

Basic chemical peeling: Superficial and medium-depth peels



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Chemical peeling, or chemexfoliation, has been used for centuries to improve signs of ultraviolet

Learning objectives

After completing this learning activity, participants should be able to discuss the components (pH, composition, vehicle) affecting tolerability and safety of superficial and medium-depth peels; explain the differences between the three major medium depth peels: JS+TCA, CO₂+TCA, glycolic acid+TCA; and recognize the level of injury of superficial vs medium depth peels.

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light-induced sun damage. Over the last 30 years, the science behind chemical peeling has evolved, increasing our understanding of the role of peeling ingredients and treatment indications. The depth of peels is directly related to improved results and to the number of complications that can occur. Key principles for superficial and medium depth peeling are discussed, as well as appropriate indications for these treatments. (J Am Acad Dermatol 2019;81:313-24.)

Key words: acne; chemabrasion; chemexfoliation; chemical peeling; glycolic acid; International Peeling Society; Jessner's solution; pyruvic acid; rejuvenation; retinoic acid; salicylic acid; solid CO₂; trichloroacetic acid.

Chemical peeling is the controlled wounding of the epidermis and dermis for medical and aesthetic improvement. Although the use of chemical peels dates to ancient Egyptian times, our

understanding of the science behind chemical peeling is still evolving.¹ Recent scientific studies investigating the histologic and long-term effects of peels provide data to support the clinical

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Abbreviations used:

CO ₂ :	solid carbon dioxide or dry ice
CROSS:	chemical reconstruction of skin scars
GA:	glycolic acid
HA:	hydroalcoholic
JS:	Jessner solution
LA:	lactic acid
MJS:	modified Jessner solution
PA:	pyruvic acid
PEG:	polyethylene glycol
PIH:	postinflammatory hyperpigmentation
SA:	salicylic acid
TCA:	trichloroacetic acid

observations. This first article in this continuing medical education series about chemical peels discusses superficial and medium-depth peels, including descriptions of the histologic effects and treatment indications of these peels.

HISTOLOGY**Key points**

- **Superficial peels induce epidermal injury**
- **Medium-depth peels penetrate into or through the papillary dermis**

Superficial peels produce injury limited to the epidermis, whereas medium-depth peels produce injury into or through the papillary dermis. Indications for superficial peels therefore include mild acne and epidermal and mixed melasma, whereas indications for medium-depth peels include actinic keratosis, lentigines, sallow discoloration, and fine, static wrinkles.

Common superficial peels include glycolic acid (GA), salicylic acid (SA), Jessner solution (JS), retinoic acid, lactic acid, mandelic acid, pyruvic acid (PA), and trichloroacetic acid (TCA) 10% to 35%. Of these, only GA and PA peels require neutralization, either by sodium bicarbonate or by removal with water. Superficial peels include alpha- and beta-hydroxy acids. Alpha-hydroxy acids, such as glycolic acid, are water soluble. Beta-hydroxy acids, such as salicylic acid, are lipid soluble.

Common medium-depth peels include 70% glycolic acid plus 35% TCA, JS plus 35% TCA, solid CO₂ plus 35% TCA, and 88% phenol.²⁻⁴ Eighty-eight percent phenol is rarely used as a solo agent for large areas because of the risk of cardiotoxicity.^{5,6}

Table I. Depth of penetration of trichloroacetic acid chemical peels

Peel strength of TCA, %	Penetration depth
10-15	Epidermis
15-30	Epidermis
35	Superficial papillary dermis
50-100	Approaching and reaching upper reticular dermis with increased risk of complications; appropriate for focal use only

SUPERFICIAL PEELS**Key points**

- **Tretinoin, salicylic acid, Jessner solution, and modified Jessner solution do not require neutralization**
- **Glycolic and pyruvic acid require neutralization**

Tretinoin peels

Because its solutions in organic solvents are essentially non-acidic as they have no measurable pH, and intranuclear mechanism of action, all-trans retinoic acid or tretinoin peels cause minimal discomfort during application. Tretinoin 5% to 10% peels left on as a 6-hour facial mask cause mild erythema and desquamation on postpeel day 2.⁷ A randomized trial on forearm rejuvenation showed that tretinoin 0.05% cream nightly was comparable to 5% tretinoin peel every 2 weeks.⁸ Tretinoin peels at varying concentrations may be used to treat acne, although supportive clinical trial data are sparse.

Salicylic acid

SA is a beta-hydroxy acid and a phenolic compound with antiinflammatory,⁹ antimicrobial,¹⁰ and depigmenting properties.¹¹ It is safe in skin of all Fitzpatrick phototypes.¹² Because of SA's lipophilic and comedolytic effects, it is particularly effective for comedonal acne.¹³ SA 20% to 30% in ethanol (hydroalcoholic vehicle [HA]) crystallizes upon ethanol evaporation, yielding a pseudofrost that can be removed from the skin with a facewash or wet cloth, if desired. The crystals cannot penetrate the skin; the peel is thus self-limiting.

Some patients develop SA-HA hot spots, or areas of overpenetration that may result in postinflammatory hyperpigmentation (PIH). In response, a polyethylene glycol (PEG) vehicle was developed that slows delivery while simultaneously increasing follicular penetration.^{13,14} Typically, the SA-PEG peel

is left on the skin for ≥ 5 minutes to allow for follicular penetration, and then rinsed off with water as the PEG vehicle is occlusive. A split-face study for acne showed superiority of 30% SA-PEG to 30% SA-HA.¹³ SA-HA peels yield mild desquamation after 2 days. In contrast, SA-PEG usually does not cause desquamation. Salicylic acid peels may cause urticaria and angioedema, with known cross-sensitivity to acetylsalicylic acid.

Trichloroacetic acid

TCA is highly water soluble, with no crystallization in up to 90% TCA solution.¹⁵ The currently accepted standard preparation of TCA is weight to volume.¹⁶ Other preparation methods, such as weight to weight, grams of TCA per 100 mL water, and 100% TCA diluted to lower percentages can result in increased TCA concentrations and complications.¹⁶

Depth of penetration correlates directly to concentration (Table 1).¹⁷ TCA $>35\%$ is used for focal treatment of individual lesions because pigmentary complications and scars are common with use over large areas. TCA penetrates slowly, so one must wait at least 5 minutes to assess the frosting endpoint and to avoid overcoating.¹⁸ There are 3 levels of frosting: 1) a light reticular frost with background erythema, 2) a confluent light white frost with background erythema, and 3) a solid white frosting without erythema (Fig 1). Frosting seen with TCA corresponds to epidermal and dermal protein denaturation.

TCA $>80\%$ is only appropriate for focal use,¹⁹ as in the following examples.

Mild to moderate rhinophyma. Chemical cauterization compares favorably to electrocoagulation, with excellent safety over a 5-decade experience.²⁰

Chemical reconstruction of skin scars. Focal ice pick or boxcar acne scar treatment increases collagen deposition and decreases scar depth.²¹⁻²⁶

Earlobe tears. TCA 90%^{27,28} creates epidermal and dermal necrosis allowing second intent reapproximation (Fig 2).

Xanthelasma. For xanthelasma, vary TCA strength based on morphology—macular lesions may be treated with TCA 50%, whereas papular lesions require TCA 70% to 100%.²⁹⁻³¹

Jessner and modified Jessner solution

JS consists of 14% resorcinol, 14% SA, and 14% lactic acid (LA) in 95% ethanol.¹⁷ The application of modified JS (MJS) is shown in [Supplementary Video 1](#) (available online at <https://www.jaad.org>). Resorcinol, which acts similarly to hydroquinone

(meta- and para-dihydroxybenzene, respectively), may cause contact allergy and risks inducing cross-sensitivity with hydroquinone with repeated exposure.³² In response, Bridenstine and Dolezal¹⁶ modified MJS by increasing the concentration of SA and LA to 17% and replacing resorcinol with 8% citric acid.^{32,33}

A study comparing JS plus 20% TCA versus 20% TCA alone in individuals with higher Fitzpatrick skin phototypes found that JS plus 20% TCA was more effective in treating melasma but with greater immediate discomfort. There was no significant difference in PIH.^{34,35}

Glycolic acid and pyruvic acid

GA is a water-soluble, alpha-hydroxy acid and PA is an alpha-keto acid. To avoid overpenetration, GA and PA must be neutralized as soon as the clinical endpoint of erythema is reached, or after 5 minutes if no erythema is present. These acids can be neutralized with 10% sodium bicarbonate, with water, or by wiping with a saline-dampened cloth. Both agents are safe at low concentrations (GA 50%/PA 40%); however, at GA 70% and PA 50%, both risk focal irritation or hot spots.

Sometimes erythema, which is the endpoint for neutralization, quickly progresses to frosting. This rapid transition is associated with scar or PIH and, consequently, a shift toward safer alternatives, such as SA, MJS, or low-strength GA, has occurred.

MEDIUM DEPTH PEELS

Key points

- **TCA 50% risks scarring and dyspigmentation**
- **Safer medium-depth peels include solid CO₂ plus TCA 35%, JS plus TCA 35%, and GA 70% plus TCA 35%**
- **88% phenol is a medium-depth peel, but hypopigmentation and cardiotoxicity are risks**
- **Medium-depth peels should not be performed off the face and scalp**

Medium-depth peels penetrate and induce histologic changes within the papillary dermis. Historically, medium-depth peels were performed using TCA 50%, yielding uneven penetration and erosions, PIH, and scars. As a result, researchers Harold Brody, Gary Monheit, and William Coleman introduced the use of a physical or chemical agent to induce epidermolysis before the application of TCA 35% and thereby allow for its safe, predictable, even penetration.

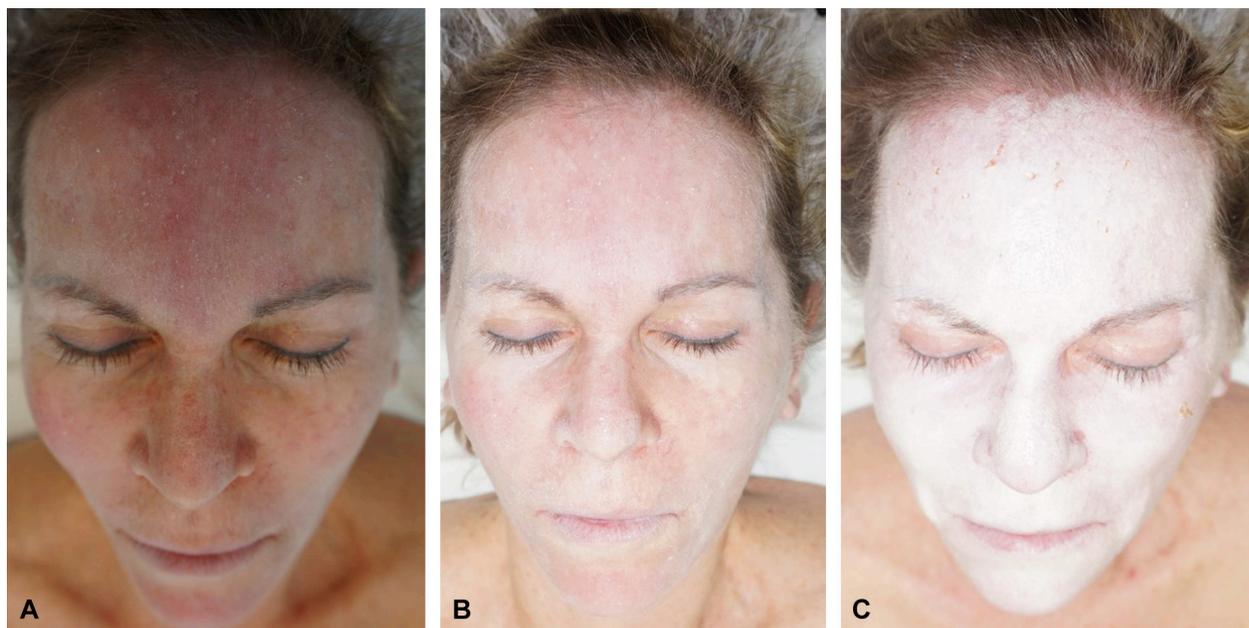


Fig 1. **A**, Level I frost showing a light reticular frost with background erythema. **B**, Level II frost showing a confluent light white frost with background erythema. **C**, Level III frost showing a solid white frosting without erythema.



Fig 2. Earlobe cleft treated with 2 sessions of 100% trichloroacetic acid administered 1 month apart.

Medium-depth peels share similar histologic effects: at day 3 postpeel, there is full-thickness epidermal necrosis, a dermal inflammatory infiltrate, and papillary dermal edema.³⁶ At day 7, the epidermis reepithelializes.³⁷ At day 30, there is regeneration of homogenized collagen.³⁶⁻³⁸ At day 90, thickened collagen bundles are present in the dermis showing a Grenz zone overlying a reticular elastotic band, the thickness proportional to the strength of the peel.³⁹ Type I collagen is also markedly increased.⁴⁰

Brody peel: Solid CO₂ (dry ice) plus TCA 35%

This approach combines solid CO₂ (dry ice) and TCA to create a controlled medium-depth peel. Solid CO₂ (−78.5°C) is available from local supermarkets, ice cream manufacturers, or pharmaceutical supply companies, food supply, or food bait packing plants.

After degreasing the face with acetone, handheld blocks of solid CO₂ are dipped in a 3:1 acetone to alcohol solution, allowing the CO₂ to glide smoothly over the skin (Supplementary Video 2; available online at <https://www.jaad.org>). The application time of solid CO₂ ranges from 3 to 15 seconds, allowing for superficial to deep penetration of TCA. The endpoint of solid CO₂ application is transient white frost with residual erythema. Afterwards, TCA 35% is applied until an endpoint of even light white or solid white frost is achieved (Fig 1; Supplementary Video 2).³⁷ TCA causes epidermal and dermal protein denaturation corresponding to the clinically observed frost (Fig 1).

Monheit peel: JS plus 35% TCA

This peel uses JS as a keratolytic agent to further TCA penetration and is performed by degreasing the



Fig 3. Before and 8 months after a medium-depth CO₂ hard plus trichloroacetic acid 35% peel on a Glogau photoaging IV female who was not a candidate for a deep peel showing a substantial reduction and removal of wrinkles, pigmentation, and actinic keratoses with medium-depth wounding.



Fig 4. Segmental combination peel using medium-depth and deep peels. The perioral and glabella areas were treated with a deep peel of 1.2% croton oil in 35% phenol. The periorcular area was treated with a medium-depth peel with straight 88% phenol without croton oil. The rest of the face was treated with a medium-depth peel with Jessner solution plus 35% trichloroacetic acid to blend skin color and texture. Liquid nitrogen was applied to larger lentigines.

face with acetone followed by the application of JS until a reticulate frost is obtained.^{41,42} MJS can be used alternatively in darker skin to treat pigmentation and has less risk of contact sensitivity.⁴³⁻⁴⁵ Although contact allergy to resorcinol is rare, it may be underreported.⁴⁶ TCA is applied after MJS/JS until the desired endpoint is obtained. JS plus TCA 20% may be used, but may not create a significant medium-depth wound and is unstudied.

Coleman peel: GA 70% plus TCA 35%

In this peel, degreasing with acetone is unnecessary if patients are not wearing make-up or other products. Patients are asked to wash their faces with soap before procedure. GA 70% is first applied for approximately 2 minutes with an endpoint of erythema, then removed with water. Next, TCA 35% is applied until the endpoint is reached.³⁹ Tse et al³⁸ compared JS plus TCA 35%



Fig 5. Segmental combination peel using medium-depth and deep peels. The perioral areas were treated with a deep peel of 1.2% croton oil in 35% phenol. The rest of the face was treated with a medium-depth peel of CO₂ plus 35% trichloroacetic acid. The neck was treated with a superficial peel with 20% trichloroacetic acid.



Fig 6. Hypopigmentation of the left cheek 6 months after 88% phenol peel.

and GA 70% plus TCA 35%, finding that the latter induced greater ne elastogenesis. Conversely, JS plus TCA 35% exhibited greater neovascularization and papillary dermal fibrosis. In their study of 13 patients, those receiving the GA 70% plus TCA 35% peel noted more pain immediately after GA application.³⁹

By way of comparison, solid CO₂ plus TCA is histologically the deepest peel, improving wrinkles when performed to a solid white frost (Fig 3). Unless a medium-depth peel penetrates the entire papillary dermis, it cannot maximize its potential results; JS and GA followed by TCA may be less capable of reaching that histologic endpoint.^{36,38} Solid CO₂ followed by TCA is easier for the patient to tolerate than JS or GA followed by TCA, which exemplify an acid followed by another acid, producing more patient discomfort. Analgesia is unnecessary for any medium-depth peel if the operator is experienced in performing the peel rapidly and smoothly. Medium-depth peels should not be used elsewhere than on the face or the scalp because of the risk of scarring.

Segmental peeling

A segmental peel uses different peeling agents on different cosmetic units to tailor the wounding agent to the degree of photodamage. Not uncommonly, the perioral or the periorbital area exhibits Glogau III or IV wrinkles while the remainder of the face exhibits only mild sun damage. The use of a phenol/croton oil formula on one or two cosmetic units, equivalent to a body surface area of <2%, does not require cardiac monitoring if each cosmetic unit is peeled over 10 to 15 minutes. The second article in this continuing medical education series discusses phenol/croton oil peels. Performing a medium-depth peel adjacent to the deep peel prevents a line of demarcation, blends, and unifies the rejuvenation effect (Figs 4 and 5). Regional anesthesia with nerve blocks, oral hydration, and oral benzodiazepines increase patient comfort.

Phenol

Unoccluded 88% phenol is a medium-depth peel and is rarely used for full-face peeling because of the risks of cardiotoxicity and hypopigmentation (Fig 6).^{47,48} Phenol immediately coagulates epidermal and superficial dermal proteins⁴⁹ with increased collagen and elastic fibers histologically.⁵⁰ A punctuated 88% phenol technique to individual rhytids has been described and decreases phenol exposure.⁵⁰

APPLICATION TECHNIQUES

Key point

- Chemical peels can be applied with brushes, gauze, or cotton-tipped applicators

Chemical peels can be applied with a sable or goat hair brush or with a gauze or cotton-tipped



Fig 7. (Left) Erythematous rolling acne scars on the forehead. (Middle) Three days after application of a medium-depth peel with CO₂ plus 35% trichloroacetic acid. (Right) Six weeks after treatment with a medium-depth chemical peel.

applicator. For superficial peeling agents, brushes that can be cleaned with soap and water provide rapid application with little waste. Gauze or cotton absorbs and therefore wastes more solution when the applicator is discarded.

COMMON INDICATIONS FOR SUPERFICIAL AND MEDIUM PEELS

Key points

- Chemical peels are safe and effective for several medical and cosmetic indications
- Medium-depth peels reduce p53 mutations in ultraviolet light–irradiated mice and actinic keratosis count

Acne

Superficial chemical peels are effective for mild to moderate acne.^{51–54} SA 30% and GA 30% were similarly effective in a split-face randomized control trial.⁵⁵ In darker skin types, superficial peels are safe and effective in reducing papule, pustule, and comedone count. One study found that SA or salicylic–mandelic acid peels were better than GA peels.⁵⁶

Acne scars

Acne scars are categorized into icepick, boxcar, or rolling scars (Fig 7).⁵⁷ Medium-depth chemical peels using solid CO₂ slush with focal 50% TCA to efface scar rims³⁷ or JS followed by 35% TCA may improve acne scars in lighter skin types. Focal dermabrasion may follow the peel.⁵⁸ Chemical reconstruction of skin scars is discussed in the second article in this continuing medical education series.

Actinic keratosis

Medium-depth chemical peel penetration into the papillary dermis supports its use in treatment of actinic keratosis.⁵⁹ In a split-face comparison using one application of JS plus 35% TCA versus topical 5-fluorouracil (5-FU) twice daily for 3 weeks, both

groups achieved a 75% reduction in AK. Skin biopsy specimens showed a similar decrease in keratinocyte atypia.⁶⁰ Long-term efficacy of JS plus 35% TCA is similar to that of 5-fluorouracil, with sustained improvement at 12 months of follow-up.⁶¹ For actinic cheilitis, one application of 50% TCA yields a median time to recurrence of 9 months, but is inferior to 5-fluorouracil 3 times daily for 2 weeks, shave removal, and CO₂ laser ablation.⁶² Consequently, 50% TCA chemical is not recommended for actinic cheilitis, except in patients compliant with follow-up.

Chemical peels may prevent photocarcinogenesis.⁶³ SA-PEG suppressed keratinocyte expression of p53 protein in ultraviolet B light–irradiated mice. In vivo experiments in human facial skin showed that SA normalizes keratinocyte differentiation.¹⁴ In another study in ultraviolet light–irradiated hairless mice, 35% GA, 30% SA, and 10% or 35% TCA suppressed p53 mutations, reduced messenger RNA expression of cyclooxygenase 2, and decreased serum concentrations of prostaglandin E₂, leading to decreased tumor formation.^{64,65}

Infraorbital hyperpigmentation

Infraorbital darkening has a multifactorial etiology, including hyperpigmentation, periorbital fat pseudo herniation, fine wrinkling, and reticular veins. Chemical peels are ineffective for pseudo herniation and veins, but microneedling combined with 10% TCA improved hyperpigmentation in >90% of patients.⁶⁶ Four weekly 3.75% TCA and 15% lactic acid peels resulted in excellent improvement in >90% of patients at 6 months of follow-up.⁶⁷ GA 20% and lactic acid 15% showed 73% and 56% improvement in periorbital melanosis.⁶⁸

Melasma

Melasma disproportionately affects darker Fitzpatrick skin phototypes; therefore, laser or



Fig 8. (A) Before and (B) after treatment of melasma. The patient was treated with superficial peels using salicylic acid 20% for 1 session, salicylic acid 30% for 1 session, and then tretinoin 1% for 1 session. Each session was performed 4 weeks apart. (Photographs courtesy of Pearl Grimes, MD.)

deep peels present a risk for PIH. Superficial peels in combination with hydroquinone offer a safe alternative. In a randomized study of 40 Indian patients, Sarkar et al⁶⁹ compared hydroquinone 2%, tretinoin 0.05% cream, and hydrocortisone 1% cream to 6 30% GA peels performed every 3 weeks. The GA group showed significant improvement compared to bleaching cream only.⁶⁹ Other clinical studies document the efficacy of LA, JS, and tretinoin peels for melasma (Fig 8).⁷⁰⁻⁷²

Postinflammatory hyperpigmentation

Chemical peels increase epidermal turnover and decrease epidermal melanin. Grimes¹² pretreated 5 patients with PIH with hydroquinone 4% before treatment with a series of 5 SA 20% to 30% peels every 2 weeks: 80% had >75% improvement, and 20% had 51% to 75% improvement in PIH.¹² Joshi et al⁷³ replicated these findings using a randomized split-face model, in which 10 subjects with PIH received SA 20% to 30% peels on half of the face, and no treatment on the other half.

Photorejuvenation

Medium-depth peels induce histologic and clinical improvement in parameters of photoaging,



Fig 9. Herpes simplex virus outbreak of the left cheek at day 4 after a JS + 35% trichloroacetic acid peel.

in particular lentiginos, fine wrinkles, sallowness, discoloration, and actinic keratosis directly related to peel depth.^{42,74}

PRE- AND POSTPEEL PREPARATION

Key points

- Topical tretinoin improves penetration and decreases healing time
- Wet soaks and emollients are recommended for reepithelialization

Table II. Postpeel prophylaxis before medium-depth peels

Timeframe	Action taken
2-4 weeks prepeel preparation	Topical tretinoin over moisturizer (stop tretinoin 1 week before peel in patients with Fitzpatrick skin phototypes IV-VI) Moisturizer
Day of procedure	Valacyclovir 1 g twice daily for 7 days
Postprocedure	White petrolatum 3 times daily for 3 days, may change to emollient cream 3 times daily on day 4 Pain, malaise, pustules: bacterial culture, empiric trimethoprim-sulfamethoxazole twice daily, and gentamycin 0.1% cream 3 times daily for 7 days Itch, pustules: candidal culture; empiric fluconazole 200 mg × 1 dose Induration: topical or intralesional steroid Sun protection Do not pick at or peel exfoliative skin If not healed in 7 days, consider complications. If HSV infection is suspected, start treatment dose of valacyclovir 1 g 3 times daily for 7 days

• **Herpes simplex virus prophylaxis is warranted**

Prepeel

Sun protection before and after the peel is mandatory. Medium-depth peels are not recommended for Fitzpatrick skin phototypes ≥IV because of the risk of PIH.¹⁸ This risk may be reduced by prepeel preparation with hydroquinone for 1 month⁷⁵ and peeling during the winter season.⁵⁴

For superficial and medium peels, pretreatment with topical tretinoin for 2 to 4 weeks enables a more uniform frosting and improves healing time.⁷⁶ For Fitzpatrick skin phototypes IV to VI, expert consensus recommends tretinoin cessation 1 week before the peel to prevent overpenetration and PIH.^{77,78} Pretreatment for 2 weeks with hydroquinone 2% is more effective than tretinoin 0.025% in decreasing PIH.^{79,80}

Postpeel

Postpeel management focuses on expediting healing and preventing infection. For edema and mild discomfort, ice packs can be used. Gently soaking and cleansing the skin followed by application of white petrolatum for 3 days enables reepithelialization; afterward, patients may continue petrolatum or switch to an emollient cream.

Patients with a history of herpes simplex virus should receive prophylactic antiviral medication for 7 days postprocedure until completely reepithelialized.⁷⁸ Herpes simplex virus infection often presents on day 2 or 3 when reepithelialization commences, with increased pain, itch, or discomfort (Fig 9). Pustules suggest bacterial or candidal infection and warrant culture and initiation of empiric therapy (Table II).

Sun protection is paramount. Physical barriers should be used until reepithelialization, at which

point a physical sunscreen can be applied. Patients should be discouraged from picking at or peeling exfoliative skin.

Complications

To prevent ocular exposure, solutions should not be passed over the eyes during the procedure, and saline eyewash bottles should be immediately available. Complications of medium depth peels include prolonged erythema, scarring, hypo- or hyperpigmentation, and infections. Common infections include *Candida albicans*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and herpes simplex virus. Prolonged erythema can be related to irritant or allergic contact dermatitis or to overpenetration.⁴⁶ Prolonged erythema may be treated with pulsed-dye or dual wavelength vascular lasers. For incipient scarring, topical or intralesional steroids may be initiated.

In conclusion, superficial and medium-depth peels can treat a variety of conditions, including dyschromia, keratinocyte dysplasia, acne, and acne scarring. Careful patient and peel selection will ensure procedural success with excellent results. For the novice peeler, starting with superficial peels on Fitzpatrick skin phototypes I and II will help the peeler gain comfort with the acids, applicator types, and techniques with minimal adverse side effects. The difference between satisfactory versus excellent results depends on the selection of the proper peeling agents and the understanding of gentle versus aggressive application technique during their use. Though artistry and the appreciation of preserving skin integrity is important, relying on the science that we have learned and are researching now is crucial to duplicating our results and preserving this art for the generations of dermatologists ahead of us.

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