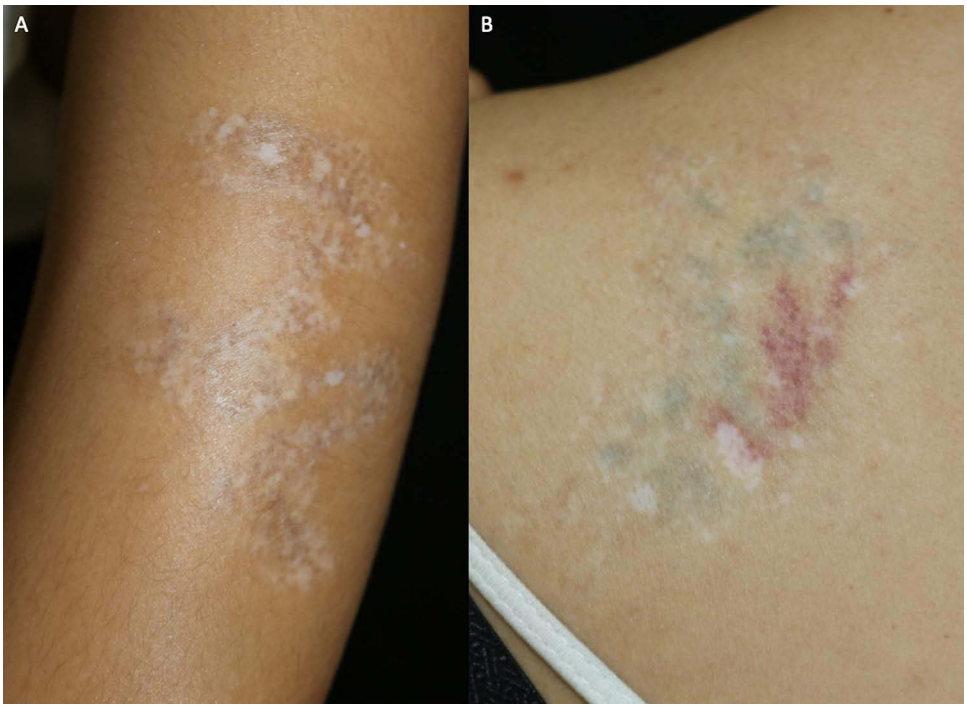

Figure 4 (**A**) Black tattoo (Fitzpatrick skin type IV) with permanent depigmentation after multiple sessions of Q-switch neodymium-doped yttrium aluminum garnet (1064 nm), (**B**) Multicolor tattoo (Fitzpatrick skin type III) with permanent depigmentation after multiple sessions of Q-switch alexandrite (755 nm) for green tattoo and Q-switch neodymium-doped yttrium aluminum garnet (532 nm) for red tattoo.

compared to nanosecond laser.[77] Chan MWM. et al showed incidence of hypopigmentation in 3.6% and hyperpigmentation in 10.2% in solar lentigines treatment for patients with FPT III–IV with 532-nm picosecond laser.[78] Longer wavelength was preferred in lowering risk of PIH. Vachiramon et al reported PIH risk was lower in 755-nm picosecond laser (3.3%), comparing to 532-nm picosecond laser (6.7%), in the treatment of solar lentigines with similar efficacy.[79]

Apart from conventional picosecond lasers, fractionated picosecond lasers are more frequently used in numerous conditions including dyspigmentation, acne scars, scars and skin rejuvenation. It induces laser-induced optical breakdown (LIOB) which leads to dermal collagen, elastin and mucin production. Kaewkes et al reported efficacy of fractional 1064-nm picosecond laser in treatment of abdominal striae distensae in patients with FPT IV–V. Postinflammatory hyperpigmentation occurred in 10% of participants, compared to 0% in other studies of patients with FPT II–III.[80,81] For the treatment of acne scar, Manuskiatti et al reported 18% incidence of PIH after all treatment sessions.[82] Chayavichitsilp et al conducted split-face study of acne scar treatment with fractional 1064-nm picosecond laser compared to non-ablative 1550-nm erbium fiber laser. Postinflammatory hyperpigmentation was observed in 6.67% after fractional 1064-nm picosecond laser treatment of acne in patients with FPT III–IV, compared to 10% in erbium treated side.[83] Other studies with fractional 755-nm and 1064-nm picosecond lasers for various conditions reported low incidence of PIH from 0–10.71%.[84–86] Apart from postinflammatory hyperpigmentation, acneiform eruption was also reported. Palawisuth S. et al conducted study using fractional 1064-nm picosecond (Enlighten^{TM}, Cutera, Inc., Brisbane, CA, USA) in the treatment of acne scar of FPT III–IV patients. Acneiform eruption was found up to 14% of participants. No postinflammatory hyperpigmentation was reported.[87]

Vascular Lasers

Vascular-specific lasers include a wide range of wavelength from 532 to 600 nm. The peak absorption of oxyhemoglobin is 577 nm. Pulsed dye laser (PDL) is the gold standard for vascular lesions. First generation of pulsed dye lasers emits yellow light at 585 nm which remains the gold standard for vascular lesion. However, the development of 595 nm pulsed dye laser allows clinician to achieve higher pulse duration and fluence. Other energy-based devices that can be used in vascular procedures are KTP 532 nm, IPL, long-pulsed alexandrite 755 nm, long-pulsed Nd:YAG (1064nm). Vascular lasers have been used to treat various skin conditions in patients with SOC such as port-wine stain, telangiectasia, spider angioma, postinflammatory erythema, keloid etc. Since vascular-specific laser has wavelength mostly within the range of melanin absorption, people with skin of color have higher risk of developing side effects after laser irradiation.[88]

Pigmentary change after PDL session is common in dark skin patients. Transient hyperpigmentation can be reduced by appropriate skin cooling during and after laser irradiation. Postinflammatory hypopigmentation can also occur either temporary or permanently (Figure 5). Concerning 532 nm frequently doubled Nd:YAG and KTP lasers, non-specific epidermal injury can develop especially in patients with skin of color. Long-pulsed 1064 nm Nd:YAG laser is considered a safer option for patients with dark skin tone. Its wavelength of 1064 nm has deeper penetration and lower absorption by melanin in epidermis. Thereby, it creates less epidermal injury than other vascular lasers.[62]

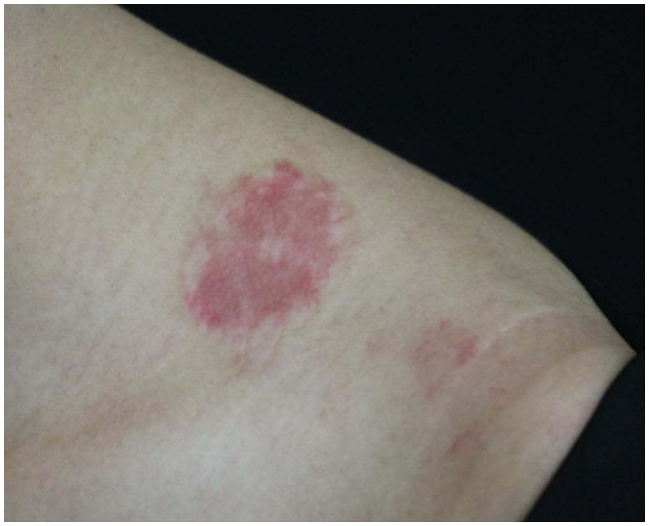

Figure 5 Nevus flammeus in patient with Fitzpatrick skin type III with permanent depigmentation after several sessions of pulsed dye laser (595 nm).

Hair Removal Lasers

Lasers and energy-based devices provide longer-term results compared to traditional hair removal procedures such as shaving or electrolysis. Currently used hair reduction lasers are long-pulsed Ruby (694 nm), long-pulsed alexandrite (755 nm), diode laser (800 nm), long-pulsed Nd:YAG (1064 nm) and IPL. The wavelength of light is limited to target melanin in hair follicles. Long pulse duration is applied (millisecond) to achieve thermal injury of the hair follicle. However, overlying epidermis contains melanin that competitively absorbs laser as well.[89]

In order to avoid possible side effects, clinicians should modify appropriate parameter settings for patients with skin of color. Longer pulse duration, longer laser wavelength and appropriate surface cooling should be strictly applied. The long-pulsed 1064 nm Nd:YAG is preferred over other devices with shorter wavelength. This long wavelength is within the end of absorptive spectrum of melanin within hair follicles but too deep to be absorbed by epidermal melanin. The other applicable devices for dark-skin individuals are long-pulsed alexandrite lasers (755 nm), long-pulsed diode lasers (800–810 nm) and IPL (590–1200 nm).[90]

Regarding the side effects after laser hair removal in patients with skin of color, the study of Lanigan SW showed that patients with FPT IV to VI (109 patients) has incidence of blistering at 14.9% with ruby laser and 5% with Nd:YAG laser. Incidence of hyperpigmentation was 9.9% with ruby laser and 2.1% with Nd:YAG laser. Overall incidence of side effects in skin type IV to VI treated with ruby laser was 3 times higher comparing with Nd:YAG laser (29.9% vs 9.4%).[90]

Concerning the use of long-pulsed alexandrite laser for hair reduction, Eremia et al demonstrated that postinflammatory hyperpigmentation can occur in 10% and hypopigmentation in 2%.[91] Moreover, Nanni et al and Alster et al also reported that pigmentary changes may occur in skin of color even when cooling was used.[92,93] Vachiramon V et al studied in patient knowledge and attitudes on laser hair removal in 221 African American subjects. The study showed that many African Americans still have negative attitudes and knowledge towards laser hair removal. Approximately half of participants (55.2%) knew that dark-skinned patients can be treated with laser hair removal procedures.[94] Another prospective study was conducted in 480 patients across United Kingdom. It demonstrated that patients with darker skin types (FPT type IV to VI, 109 patients from total 480 patients) have higher incidence of hyperpigmentation from ruby laser (9.9%) than Nd:YAG laser (2.1%). Moreover, this group of patients also developed blistering from ruby laser treated group up to 14.9% which was more than Nd:YAG laser (5%).[90] For diode laser, Greppi I reported dyspigmentation after diode laser treatment in almost 40% (3 out of 8 patients with FPT V–VI).[95] Recently, Atta-Motte et al reported side effects in patients with various ethnicities from diode hair removal laser. Multiple side effects were reported in darker skin population ten times more frequent than in white and Asian populations. Skin sensitivity, hyperpigmentation and burns occurred statistically significant more in black and mixed races. Skin sensitivity was reported in almost a half of black patients compared to 17.24% in Asian and 23.62% in white. Hyperpigmentation was reported in 28% in black patients compared to 10.34% in Asian and 0% in white population. While burns occurred in 36% in black patients compared to approximately 10% in Asian and white groups.[96]

Intense Pulse Light (IPL)

Intense pulse light (IPL) emits polychromatic broad bandwidth wavelengths from non-coherent filtered flash lamp. Cut-off filters selectively exclude the undesirable wavelength to treat specific target depending on clinical scenarios. The selected wavelength can be adapted to the patient's skin type. Higher filter wavelength helps to reduce the absorption of melanin and prevent complications such as erythema, blistering, crusting or hyperpigmentation in patients with dark skin types.[97]

The studies regarding side effects and complications after IPL procedure are still limited. The most commonly observed reactions were transient erythema and edema which gradually resolved within 48 hours. The pain of the procedure increases with higher fluence and shorter pulses which usually accompanied by adverse effects such as erythema, edema, blistering, burning or dyspigmentation. It is important to ask the patient during the procedure to check the degree of pain, especially in patients with darker skin tone. Individualized parameter setting, for example, lower fluence, longer and splitted pulses should be applied. Furthermore, sufficient epidermal cooling is also essential to protect epidermis from being burned by the system. The cooling can be done by using cool gels, ice pack or external air cooling, etc.[98]

Skin Tightening Devices

Photoaging includes both textural and pigmentary change of the skin. Furthermore, loss of skin and soft tissue integrity in combination with the pulling effect of gravity lead to the development of laxity especially in lower face area.[37] Various lasers and energy-based devices have been adapted to treat photoaging process, both superficial and deep layer of the skin. The use of devices to reverse the laxity process involves the technology that treat deep layer of skin such as infrared energy, radiofrequency and focused ultrasound devices. These technologies create a thermal energy to reticular dermis, subcutis or superficial muscular aponeurotic system (SMAS) to cause tissue contraction and remodeling while minimizing epidermal injury.[99]

Infrared Skin Tightening

Infrared light produces volumetric heat at the dermis, causing immediate collagen contraction. As a result, collagen remodeling and new collagen synthesis subsequently occur. Chua et al studied the efficacy of infrared light in 21 patients with FPT IV to V. Infrared non-ablative heating device (Titan™, Cutera, Inc., Brisbane, CA, USA) was used to treat face and neck laxity. The study showed satisfactory result with tolerable safety profiles. Pain and edema occurred temporary after the treatment. The reported side effect was superficial blistering which gradually subsided without scarring in all patients.[100]

Radiofrequency

Radiofrequency (RF) has been used for tissue heating and tightening for both facial and body contouring. The depth of penetration is inversely proportional to the frequency used. Low frequency RF penetrates more deeply than high frequency RF. It can be delivered by using monopolar, bipolar, unipolar or multipolar devices. According to the latest development of fractional technology, fractional RF has been used to treat multiple skin conditions as well. Monopolar RF has the highest penetrating effect comparing to bipolar and unipolar devices. Patients have to be grounded by applying electrode pad. Bipolar devices deliver RF between 2 poles built into single handpiece. Unipolar device has single electrode and no grounding pad. It delivers RF in an omnidirectional field around the electrode.[99,101]

RF energy does not target specific chromophore especially melanin in epidermis. Hence, RF is considered safe for all skin types. Kushikata et al studied the use of monopolar RF (Thermage®, Solta Medical, Hayward, CA, USA) in 85 Japanese patients with FPT III–IV. It demonstrated that RF was effective for skin tightening in Asian face. However, there were reported two cases of blisters and secondary hyperpigmentation after RF treatment which may be due to improper contact of treatment tip.[102]

In conclusion, RF is a safe technology that helps improve skin laxity for all skin types. Proper handling of RF devices is crucial to prevent possible side effects such as burn and blistering.

Focused Ultrasound

Ultrasound is an energy that can be delivered in focused pattern and penetrate deep to cause thermal coagulation points (TCPs) within tissue. Focused ultrasound has been used in medical field to do skin lifting. As also in RF, focused ultrasound has no specific chromophores. Thus, it is safe for all skin types. There are two major types of focused ultrasound include high-intensity focused ultrasound (HIFU) and microfocused ultrasound (MFU). HIFU uses high energy ultrasound to cause both thermal and cavitations to cause cell disruption and subsequent cell death, called thermomechanical process. Meanwhile, MFU uses much less ultrasound energy but creates small coagulation point (< 1 mm^3) with greater heating than 60-degree Celsius to a depth of up to 5 mm.[99,103]

The study regarding the safety of focused ultrasound is still limited especially with HIFU technology. This review will focus mainly on the use of MFU system. A commercially available MFU system is MFU with high-resolution ultrasound imaging which enables visualization of deep tissue planes to the depth of 8 mm (Ultherapy®; Merz Aesthetics, Raleigh, NC, USA). The device delivers energy to various depth, 1.5-mm, 3.0-mm and 4.5 mm focal depth with varying frequencies. The thermal injury is limited by short pulse duration and affects only deeper tissue plane. Due to the sparing of epidermal layer, cooling is unnecessary. MFU is considered safe procedure with no long-term side effects. The commonly found adverse effects include transient erythema (less than 24 hours), mild edema (last 2–4 weeks), dysesthesia (lasting 2–4 weeks) and bruising. Striated erythematous and edematous plaques can occur after treatment with superficial depth transducers, especially

1.5-mm focal depth transducer or from applying excessive gel on the skin. Less commonly observed side effects include transient inflammation of a superficial branch of the facial nerve which gradually subside within 2 to 4 weeks.[104] As previously mentioned, inappropriate application technique may cause severe epidermal injury and lead to dyspigmentation as demonstrated in Figure 6.

The study regarding the safety of MFU system in patients with skin of color was conducted in 2011, Fifty-two patients with FPT III to VI was treated with MFU with visualization for facial and neck laxity. There were three adverse events, such as prolonged erythema, mild edema which most likely due to procedure or technique. There were no neurological events, acute skin damage, ulceration or abnormal pigmentation occurred in this group of patients.[105]

As a result, MFU technology can be safely use for all skin types. However, clinician should learn how to use MFU properly especially the application and gel coupling technique. Energy setting should be lowered when treated with superficial depth transducer.

Patients' Education

Over the past decades, light skin tones have been worshiped more extensively than dark skin tones across all ethnic groups. A study concerning influence of skin tone and ratings of women's physical attractiveness had been done. The result showed that light-toned skin was rated more attractive than dark or tan skin tone from both male and female raters.[106]

An epidemiological study of skin of color found that skin lightening is one the main reasons why women chose to use lightening agents (33%). African women use skin lightening agents 1.71 times more than Indian women. Prolonged abusive use of lightening agents to lighten the skin can lead to permanent complications such as ochronosis from hydroquinone, or skin atrophy from topical corticosteroids.[107] On the contrary, nowadays, some light-skinned individuals consider becoming tanned is more beautiful than the pale white skin. However, frequent tanning both from natural or artificial sources can increase risk of developing skin cancers.[108]

Social and multimedia should encourage people to change attitudes towards darker shades of skin. Dark-skinned people can be beautiful and attractive as fair skin individuals. Sun protection is essential for all skin types to prevent premature aging and risk of developing skin cancers. Lasers can be done for dark skinned patients but with appropriate selection of lasers and parameter settings. Recommendation toward each procedures is summarized in Table 3.

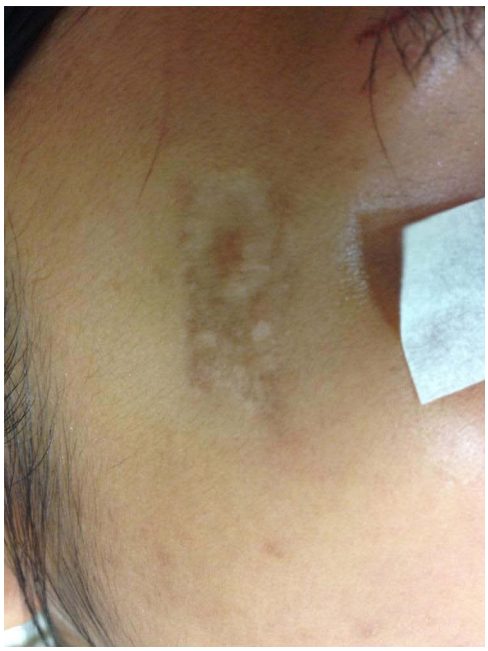

Figure 6 Dyspigmentation and scarring after high-intensity focused ultrasound technology in patient with Fitzpatrick skin type IV.

Table 3 Summary of Cosmetic Procedures Recommendation in Dark-Skinned Complexion

Cosmetic Procedures	Recommendation
Microdermabrasion	- Use of low-power setting
Botulinum toxin	- Same efficacy and tolerability without dose adjustment - Higher risk of ocular adverse reaction (eyelid edema) in Asian
Fillers	- Less aggressive approach and decreasing number of punctures - Use of linear threading and mid dermal placement
Energy-based devices	- Appropriate skin cooling during treatment - Adequate post-laser care eg sun protection and wound care
Ablative lasers	- Pre-treatment with retinoic acid and sunscreen to reduce PIH risk - Use of ultra-pulse mode to minimize tissue charring - Removal of desiccated tissue to decrease heat accumulation
Fractional lasers	- Use of lower energy, fewer passes and lesser density
Pigmented-specific lasers	- Avoiding excessive treatment sessions, frequency and pulse stacking - Choosing longer wavelength and optimal fluence to achieve end-point (Lowest possible) - Pre-treatment with hydroquinone to reduce PIH
Vascular lasers	- Preferred use of longer wavelength - Choosing optimal end-points (avoid too purpuric and blister end-points)
Hair removal lasers	- Preferred use of longer wavelength (1064-nm) - Choosing optical parameters and avoiding multiple passes - Keeping skin dry during treatment
Intense pulse light	- Choosing specific wavelength and higher cut-off filters - Using lower fluence, longer and splitted pulses
Skin tightening devices	- Similarity in safety and efficacy as in lighter skin

Abbreviation: PIH, postinflammatory hyperpigmentation.

Conclusion

Nowadays, physicians have to encounter with patients with different skin types. Patients with SOC or different ethnics have different anatomical and physiological factors. These may affect the efficacy and safety of cosmetic treatments. For topical medication, knowledge in effects of topical treatment against darker skin remain controversial. While chemical peeling can be safely done with selective superficial depth peel. Deeper peel should be used cautiously or avoided. Injectables, including botulinum toxin and fillers, are not approached similarly between darker and lighter skin individuals. However, injectables should be customized to each individual patients regarding their anatomical differences and problems. Lastly, for lasers and energy-based devices, clinicians should select appropriate parameters to avoid complications which is more common in darker skin individuals. Pre-treatment prevention, adequate cooling during procedures and post laser care are also essential factors. These procedures help to achieve safe and satisfactory outcomes.

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