Microneedling in skin of color: A review of uses and efficacy

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In ethnic skin, traditional skin resurfacing procedures such as dermabrasion, chemical peels, and laser therapy can be effective but can also be associated with prolonged recovery and risk of complications. These complications can include a higher risk of dyspigmentation and scarring, and unsatisfactory clinical outcomes. Microneedling is an evolving treatment technique for an expanding number of dermatologic conditions. Microneedling may offer a more advantageous safety profile, particularly in the skin-of-color population (Fitzpatrick skin types IV-VI), compared with more conventional resurfacing modalities. Thus far, it has been shown to be effective for a number of dermatologic conditions in this population, including scarring, melasma, melanosis, skin rejuvenation, acne vulgaris, and primary hyperhidrosis. This article aims to provide a comprehensive review of the literature regarding the efficacy and safety of microneedling in skin of color. (J Am Acad Dermatol http://dx.doi.org/10.1016/j.jaad.2015.09.024.)

Key words: acne vulgaris; hyperhidrosis; melasma; microneedling; scarring; skin of color: skin rejuvenation.

Microneedling is an evolving treatment modality for a growing number of dermatologic conditions.[1-4] Microneedling instruments (Fig 1) are devised of rows of fine needles, which are rolled over the skin to create rapidly healing punctures (Fig 2), resulting in a wound-healing response and subsequent collagen and elastin production.[1-3,5-7] This technique is also used to augment transdermal drug delivery through pores created through the stratum corneum.[3] The use of microneedling has further expanded with the advent of fractional radiofrequency microneedling (FRFM). In FRFM, insulated needles penetrate the skin and release radiofrequency currents from the needle tips producing therapeutic changes in dermal structural components and accessory glands without destruction of the epidermis.[8]

Procedures traditionally used for skin resurfacing include dermabrasion, chemical peels, and lasers. Although these modalities can be effective, they may be associated with prolonged recovery and adverse effects. These complications, which are at higher risk of occurring in patients with skin of color (Fitzpatrick skin types [FST] IV-VI), can include dyspigmentation, including postinflammatory hyperpigmentation (PIH) and hypopigmentation, infection, milia, and scarring.[2,9,10] These potential adverse effects can all lead to decreased use of resurfacing procedures when treating patients with skin of color.

Abbreviations used:

FRFM:	fractional radiofrequency microneedling
FST:	Fitzpatrick skin type
PIH:	postinflammatory hyperpigmentation

Microneedling therapy carries a decreased risk of many of the cutaneous adverse effects that can occur with conventional resurfacing modalities. Compared with ablative procedures, microneedling keeps the epidermis partially intact, and the retained skin barrier hastens recovery and limits the risks of infection and scarring. Although other modalities, such as nonablative and fractional lasers, also preserve much of the epidermis, patients with darker phototypes can continue to be at risk for dyspigmentation from potential thermal activation of

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Funding sources: None.
Conflicts of interest: None declared.
Accepted for publication September 12, 2015.
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Published online November 5, 2015.
0190-9622/$36.00

http://dx.doi.org/10.1016/j.jaad.2015.09.024

melanocytes. Other lasers can also use wavelengths that are absorbed by melanin. In contrast, microneedling does not target specific chromophores in the skin or use thermal energy, and therefore has minimal effect on pigmentation.[2,9,11,12]

This review aims to provide a comprehensive overview of the current literature and evidence regarding the efficacy and safety of microneedling in the skin-of-color population. PubMed/MEDLINE databases were used to identify studies pertaining to the use of microneedling in the skin-of-color population. All studies and reports available in English since 1966 were included with priority given to prospective randomized trials. Search terms included "microneedling," "percutaneous collagen induction," "dermaroller," "skin of color," and "skin types IV-VI." The literature search yielded studies investigating the use of microneedling in patients with skin of color for several conditions, including acne vulgaris, atrophic acne scars, melasma, melanosis, skin rejuvenation, and primary hyperhidrosis (Table I).

CAPSULE SUMMARY

- Microneedling is an evolving treatment that has been studied in skin of color.
- Microneedling modalities have been used to treat scarring, melasma, skin rejuvenation, acne vulgaris, and primary hyperhidrosis in the skin-of-color population.
- Available evidence, although limited, suggests that in darker skin types, microneedling can be a useful therapeutic option.

ACNE SCARS

Acne scarring is a common consequence of acne vulgaris. Lasers and chemical peels are often used to improve the appearance of atrophic scars primarily through the induction of collagen and elastin.[22,23] However, these modalities can be associated with risks, such as dyspigmentation and scarring, especially for patients with darker skin types.[6,24] Microneedling can also treat acne scarring through stimulating dermal remodeling and production of dermal components with minimal risk of dyspigmentation in patients with skin of color.

Fabbrocini et al[6] investigated the use of microneedling for acne scars and directly compared the outcomes and safety profile among patients with FST I to II (n = 10), FST III to V (n = 45), and FST VI (n = 5). After 3 monthly treatments, there was a statistically significant improvement of acne scars in all groups. Notably, adverse effects were comparable between skin types. The most significant side effect was transient postprocedure erythema occurring most prominently in patients with FST I to II. There were no reports of dyspigmentation in any group at 1 year after final treatment.[6]

Hassan[14] conducted a trial comparing microneedling alone to microneedling with subcision in patients with atrophic acne scars. Subcision is a technique in which depressed lesions are undercut using a needle to release attachments to deeper structures.[25] In the study, Hassan[14] included 70 patients who reported to be Asian with "dark skin." After 3 treatments, "efficacy," defined by at least 25% improvement on subjective photographic assessment, was demonstrated in 77% of patients who received microneedling alone, compared with 100% of patients receiving microneedling and subcision. Adverse effects were limited to transient posttreatment erythema, edema, and scabbing.[14]

In another study, 60 patients (FST III-V) with acne scars were treated with 5 sessions of either microneedling alone (group 1, n = 30) or microneedling combined with 35% glycolic acid peels (group 2, n = 30).[10] At 3-month follow-up, mean improvement was 31% in group 1, compared with 62% in group 2. Adverse effects included transient bruising and edema immediately after treatment in both groups, milia occurred in 2 patients within each group, and 3 patients within group 1 experienced PIH.[10]

Garg and Baveja[7] treated 50 patients (FST III-V) with atrophic scars with microneedling and 15% trichloroacetic acid peels performed at alternative sessions, at 2-week intervals during a 6-week period. At the initiation of the study all patients underwent 1 session of subcision with a 24-gauge needle. Outcomes were assessed using the Goodman and Baron qualitative scale, which grades scars as macular (grade 1), mild (grade 2), moderate (grade 3), and severe (grade 4). All patients with grade-2 scars showed full resolution of scarring, whereas patients with grade-4 scars at baseline improved to grade 2 and 3 in 63% and 38% of patients, respectively. PIH occurred in 6% of patients, which resolved 5 months after topical treatment with tretinoin, hydroquinone, and mometasone.[7] The lack of a comparison group treated with either microneedling or trichloroacetic acid alone is a limitation to this study, which makes it difficult to assess which modality primarily contributed to the dyspigmentation reported.

In 1 retrospective study by Chandrashekar et al,[8] the use of microneedling with a fractional radiofrequency device was investigated in 31 patients

Fig 1. Example of a microneedling device (Medical Roll-Cit, Vivida C.C. Renaissance Body Science Institute, Cape Town, South Africa). Reprinted with permission from: Aust MC, Reimers K, Kaplan HM, Stahl F, Repenning C, Scheper T, et al. Percutaneous collagen induction-regeneration in place of cicatrization? J Plast Reconstr Aesthet Surg 2011;64:97-107.

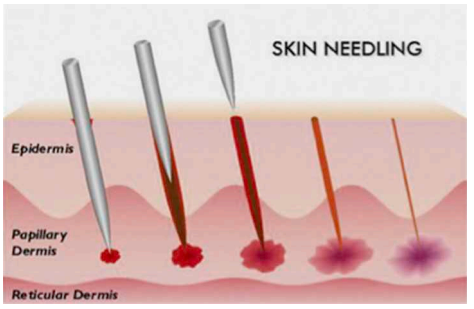

Fig 2. Schematic diagram of skin needling procedure. Reprinted with permission from: Aust MC, Reimers K, Kaplan HM, Stahl F, Repenning C, Scheper T, et al. Percutaneous collagen induction-regeneration in place of cicatrization? J Plast Reconstr Aesthet Surg 2011;64:97-107.

(FST III-V) with moderate to severe acne scars. After 4 treatments, 81% of patients improved by 2 grades on the Goodman and Baron scale and 19% of patients had improvement by 1 grade. Adverse effects included transient erythema and edema in all patients, PIH (16%), and tram track marks (6%).[8]

Dogra et al[13] treated 36 patients (FST IV-V) with 5 microneedling sessions. Outcomes were assessed using the Acne Scar Assessment Score, which considers scar number, severity, and scar type, and assigns a score between 1 and 18 points. One month after final treatment, the mean scores decreased from 11.7 to 6.5 points, which correlated clinically to a 50% to 75% improvement in the majority of subjects. PIH occurred in 5 patients (14%), 3 of which experienced severe hyperpigmentation resulting in discontinuation of treatment. The authors attributed the higher rate of significant PIH observed in this study to inadequate sun protection. Other adverse effects included procedural pain and tram track scarring (6%).[13] Of note, the risk of tram track scarring is thought to primarily relate to improper operator techniques, such as the use of inappropriately large needles or a consequence of excessive pressure applied during treatment over bony prominences.[26]

NONACNE SCARS

Several case reports describe successful treatment of nonacne scars in patients with skin of color using microneedling. In 1 report, a 15-year-old girl (FST V) was treated with microneedling for facial atrophic scars related to childhood varicella infection.[5] After 3 treatments, significant improvement was observed. There were no reported side effects, apart from 1 week of erythema after each treatment session.[5] In another case, a 50-year-old Korean woman with a facial burn scar extending across her right mandible was treated with a combination of microneedling and a traditional ablative carbon-dioxide laser.[15] The patient underwent 5 treatment sessions in which multiple "pinholes" were created with the carbon-dioxide laser, followed by microneedling over the surface of the burn scar. The authors proposed that a combination of using an ablative carbon-dioxide laser and microneedling would offer a favorable balance between thermal energy and fine punctures into the burn scar. Significant improvements in scar texture and contracture were achieved without any reported adverse effects. However, given that this report lacked a separate assessment of each treatment modality it is difficult to ascertain the benefit obtained from microneedling versus the ablative laser treatment.[15]

MELASMA AND MELANOSIS

Microneedling has also been explored as a means of transdermal drug delivery in the skin-of-color population for the treatment of disorders of hyperpigmentation. In 1 prospective, randomized study, the use of tranexamic acid microinjections was compared with microneedling followed by topical tranexamic acid application in 60 patients (FST IV-V) with moderate to severe melasma.[16] After 3 treatments, a mean improvement of 38% was observed in the Melasma Area Severity Index score in patients treated with tranexamic acid alone, compared with 44% improvement in patients who received tranexamic acid and microneedling. Furthermore, at least 50% improvement was achieved in 26% of patients in the microinjection group, compared with 41% of patients in the combined treatment group. No adverse effects were reported in either group.[16]

Fabbrocini et al[9] conducted a split-face trial in 20 patients (FST III–V) with melasma investigating the administration of a depigmentation serum containing rucinol and sophora-alpha with and without

Table I. Microneedling studies in skin of color

Author	Year	Patient no.	FST	Methods design	Device	Treatment no. (interval)	Scoring method	Blinded evaluation (yes/no)	Primary outcome	Adverse effects
Acne scars										
Chandrashekar et al[8]	2014	31	III-V	Retrospective	FRFM (power: 25-40 W, depth: 1.5-3.5 mm)	4 (6 wk)	Goodman and Baron acne scar grading system	No	81% Improved by 2 grades, 19% improved by 1 grade	Erythema and edema (100%), PIH (16%), tram track marks (6%)
Dogra et al[13]	2014	36	IV-V	Uncontrolled trial	Dermaroller MS4*	5 (4 wk)	Photograph assessment on a quartile scale	No	Mean 50%-75% improvement in the majority of subjects	PIH (17%), tram track scarring (7%)
Fabbrocini et al[6]	2014	60	I-II (n = 10), III-V (n = 45), or VI (n = 5)	Prospective, nonblinded study	Dermaroller MS4*	3 (4 wk)	Global Aesthetic Improvement Scale	No	Significant reduction in the depth of scars and average reduction of 31% in skin texture irregularity	Posttreatment erythema (majority FST I-II patients)
Garg and Baveja[7]	2014	50	III-V	Uncontrolled investigation of microneedling combined with 15% TCA peels	Dermaroller MS4*	3 (2 wk)	Goodman and Baron qualitative grading scale	No	23% of Patients with grade-4 scars had full resolution, all patients with grade-2 scars complete resolution	Erythema and edema (''majority of patients''), PIH (6%), and cervical lymphadenopathy (2%)
Hassan[14]	2015	70	Not reported	RCT of microneedling alone or a combination of microneedling and subcision	Dermaroller (500 needles, 2-mm long); 20-gauge cataract blade for subcision	3 (4 wk)	Photograph assessment by investigators on a quartile scarring scheme	No	Efficacy observed in 77% of patients who received microneedling alone, compared with 100% receiving combined treatment	Posttreatment erythema, edema (100%), scabbing (unreported)
Sharad[10]	2011	60	III-V	Prospective nonblinded study of microneedling with or without 35% glycolic acid peels	Dermaroller MS4*	5 (6 wk)	Echelle d'Evaluation clinique des Cicatrices d'acne (Scale for Clinical Evaluation of Acne Scars)	No	31% Mean improvement with microneedling alone, compared with 62% in combined treatment group	Transient bruising and edema (''majority of patients''), milia (7%), PIH (10%)
Nonacne scars										
Cho et al[15]	2008	1	III	Case report (burn scar)	Dermaroller and ablative carbon-dioxide laser	5 (4 wk)	Subjective assessment of photographs	No	Reduction of contracture and improvement in texture	None
Costa and Costa[5]	2014	1	V	Case report (varicella scar)	Dermaroller MS4*	3 (4 wk)	Subjective assessment of photographs	No	Significant improvement in the appearance of scars	Postprocedure erythema (100%)
Melasma and periorbital melanosis										
Budamakuntla et al[16]	2013	60	IV-V	RCT of TA microinjections with or without microneedling for melasma	Dermaroller MS4*	3 (4 wk)	Clinical photographs, MASI, physician global assessment	No	38% Improvement in MASI score with TA alone vs 44% improvement with combined treatment	None
Fabbrocini et al[9]	2011	20	III-V	Split-face trial of depigmentation serum with or without microneedling for melasma	Dermaroller CIT 8 (office treatment), Dermaroller C8 (home treatment)†	1 (n/a)	MASI	No	Baseline MASI score improved by 7.1 points in depigmenting serum alone group, vs 10.1 points after combined treatment	Transient erythema and edema (100%)

Sahni and Kassir[17]	2013	1	V	Case report (periorbital melanosis)	DermaFrac‡	12 (2 wk)	Physician global assessment	No	50%-75% and 75%-90% Improvement, after 4 and 12 sessions, respectively	None
Acne vulgaris										
Kim et al[18]	2014	25	III-V	Pilot study (no control group)	INTRAcel device§	3 (4 wk)	Photograph assessment of lesion no.; Sebumeter for sebum excretion measures	No	76% Reduction in the no. of active lesions, 37% mean reduction in sebum content	Bleeding (20%) and edema/erythema (32%), and crusting (24%)
Lee et al[19]	2013	20	III-V	Pilot study (no control group)	Infini device//	1 (not applicable)	Physician global assessment, measurement of and sebum excretion rate	No	Decrease in sebum excretion of 70%-80%; acne appearance and lesion no. showed transient improvement	Bleeding, erythema, and edema (unreported)
Lee et al[20]	2012	18	IV	Retrospective chart review	FRFM (depth: 3 mm, RF conduct time: 100 off/ 500 on/100 off ms)	2 (4 wk)	Photograph assessment on a quartile scoring scheme	Yes	Mean improvement in the no. of inflammatory lesions and lesion severity of 2.6 points and 2.4 points, respectively (scale: 0-4 points)	Postprocedure, erythema/ edema (majority), bleeding/crusting (unreported)
Skin rejuvenation										
Seo et al[11]	2013	15	II-IV	Split-face trial of FRFM with or without "stem cell medium"	5 Noninsulated microneedle electrode pairs per 10 mm^2, depth: 0.5-3 mm	3 (4 wk)	Physician global assessment on quartile scale	Yes	Addition of the stem cell medium produced significant benefit in skin roughness and moderate benefit in overall appearance, compared with FRFM alone	Mild erythema (100%)
Primary axillary hyperhidrosis										
Kim et al[21]	2013	20	IV	Uncontrolled trial	Infini device//	2 (4 wk)	HDSS and starch iodine test	No	HDSS score decreased from 2.2-1.8 points; histologic analysis revealed decrease in the no. and size of eccrine and apocrine glands	PIH (unreported), compensatory hyperhidrosis (10%)

Manufacturers: DermaFrac, Genesis Biosystems, Lewisville, TX; Dermaroller, Horst, Liebel, Germany; Infini device, Lutronic, Goyang, Korea; INTRAcel device, Jeisys Medical, Seoul, South Korea; Sebumeter, C-K Electronics, Cologne, Germany.

FRFM, Fractional radiofrequency microneedling; *FST*, Fitzpatrick skin type; *HDSS*, Hyperhidrosis Disease Severity Scale; *MASI*, Melasma Area Severity Index; *n/a*, unreported; *PIH*, postinflammatory hyperpigmentation; *RCT*, randomized controlled trial; *RF*, radiofrequency; *TA*, tranexamic acid; *TCA*, trichloroacetic acid.

*Dermaroller MS4: 192 needles, length 1.5 mm, width 0.25 mm.

†Dermaroller CIT 8: 192 needles, length 0.5 mm, width 0.02 mm; Dermaroller C8: 196 needles, length 0.15 mm; Dermaroller: 200 needles, 0.5-2.5 mm.

‡DermaFrac: 0.25-mm tip cap, pressure 10 mm Hg.

§INTRAcel: 49 microneedles, depth 1.5 mm, spot size 10 mm.

//Infini: 49 insulated microneedles spanning 10 mm^2 depth 0.5-3.5 mm, 1 MHz of RF current.

microneedling to augment serum delivery. In the group treated with depigmenting serum alone, baseline Melasma Area Severity Index score improved by 7.1 points after 2 months, compared with a decrease of 10.1 points after combined treatment. These results were confirmed with significant increases in luminance index in patients who received combination treatment, compared with those treated with serum alone.[9]

Microneedling has been successfully used in the treatment of periorbital melanosis. In 1 case report, a 48-year-old man (FST V) with severe, idiopathic periorbital melanosis underwent treatment with the DermaFrac device, which uses microneedling, along with an infusion of a serum containing antiaging and lightening compounds.[17] Physician global assessment revealed 50% to 75% and 75% to 90% improvement after 4 and 12 sessions, respectively. There were no side effects observed. The authors postulate that the mechanism of benefit may be secondary to improved skin hydration and induction of collagen and elastin synthesis, which may have diminished the visibility of dermal pigment.[17]

ACNE VULGARIS

One modification to traditional microneedling is the development of FRFM devices, which have expanded the indications for microneedling (Table II). In FRFM, insulated needles penetrate the skin and release radiofrequency energy from the needle tips into the dermis producing therapeutic changes in the skin structure without destruction of the epidermis.[11,18,19] One advantage of FRFM over fractional laser devices is that the energy is delivered more selectively because of the fixed spacing and depth of each needle.[27]

It has been proposed that FRFM causes thermal damage to sebaceous glands and may result in a reduction of sebum excretion and improvements in acne. Lee et al[20] investigated the use of a FRFM device in moderate to severe acne vulgaris in 18 patients (FST IV). After 2 treatment sessions, blinded photograph analysis revealed a 26% to 50% mean reduction in the inflammatory lesion count and in lesion severity scores. Adverse effects included posttreatment erythema and crusting. There was no report of pigmentary change.[20]

Kim et al[18] treated 25 patients (FST III-V) with moderate to severe acne using FRFM. Three months after 3 treatment sessions, patients demonstrated significant improvements in the mean lesion number (76% reduction) and sebum content (37% reduction). Inflammatory lesions responded more favorably to treatment than noninflammatory lesions. Adverse effects were limited to procedural pain, transient erythema, and crusting.[18] In another study, 20 patients (FST III-V) with facial acne were treated with a FRFM device. After a single treatment, sebum parameters demonstrated a sustained, significant reduction in sebum excretion of 70% to 80%.[19] Improvements in overall acne appearance and lesion count were observed 2 weeks after treatment but returned to baseline by 8 weeks posttreatment.[19]

SKIN REJUVENATION

FRFM has also been studied for skin rejuvenation in the skin-of-color population. Seo et al[11] conducted a split-face trial using FRFM with or without a "stem cell conditioned medium" of growth factors and cytokines for the purpose of skin rejuvenation in 15 female patients (FST III-IV). Patients were treated with FRFM alone on 1 side of the face and FRFM plus the stem cell medium on the contralateral side. After 3 treatment sessions, both sides of the face showed improvements in hydration, erythema index, and skin roughness. Two blinded dermatologists assessed preprocedure and postprocedure photographs and graded overall improvement on a quartile scale, ranging from 0- to 4-point mean improvement. The addition of the stem cell medium produced a significant improvement in fine wrinkles and overall appearance, compared with FRFM alone (2.06 vs 2.20, $P < .05$). Histologic specimens demonstrated neocollagen and fibrillin-1 production. Side effects were limited to procedural pain and transient erythema.[11]

HYPERHIDROSIS

FRFM has also been used to treat hyperhidrosis in patients with skin of color. In 1 study, 20 patients (FST IV) with primary axillary hyperhidrosis underwent 2 treatment sessions with a FRFM device and demonstrated a significant reduction in scores on the Hyperhidrosis Disease Severity Scale from 2.2 to 1.8 points (range: 1-4 points). Starch iodine test similarly demonstrated significant improvements in 95% of patients. Histologic analysis confirmed decreases in the number and size of eccrine and apocrine glands. The most common reported adverse effect was transient PIH, which self-resolved within 2 weeks. Other side effects included postprocedure edema, and compensatory hyperhidrosis of the chin and upper lip in 2 patients.[21]

Conclusion

The use of conventional resurfacing procedures can be limited in patients with skin of color because of concerns of adverse effects, most notably dyspigmentation. Microneedling represents a favorable alternative treatment in darker skin types, as it can

Table II. Microneedling studies in patients with skin of color by treatment modality

Technique	Description of technique	Conditions treated	No. of studies	Adverse effects (incidence range)*
Microneedling	Instrument with numerous rows of fine needles that are rolled over the skin to create small, rapidly healing punctures	Atrophic acne scars, varicella scars	3	Postinflammatory hyperpigmentation (0%-17%) Tram track scarring (0%-7%)
Fractional radiofrequency microneedling	Insulated needles penetrate the skin and release radiofrequency currents from the needle tips into the dermis producing changes in dermal structural components and accessory glands	Atrophic acne scars, acne vulgaris, primary hyperhidrosis, skin rejuvenation	6	Bleeding/crusting (0%-24%) Postinflammatory hyperpigmentation (0%-16%) Tram track scarring (0%-6%)
Microneedling + subcision	Depressed lesions are undermined using a needle to release attachments to deeper structures before microneedling	Atrophic acne scars	1	Bleeding/scabbing (unreported)
Microneedling + transdermal drug delivery	Tranexamic acid or depigmenting serum applied topically either after channels are created by microneedling or can be simultaneously infused during microneedling (DermaFrac device, Genesis Biosystems)	Melasma, melanosis	3	No reported adverse effects

*Transient postprocedure erythema and edema were reported side effects in all studies.

yield clinical efficacy in a number of dermatologic conditions with minimal risk of adverse effects. The tolerability of microneedling and preservation of the epidermis allows for the procedure to be repeated multiple times until satisfactory outcomes are achieved. In addition, the development of radiofrequency microneedling has expanded the indications for microneedling without additional significant risk of side effects. The versatility, practicality, and safety of microneedling renders it a promising treatment modality for a variety of dermatologic conditions in the skin-of-color population. Although microneedling may positively add to the current treatment armamentarium available for this population, it is important to note that the number of randomized controlled trials completed remains limited, and larger, controlled studies are needed to provide further data on the efficacy and safety of microneedling, particularly in darker skin types.

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