Chapter 4

Chemexfoliation and Superficial Skin Resurfacing

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Core Messages

- Superficial chemical peeling produces a controlled injury to the epidermis. Downtime and complications are minimal, and it is found to be suitable for any skin type.
- Medium-depth chemical peeling induces damage to the papillary dermis, thus the preprocedure regimen is essential to avoid postpeel pigmentary alterations.
- Deep chemical peeling penetrates deeper into the dermis and consequently has a higher risk of postoperative complications and downtime in all skin types.
- The latest technology used to potentiate rapid epidermal exfoliation in all skin types is microdermabrasion, a process involving superficial abrading of the skin with fine, sharp crystals with a vacuum closed-loop suction device to remove the crystals.

Contents

4.1 Introduction

Chemical and mechanical skin resurfacing has been utilized by humans to improve the overall appearance and well-being of skin. The first chemical peels date back to the Egyptians who used sour milk baths (lactic acid), various chemicals (e.g., alabaster and salt), and sandpaper in order to attain a smoother skin surface [1]. In 1882, P.G. Unna, a German dermatologist, described the properties of salicylic acid, resorcinol, phenol, and trichloroacetic acid (TCA) and used these chemicals as peeling agents [2]. In 1976, Resnik et al. described the utility of TCA peels in various skin conditions [3]. In the late 1980s and the 1990s, α-hydroxy acids (AHAs) became available for superficial peeling agents. For nearly 20 years, a newer technique for superficial skin resurfacing, microdermabrasion, has become a key player in the arena of noninvasive anti-aging medicine. Over the last several decades, the science behind resurfacing procedures has expanded, as has the public's increasing demand for cosmetic surgery and skin rejuvenation. To date, chemical peeling and microdermabrasion are among the most common procedures performed in dermatologic offices and are an important component of our armamentarium in the management of both cosmetic and noncosmetic skin conditions.

4.2 Superficial Chemical Peeling

- Primary effects on epidermis
- Safe for any skin type
- Minimal downtime and complications

4.2.1 Scientific Background

Chemical resurfacing has a long and well-documented history [1]. Since the late 1800s, physicians have been experimenting with various procedures and techniques involving both chemical and mechanical skin resurfacing. Chemical resurfacing procedures involve the application of a caustic chemical agent to the skin, which produces a controlled, partial-thickness injury, thereby promoting the growth of new skin with improved surface characteristics. Chemical peeling is intended to produce a controlled partial-thickness injury to the skin, destroying varying amounts of epidermis and upper portions of the dermis. A wound-healing response following the injury involves (depending on the depth of injury) (1) removal of actinic keratoses (AK) and lentigines, (2) epidermal regeneration by epithelial migration from adnexal structures, (3) decrease in solar elastosis, and (4) replacement of new dermal connective tissue [4].

Chemical peels are categorized into superficial, medium-depth, and deep types of wounding (Table 4.1). In this section, the focus will be on superficial peels with a target depth penetration from the stratum corneum through to the superficial papillary dermis (0.06 mm). Superficial chemical peels are divided into two subgroups: very light and light. Examples of very light superficial chemical peels include low-potency concentrations (20–60%) of glycolic acid, alpha-hydroxy acids, 10–20% TCA, tretinoin, Jessner's solution, and salicylic acid. With very light peels, the level of injury is generally limited to the stratum corneum, which creates exfoliation without clinical vesiculation but may also penetrate into the stratum granulosum. With light superficial chemical peels, such as 70% glycolic acid, 25–30% TCA, and solid carbon dioxide (CO_2) slush, the injury is to the entire epidermis extending down to the basal cell layer or upper papillary dermis, stimulating the regeneration of a new epithelium.

4.2.2 Indications

Indications for superficial chemical peeling include fine to mild rhytids, photoaging, actinic and seborrheic keratoses, acne, dyspigmentation in the form of melasma and postinflammatory hyperpigmentation (PIH), and to improve overall textural alterations of the skin (Table 4.2). There are several different chemical

Table 4.1. Chemical peel classifications

Chemical peeling agents	Depth of penetration
Glycolic acid 20–50% Salicylic acid 20–30% Resorcinol 20–30% (5–10 min) Jessner's Solution (1–3 coats) Trichloroacetic acid 10% (1 coat) Microdermabrasion (2 passes)	Very superficial/stratum corneum exfoliation
Glycolic acid 50–70% (5–20 min) Jessner's solution (5–10 coats) Resorcinol 50% (30–60 min) Trichloroacetic acid 10–35% (1 coat)	Superficial/epidermal necrosis
Phenol 88% Glycolic Acid 70% (5–30 min) Trichloroacetic acid 35% in combination with: Glycolic acid (50–70%) Solid CO_2 Jessner's solution Pyruvic acid 40–70% Modified Baker's peel (2 drops croton oil)	Medium-depth/papillary dermal necrosis
Baker-Gordon phenol peel	Deep/reticular dermal necrosis

Table 4.2. Chemical peel indications

Peel depth	Indications	Contraindications
	Fine wrinkling, Glogau I Atrophic acne scars, minimal	Active herpes simplex infection Active eczema
Superficial	Melasma, epidermal Postinflammatory hyperpigmentation Acne vulgaris Pseudofolliculitis barbae Mottled dyschromia (ethnic skin)	Presence of tan Isotretinoin use within 1 year Skin malignancy
Medium	Mild to moderate photoaging/Glogau II and III Actinic keratoses Melasma, dermal Atrophic acne scars, moderate Pigmentary dyschromias	As above Deeply pigmented skin (Relative contraindication)
Deep	Severe photodamage, Glogau IV	As above Deeply pigmented skin Cardiac disease Renal disease Liver disease

agents classified under superficial peels, which will be discussed individually. They include glycolic acid (20–70%), salicylic acid, Jessner's solution, solid CO_2, and TCA (10–35%).

4.2.3 Patient Selection

Proper patient selection and assessment of each individual's skin condition is crucial prior to determining if a chemical resurfacing procedure is indicated. The preoperative consultation is important in identifying at-risk patients who are best avoided or who necessitate an extra-cautious approach, as well as selecting patients who are ideal candidates for the resurfacing procedure. At the time of initial consultation, the dermatologist must evaluate the patient for relative contraindications; discuss the indications of the procedure; and assess the patient's goals, expectations, anticipated results, and limitations as well as the potential risks of the procedure. It is crucial that the patient's goals and expectations are realistic prior to selecting the patient for the procedure. The patient must fully understand the potential benefits, limitations, and risks, and an informed consent must be signed prior to performing the surgical procedure.

Several different factors must be assessed to determine if the patient is an appropriate candidate for skin resurfacing. A thorough history and physical examination must be taken during the initial evaluation. The patient's skin type should be evaluated using Fitzpatrick's classification (Table 4.3) measuring pigmentary responsiveness of the skin to ultraviolet (UV) light, which is most often based on the ethnic background. Skin types I–III are ideal for peeling. Ethnic skin types IV–VI can also be peeled, but the risk of unwanted pigmentary change in the form of hypopigmentation and hyperpigmentation is greater. Regarding skin types IV–VI, it is best to limit peels to superficial and medium-depth and to avoid deep peels in order to reduce the risk for potential side effects. In addition, Glogau's classification of photoaging (Table 4.4) is helpful in assessing sun damage. Superficial peels are indicated for patients with early to moderate photodamage. Past (within the last 6 months) or present use of systemic isotretinoin must be ascertained, since retinoids are known to be associated with a greater risk of scarring after peeling [5]. Patients should be asked about prior resurfacing procedures or cosmetic procedures such as rhytidectomy, coronal brow lift, or blepharoplasty as these procedures can increase the risk of complications following medium-depth and deep resurfacing [6]. An interval of 4–12 weeks is recommended between peeling and procedures involving undermining [7]. Individuals with prior radiation exposure (e.g., history of superficial X-ray treatment for acne) should be examined carefully to evaluate for presence of vellus hairs in order to ensure that there are enough adnexal structures to promote re-epithelialization [8]. Patients, irrespective of their history of recurrent herpes simplex, should be give prophylactic acyclovir, valacyclovir, or famciclovir beginning the day of the procedure and continuing for 3–5 days postprocedure whereas previously, treatment was continued for 10–14 days [9]. Patients with active inflammation as seen in seborrheic, atopic dermatitis, irritant or allergic dermatitis, rosacea, psoriasis, or vitiligo, may be at an increases risk for postoperative complications secondary to alterations in the skin's normal barrier function. Thus, these conditions should be controlled before receiving a superficial peel [10]. Any history of abnormal scar formation, either hypertrophic scar or keloids, creates a greater risk to scar with deep as opposed to medium-depth peeling. In addition, the patient's pregnancy history and medications should be considered,

Table 4.3. Fitzpatrick classification

Skin type	Color	Skin characteristics
I	White	Always burns, never tans
II	White	Usually burns, tans less than average
III	White	Sometimes mild burn, tans about average
IV	White	Rarely burns, tans more than average
V	Brown	Rarely burns, tans profusely
VI	Black	Never burns, deeply pigmented

Table 4.4. Glogau's classification of photoaging

Glogau photoaging classification	Skin features
Type I	"No wrinkles" Early photoaging, minimal wrinkles Mild pigmentary changes, no keratoses Younger patient, 20s–30s Minimal or no makeup
Type II	"Wrinkles in motion" Early to moderate photoaging Early senile lentigines visible Keratoses palpable but not visible Parallel smile lines beginning to appear Patient age late 30s or 40s Usually wears some foundation
Type III	"Wrinkles at rest" Advanced photoaging Obvious dyschromia, telangiectasia Visible keratoses Wrinkles even when not moving Always wears heavy foundation
Type IV	"Only wrinkles" Severe photoaging Yellow-gray color of skin Prior skin malignancies Wrinkles throughout, no normal skin Patient age 60s or 70s Can't wear makeup; "cakes and cracks"

especially postmenopausal women on estrogens and women on oral contraceptives, which may sensitize the skin to the sun or produce postinflammatory splotching. Most importantly, the physician must understand the patient's philosophy regarding sun exposure, as patients are expected to avoid sun exposure and must use sunscreens postprocedure to prevent continuing sun damage. Patients infected with HIV may experience delayed healing or be at risk for secondary infection after peeling. The general health and nutritional status of the patient is also an important consideration, especially for medium-depth and deep chemical peels. Of note, superficial peels are tolerated with little risk in all patients of all skin types regardless of their general state of health.

It is worth mentioning that a postauricular test peel may be useful in select patients to assess their suitability for chemical resurfacing and may be especially helpful in identifying patients at increased risk of postoperative pigmentary dyschromias [11]. Although a favorable test post is reassuring, it does not guarantee a positive outcome following full-face resurfacing.

4.2.4 Treatment and Clinical Management

4.2.4.1 Preprocedure Rejuvenation Regimen

Several different prepeel regimens have been described in the literature. Multiple combinations exist with a few key players such as topical tretinoin, hydroquinone, alpha-hydroxyl acids, kojic acid, and low-potency steroids. It is also important to counsel patients to minimize sun exposure, utilize sun blocks with UVA/UVB protection, and to avoid smoking.

There is evidence that pretreatment with 2–4% hydroquinone twice daily and topical tretinoin (0.05% and 0.1%) or retinoic acid nightly 1 month prior to the peeling reduces dyschromias and promotes faster healing in the immediate postpeel period. The use of tretinoin prior to chemical peeling speeds epidermal healing and enhances the effects of the procedure [12]. These agents act by priming the skin. They help to achieve a more uniform penetration of peeling agents by reducing sebum and thinning the stratum corneum. They also accelerate re-epithelization, reduce wound healing time, and have a lightening effect by en-

hancing dispersion of melanin granules [13]. Hydroquinone blocks the enzyme tyrosinase from developing melanin precursors for the production of new pigment in the epidermis during the healing phase.

Another approach to patients with pigment dyschromias is to start a prepeel regimen that consists of using 4% hydroquinone twice daily 2–4 weeks prior to the peel and to resume using the 4% hydroquinone 2 days postpeel. The combination of the peel and twice-daily application of 4% hydroquinone produced substantial decreases in the intensity of hyperpigmentation and lesional area for both PIH and melasma [14]. Of note, prolonged use of high concentrations of hydroquinone (6–10%) may paradoxically produce ochronosis, especially in patients with Fitzpatrick types V and VI skin.

Combinations of hydroquinone, topical steroids, and tretinoin have also been reported for the treatment of melasma and used in combination with glycolic acid peels in darker-skinned patients [15], the best-known combination being Kligman's formula (tretinoin 0.1%, hydroquinone 5%, and dexamethasone 1% in hydrophilic ointment) used daily [16]. There are other variations of Kligman's formula, which have been adapted using lower concentrations of hydroquinone and lower potency steroids. Additional adjunct to topical therapy include AHAs, which are incorporated into many skin care maintenance regimens. The use of AHA has been shown to reverse histologic signs of photoaging by increasing epidermal thickness, reversing basal cell atypia, dispersing melanin pigmentation, and normalizing the rete pattern of the dermoepidermal junction. There are multiple combinations that can be used, such as 2% hydroquinone/10% glycolic acid gel twice daily and 0.05% tretinoin cream at night. Kojic acid is another topical agent that can be used in the preprocedure rejuvenation regimen. Kojic acid, like hydroquinone, can be combined with chemical peels to utilize its bleaching effects. It is an antibiotic produced by many fungal species such as *Aspergillus* and *Penicillium* in an aerobic process from a wide range of carbon sources [17]. Its mechanism of action is likely due to competitive inhibition of the catecholase activity of tyrosinase [18].

The combinations of prepeel rejuvenation regimens are endless. Many studies have shown that the combination of the prepeel regimens with superficial peels provides additional benefits with minimal adverse effects in patients of all skin types. Typically, the prepeel regimen is begun 2–4 weeks prior to the peel, stopped 2–3 days before the peel, and resumed postoperatively after complete re-epithelialization has occurred.

4.2.4.2 Application of the Wounding Agent

Prior to the application of all peeling solutions, cutaneous lipids, debris, and excess stratum corneum are removed by vigorously cleansing the skin with alcohol or acetone-soaked sponges [19]. Then the area is rinsed with water and dried. Prior to applying the peeling agent, the cleansed skin should be checked for the presence of residual oil and, if needed, the cleansing process repeated. The wounding agent is then applied. Depending on the agent used and the concentration, the amount of time the agent is left on the skin varies, generally between 2–4 min. Frosting with different wounding agents is variable in rate and appearance and depends on the preexisting degree of photodamage, the choice of applicator used, and the adequacy of defatting [7]. Neutralization of the agent is used with either water or sodium bicarbonate. Of note, the effect of AHAs and glycolic acid depends on the contact time on the skin and therefore must be washed off with water or neutralized with 5% sodium bicarbonate after 2–4 min. During this time, patients may experience mild stinging and burning with minimal discomfort; the patient undergoing a superficial peel does not require sedation or general anesthesia. Finally, an emollient is applied to the treated area of skin postprocedure.

The amount of peeling agent applied, the degree of rubbing, and the duration of skin contact must be carefully monitored. The effect of a chemical peel is dependent upon the chemical agent, its concentration, and the techniques employed before and during the application. Each wounding agent has individual chemical

properties and causes a specific pattern of injury to the skin. All superficial wounding agents will be discussed individually.

4.2.4.3 Postprocedure Management

All patients who undergo any type of resurfacing procedure must adhere to strict sun avoidance and sun-protective measures during the postoperative period. In addition, patients should be counseled not to smoke, as smoking impairs the healing process. Patients may resume their prepeel rejuvenation regimen only after complete re-epithelialization has occurred. Typically, the recovery time post superficial peel is minimal.

4.2.5 Adverse Effects

Superficial peels are generally well tolerated. The majority of patients will experience mild stinging and burning during the application of the wounding agent, which is an expected sensation and is not considered a procedural complication. Although the adverse reactions associated with superficial peels are much less than with the deeper peels, the risks are not negligible.

Pigmentary changes in the form of both hypopigmentation and hyperpigmentation are possible complications. The risk of hyperpigmentation is greater in patients with darker skin types. Typically, hypopigmentation resolves with in several months after the peel. Hyperpigmentation can be treated effectively with hydroquinone regimens.

Prolonged erythema, milia, pustulocystic acne, reactivation of latent herpes simplex infection, and superficial bacterial infection are all potential complications postpeel [20]. The incidence with superficial peels is significantly less than with deeper peels although not negligible. Patients with a history of herpes should be treated prophylactically with acyclovir, valacyclovir, or famciclovir beginning on the day of the peel and complete a course of 10–14 days at therapeutic doses. Prolonged erythema may be treated with a low-dose topical steroid such as hydrocortisone or with desonide 0.05% lotion twice daily for 2–3 days. Milia or acne that occurs after the peel may be aggravated by thick ointments applied to the treated area. An irritant reaction due to pooling of the acid in the skin creases (e.g., oral commissures, lateral and medial canthi) are best avoided by applying petrolatum ointment prior to beginning the procedure.

The risk of hypertrophic scarring is less than 1% with superficial peels [7]. The rate of scaring may be increased with a history of recent isotretinoin use or poor patient selection. If hypertrophic scaring does occur, treatments include dilute triamcinolone injections into the scar, topical or tape-impregnated glucocorticoids, silicone gel sheeting, or the 585-nm flashlamp-pumped pulse dye laser [21].

4.2.6 Outcome

Patients who complete a series of treatments with superficial chemical peels experience regeneration of new skin and improvement in their overall complexion and appearance. Of note, the effects on photoaging are very subtle, since superficial peels do not reach the dermis. The benefits to superficial chemical peels are that there are minimal risks as well as no downtime postprocedure. Also, superficial peels, especially glycolic acid and salicylic acid, are well tolerated in patients with darker complexions with minimal side effects since these peels only affect the epidermis and do not penetrate into the dermis.

4.2.7 Ethnic Skin Considerations

When considering using chemical peels in ethnic skin, it is critical to identify the patient's Fitzpatrick skin type as well as determine the patient's ethnicity prior to selecting the peeling agent. Indications for chemical peeling in darker skin include acne vulgaris, PIH, melasma, scarring, photodamage, and pseudofolliculitis barbae. However, the primary indication for chemical peeling in skin types III–VI is for pigmentation dyschromias.

As a dermatologist treating ethnic/darker skinned patients, it is important to understand the different properties of the superficial chemical peeling agents in order to choose the most appropriate agent to address the patient's dermatological needs. For example, glycolic acid and salicylic acid peels are excellent tools to treat acne in skin of color. In addition, salicylic acid in ethanol solutions is a great peeling agent for dark-skinned patients with melasma and PIH whereas glycolic acid is a less favorable agent to treat melasma and PIH because it may induce PIH in skin types V and VI. Trichloroacetic acid at low concentrations of 10–25% works well to treat acne scarring in skin of color, and when used in combination with 70% glycolic gel, it also rejuvenates uneven mottled facial pigmentation. Jessner's solution may create depigmentation in patients with skin types V and VI but may be successful in spot-peeling for PIH in ethnic skin. In addition, TCA 25% and salicylic acid are important tools for spot-peeling for PIH.

Regarding the treatment of melasma with superficial peeling agents, Asian and Asian Americans respond well to serial glycolic peels maintained at the same concentration. Africans and darker African Americans (skin types V and VI) have better results with salicylic acid peels because the risk for PIH is higher with glycolic acid peels. Finally, serial glycolic acid peels and salicylic acid peels have been successful in improving the skin texture in patients with pseudofolliculitis barbae [22].

No matter which superficial agent is chosen in ethnic/dark skin, it is critical to start a prepeel regimen that includes the morning application of sunscreen with UVA/UVB SPF 30 and a moisturizer containing alpha-hydroxy acid as well as an evening combination including retinoid, hydroquinone, kojic acid, or azelaic acid and possibly at low-potency steroid. The duration of this pre- and postpeel regimen is similar in all skin types.

4.3 Glycolic Acid Peels

Glycolic acid is an AHA, which belongs to a class of naturally occurring compounds derived from food sources such as sugar cane [23]. Glycolic acid peels range in concentration from 20–70% glycolic acid. This type of peel is generally performed every 3–4 weeks for a total of four to six treatments. Glycolic acid peels are indicated in the treatment of melasma, postinflammatory hyperpigmentation, mild photoaging (Glogau I and II), and acne. Glycolic acid peels are generally well tolerated by all skin types I–VI. Several studies have shown that up to 70% glycolic acid is well tolerated with minimal adverse effects and has shown improvement in melasma and postinflammatory hyperpigmentation [24, 25]. Glycolic acid peels may be used as monotherapy, combined with a topical preprocedure rejuvenation regimen consisting of tretinoin and hydroquinone, or even combined with 5-fluorouracil (5-FU) known as the fluor-hydroxy pulse peel for the treatment of actinic keratosis with an improved overall cosmesis [26].

Glycolic acid has been shown to cause discohesion of keratinocytes at low concentrations of 20–40% and causes epidermolysis at higher concentrations 50–70% [27]. Very low concentrations of glycolic acid peels cause an injury limited to the stratum corneum and only creates exfoliation, but the injury may extend into the stratum granulosum. The higher potency glycolic acid formulations injure the entire epidermis down to the basal layer. In contrast to beta-hydroxy acid (e.g., salicylic acid), AHAs are lipophobic in nature. A previous study by Moy et al. demonstrated that glycolic acid has a stimulatory effect on collagen production in fibroblasts. This increased collagen stimulation in normal dermal fibroblasts may account for the production of a new zone of collagen in the upper dermis that would replace the elastotic deposits that form from photodamage [28]. This proposed mechanism may account for the decrease in fine wrinkling, leading to improvement of fine rhytids.

The major factors that determine whether glycolic acid peels result in desquamation or epidermolysis are the concentration of the acid, the pH, the degree of buffering or neutralization with sodium bicarbonate, the vehicle formulation, the frequency of application, the conditions of delivery, the amount of acid delivered

to the skin over a given period, and most importantly, the length of time that the acid remains on the skin [7]. Prior to the application of the wounding agent, the face must be cleansed to remove any preexisting debris and cutaneous lipids with alcohol or acetone-soaked sponges. Then the agent is applied in any cosmetic unit order, covering the face within 20 s (forehead, cheeks, chin, nose, and upper lip) with large cotton swabs, sable brush, or 2″ × 2″ gauze pads. The time of application is critical for glycolic acid as it must be rinsed off with water or neutralized with 5% sodium bicarbonate 2–4 min after application.

Postprocedure regimen should include the use of sunscreen, avoidance of excessive sun exposure, and the daily application of a moisturizer. The advantage of this superficial peeling agent is that it only causes mild irritancy, and minimal time is needed for recovery. Patients may return to their normal level of daily activities and can wear makeup to conceal erythema. Complications with glycolic peels are very rare.

Treatment of AK with a superficial peel is best approached by combing 5-FU and glycolic acid. A study conducted by Marrero and Katz found that the use of the fluor-hydroxy pulse peel applied in a pulse dose regimen not only provides cosmetic improvement but, more importantly, has a therapeutic effect on ablating premalignant AKs [26]. The ability of AHAs to eradicate AKs is variable and depends on peel depth [29]. 5-FU is an antimetabolite that inhibits DNA and RNA synthesis and destroys hyperproliferative AKs [30]. A major limitation in the use of daily 5-FU topical regimen is severe erythema, local irritation, and discomfort associated with the treatment period of 4–8 weeks [31]. However, it has been shown that weekly pulse dosing of 5-FU is equally efficacious at treating facial AKs as the conventional treatment regimen without the severe side effects [32]. Therefore, the study conducted by Marrero and Katz [26] hypothesized that the use of 5-FU with AHAs (glycolic acid) would work synergistically to improve cosmesis as well as treat AKs. This study found there was a dramatic reduction in the number of AKs, which was sustained at 6 months follow-up after the fluor-hydroxy pulse peel side of the face, with 92% reduction in AKs versus 20% for the glycolic acid side alone. In addition, there was also a significant cosmetic benefit to the combination peel.

4.4 Salicylic Acid Peels

Salicylic acid (SA) is a beta-hydroxy acid. Salicylic acid is a naturally occurring substance found in the bark of the willow tree. Salicylic acid peels range in concentration from 20–30%, and peels are performed every 3–4 weeks for a total of three to five treatments. Salicylic acid peels are indicated in the treatment of acne vulgaris, melasma, postinflammatory hyperpigmentation (Figs. 4.1, 4.2, 4.3, 4.4), rough/oily skin with enlarged pores, and mild to moderate photodamaged skin (Table 4.2). Salicylic acid peels are safe and efficacious in skin types I–VI [14].

Salicylic acid has been formulated in a hydroethanolic vehicle at concentrations of 20%

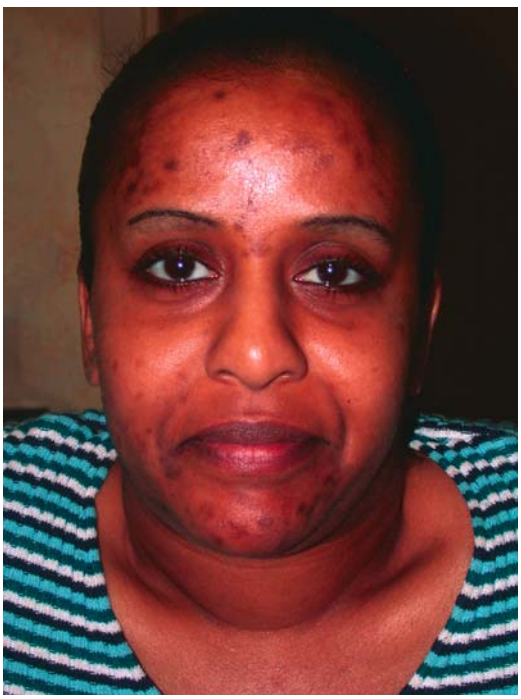
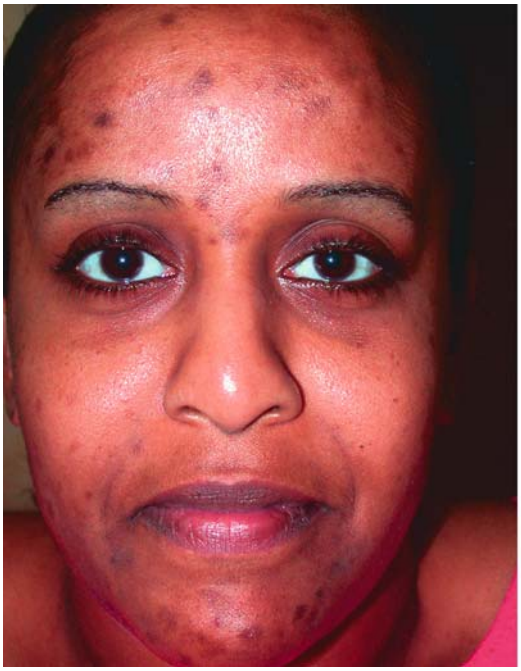


Fig. 4.1. Baseline postinflammatory hyperpigmentation



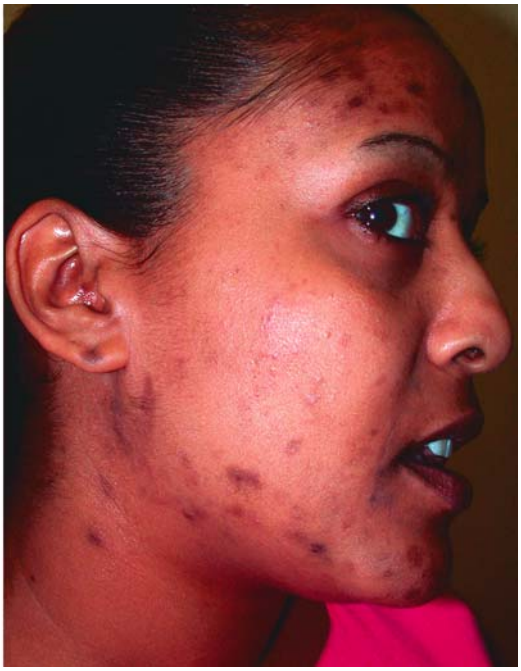


Fig. 4.2. Status post third salicylic acid peel

Fig. 4.3. Status post sixth salicylic acid peel

and 30% for use as a superficial peeling agent [33]. It is a lipophilic agent, which produces desquamation of the upper lipophilic layers of the stratum corneum [14]. Its efficacy for the treatment of acne and photoaging has been well documented in the Fitzpatrick skin types I–III [33, 10] as well as in patients with Fitzpatrick skin types V and VI [14]. Salicylic acid peels are the preferred therapy for comedonal acne as it is lipophilic and concentrates in the pilosebaceous apparatus. It is effective as adjunctive treatment for open and closed comedones and at resolving postacne erythema and hyperpigmentation [34]. Because it is a lipid-soluble comedolytic, salicylic acid acts by decreasing corneocyte cohesion at the follicular opening and assists in comedone plug extrusion [35, 36]. In addition, the salicylic acid peel can be combined with hydroquinone 4% (pre- and postprocedure) to expedite the clearing of hyperpigmented lesions and significantly decrease the occurrence of postpeel hyperpigmentation seen more commonly in skin types V and VI [14].

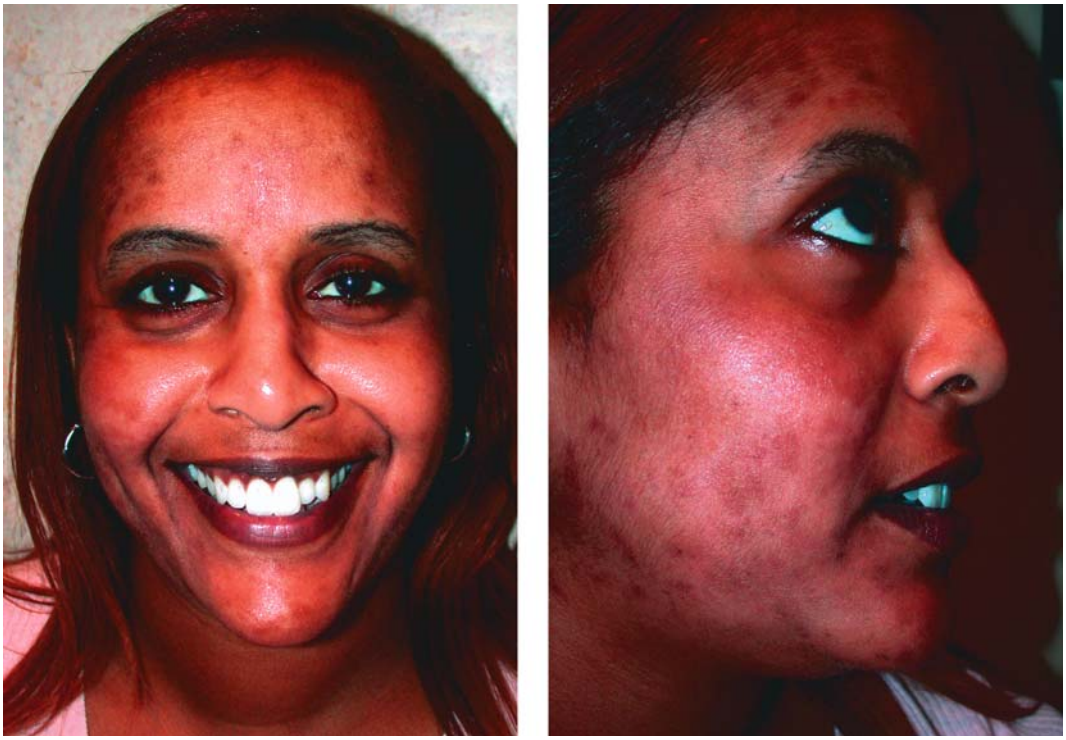


Fig. 4.4. Status post eight salicylic acid peel

As with all superficial peeling agents, prior to applying the wounding agent, the face is cleansed with alcohol- or acetone-soaked sponges. Then the salicylic acid agent (20% or 30% in a hydroethanolic solution) is applied to the face. Patients experience stinging and burning with an intensity that is greater than that of 70% glycolic acid, but this ceases rapidly. The SA peel causes a superficial anesthesia so patients can be reassured that the stinging and burning will cease within a couple of minutes [10]. The agent should be applied to cosmetic units of the face in any order. Uniformity of application is easily observed as a white precipitate of salicylic acid is seen in the areas where the agent has been applied. The agent is applied to the face for 3–4 min. Then the face is washed with water or a mild cleanser. Of note, once the hydroethanolic vehicle has volatilized leaving a white precipitate of salicylic acid on the surface of the skin, there is very little penetration of the active agent. Thus, there is no concern regarding timing or overpeeling.

The majority of patients tolerate this procedure without side effects. Side effects, which are seen, include transient dryness and hyperpigmentation, which resolve within 1–2 weeks; and temporary superficial crusting (Fig. 4.5) and edema, which clear in about 7 days. Salicylism has not been seen as a side effect postpeel since the total amount of SA applied is very small and the majority of the solution is removed once the solution has volatized. In addition, Kligman tested serum levels of subjects after peeling, and the concentrations were far below levels of salicylate toxicity and were below anti-inflammatory levels [10]. Of note, more peeling is seen in areas of prepeel inflammation, e.g., inflammatory acne or seborrheic dermatitis. Peeling usually begins 2 days postpeel and can extend for up to 7 days postpeel. This agent causes significantly more desquamation than glycolic acid peels [10]. The efficacy of salicylic acid peels is directly correlated to the degree of desquamation that is seen postpeel. Postprocedure regimen should include the use of sunscreen,

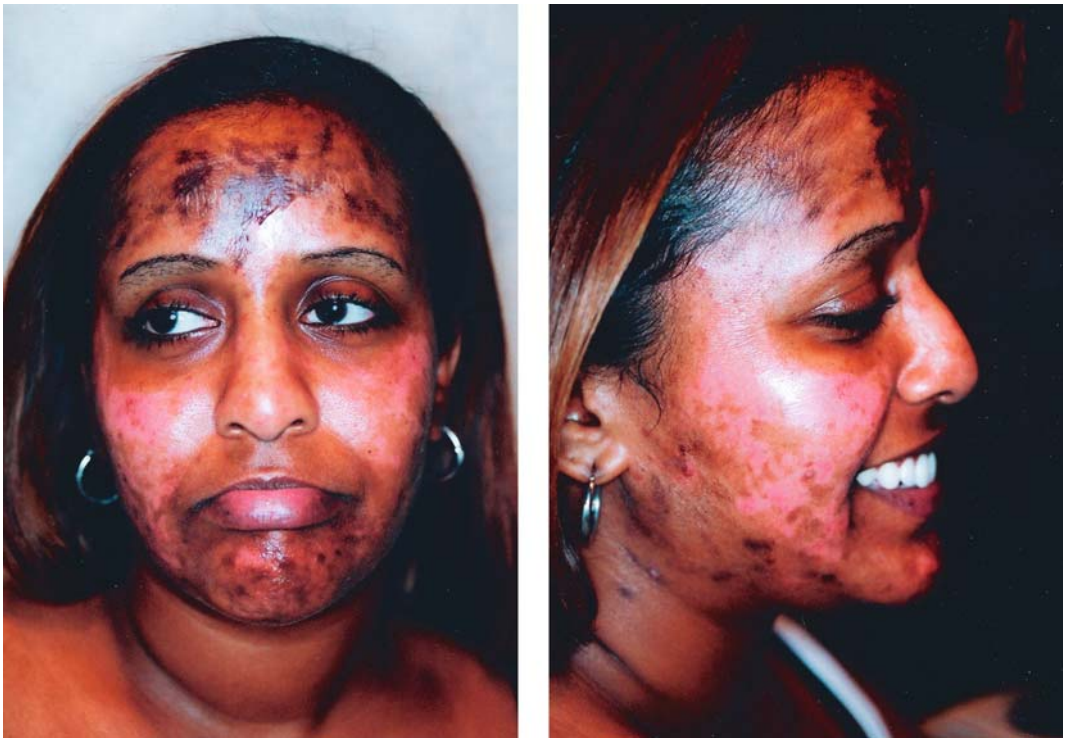


Fig. 4.5. Postoperative day 3 salicylic acid peel with epidermal necrosis

avoidance of excessive sun exposure, and the daily application of a moisturizer.

4.5 Jessner's Peel

Jessner's peel is a solution that combines resorcinol (14 g), salicylic acid (14 g), 85% lactic acid (14 g), and 95% ethanol (q.s.a.d. 100 ml). Jessner's peels are indicated in the treatment of inflammatory and comedonal acne and melasma as well as hyperkeratotic skin disorders. Jessner's solution was formulated to lower the concentration and toxicity of any one agent and to enhance the keratolytic effects. Jessner's solution has intense keratolytic activity, initially causing loss of corneocyte cohesion within the stratum corneum and subsequently creating intercellular and intracellular edema within the upper epidermis if application is continued [37].

Prior to applying the wounding agent, the skin should be degreased with alcohol or acetone. Then Jessner's solution is applied to the skin with 2"×2" gauze or a sable brush, which produces erythema and a very light frost within 15–45 s. The clinical endpoint of treatment is the erythema and blotchy frosting. The depth of penetration of the peeling agent is related to the number of coats applied. The advantages of Jessner's solution are that only a single solution is needed, timing the duration of application is unnecessary, and dilution or "neutralization" is not performed [7]. Jessner's peel can also be combined with 5-FU delivered in a weekly pulse dose regimen, also known as the fluor-hydroxy pulse peel, to treat AKs with an associated improvement in cosmesis. This study showed an 88.14% clearing of AKs [29]. Both studies combining Jessner's solution or glycolic acid with 5-FU showed synergism for the treatment of AKs, with no significant difference between the use of either Jessner's or glycolic acid as adjuvant therapy.

4.6 Trichloroacetic Acid 10–30%

TCA produces superficial peeling when used in strengths from 10% to 30% [38]. At these strengths, TCA is indicated for the treatment of fine rhytids, actinic damage, mild epidermal dyschromia, reduction of superficial keratoses, scars, and comedone formation. Treatment intervals between applications of this superficial chemical peeling agent are generally within 7–28 days [7]. As a general rule, repeating the application before the erythema has faded from the previous treatment may enhance penetration of the successive application and produce deeper wounding [39].

TCA precipitates epidermal proteins and causes necrosis and exfoliation of normal and actinically damaged cells. TCA is nontoxic systemically and is neutralized by serum in superficial dermal blood vessels [19]. Partial epidermal exfoliation occurs with 20% TCA; therefore, a series of peels may be necessary in order to optimize the rejuvenating effects of papillary dermal remodeling [40].

Prior to starting the peel, the face is cleansed/degreased with alcohol- or acetone-soaked sponges. Then the TCA agent (10–30%) is applied to the face with short, gentle strokes using only light pressure. Proceeding clockwise or counterclockwise is according to preference, but returning to an already painted area must occur before 2 min have passed to allow the acid to be neutralized before more solution is applied. One or two applications of TCA solution to the entire face produce a transient frost and mild erythema. The depth of penetration of the peeling solution is related to the number of coats applied. Protein precipitation results and leads to exfoliation without vesiculation. TCA is self-neutralizing and does not require water or bicarbonate to terminate the action of peeling. Patients experience a temporary burning and stinging sensations that can be relieved with cool compresses and cool air blown over the skin by an electric fan [41]. Superficial TCA peels are well tolerated by most patients and thus do not require sedation. Of note, topical anesthetics should be avoided because they can increase peel depth by increasing stratum corneum hydration [42]. In the subsequent 24–48 h, the skin turns brown, which is followed by exfoliation by the third to fifth day. Complete re-epithelialization takes place within a week to 10 days. Depending on the desired affects, the patient may undergo a second treatment within a week or two [43].

Postprocedure regimen should include the use of sunscreen, avoidance of excessive sun exposure, and the daily application of a moisturizer. Once the skin is re-epithelialization (postoperative days 7–10), the patient may resume their pre-rejuvenation regimen (such as AHA-containing moisturizers once a day, topical hydroquinone preparations, and tretinoin therapy nightly).

Complications from superficial peeling agents are usually minor and reversible, including transient hyperpigmentation, prolonged erythema (<3 months), colloid milia, acne flares, reactivation of latent facial herpes simplex virus (HSV) infection, and superficial bacterial infection [44]. Scarring in the absence of supervening infection is highly unlikely [43].

One common problem for the physician is discerning the degree of evenness of the application of 10–30% TCA because the frost produced is minimal and transient. To avoid skip areas and to ensure an even application of acid, some manufacturers add sodium fluorescein to the solutions, rendering the preparation visible under a Wood's lamp. This technique helps to detect skip areas and avoids overcoating [45]. Another TCA peel modification is Obagi "blue peel," which contains a nonionic blue color base with glycerin and saponins, which slows the penetration and release of TCA in the skin by reducing the surface tension of the TCA, water, and glycerin. This results in a homogeneous TCA-oil-water solution and provides a gauge to the depth of the peel [46]. A light blue end point signifies exfoliation to the papillary dermis while a medium/dark-blue endpoint denotes coagulation to the immediate upper reticular dermis. The lighter procedure results in skin tightening whereas the deeper procedure results in skin leveling. The minimal recommended waiting period before repeating a blue peel is 6–8 weeks, and two to three blue peels may be required for maximum benefit [42].

4.7 Solid Carbon Dioxide

Solid CO_2 (dry ice)/solid CO_2 slush is used for superficial peeling. Solid CO_2 is actually a physical modality for peeling and not a true chemical peeling agent. The dry ice is wrapped in a small hand towel and dipped, as needed, in a solution of approximately 3:1 acetone and alcohol, which serves to facilitate application to the skin [7]. CO_2 ice causes mechanical injury to the epidermis, which results in microvesiculation and disruption of the stratum corneum barrier. It may be used alone (superficial peel) or to amplify TCA as a medium-depth peel [19].

4.8 Medium-Depth Chemical Peeling

- Primary effects on papillary dermis
- Combination peels safer than higher concentration TCA
- Prepeel rejuvenation program mandatory, especially in darker skin types

Medium-depth peels by definition are chemical peeling agents used to exert a controlled injury extending to the papillary dermis [47]. The prototypical medium-depth peeling agent, 50% TCA, has fallen into relative disuse because of its high risk of complications. Scarring and postpeel dyschromias are possible sequelae of higher concentrations of TCA due to an unpredictable pattern of absorption and resultant "hot spots". Many clinicians have abandoned the higher level TCA peels for combination peels using 35% TCA with Jessner's solution, 70% glycolic acid, or solid CO_2 [47]. Although comparative data is not yet available, pyruvic acid is a new addition to the medium-depth chemical peel armamentarium showing many of the same clinical benefits as the traditional medium-depth peeling agents [48]. The combination peels can achieve the same depth of penetration as the solitary 50% TCA but without the associated risks.

4.8.1 Scientific Background

TCA has long since been considered the gold standard of chemical peeling agents. It is a stable agent (shelf life greater than 6 months) that is not light sensitive and requires no refrigeration. TCA crystals are naturally occurring and are mixed with distilled water to form a solution concentration measured by a ratio of weight to volume [49]. By priming the skin with 70% glycolic acid, Jessner's solution, or solid CO_2, the cosmetic surgeon can allow for penetration of a lower and safer concentration of TCA (35%) that is deeper and more evenly distributed. The end result is more uniform peeling with fewer complications. Glycolic acid at a concentration of 70% melts away the epidermal barrier by breaking up the individual keratinocytes. Jessner's solution is composed of 14% lactic acid/14% resorcinol/14 g salicylic acid in 100 ml of ethanol. When applied, this solution destroys the epidermis in a manner similar to that of 70% glycolic acid. Solid CO_2 with acetone, however, creates epidermal necrosis, again enhancing the penetration of the subsequently applied 35% TCA. Following the chemical peel, the process of wound healing is responsible for the smoothening and tightening effect on the skin.

In the immediate postprocedure phase, inflammation and coagulation are present. The inflammatory cells promote bacterial killing, granulation tissue production, and probable fibroblast growth. Within 1 day postpeel, keratinocytes have already begun to migrate from the adnexal epithelia across a fibronectin matrix. In the 10–14 days that follow, re-epithelization is completed, as evidenced by the clinical appearance of an erythematous fresh epidermal layer. Collagen remodeling ensues, a process that may take 3–4 months after a medium-depth chemical peel [47]. Histologic studies taken 3 months following a medium-depth peel demonstrate an increased grenz zone, parallel aggregates of new collagen, mucin deposition, and activated fibroblast [50]. Decreased intracytoplasmic vacuoles and spongiosis have also been seen ultrastructurally [51].

Other less popular chemicals used to achieve a medium-depth peel include pyruvic acid, and a modified Baker-Gordon peel using only one or two drops of croton oil [52]. Pyruvic acid at concentrations of 40–70% is a potent peeling agent. It physiologically converts to lactic acid, and with a pKa of 2.39, this small molecule penetrates down to the upper papillary dermis [48]. Use of this agent has lead to increased production of collagen, elastin, and glycoproteins [26]. The depth of penetration of a phenol peel, as a photocoagulant, has an inverse relationship with its concentration. A phenol peel at 88% causes a barrier to be formed by precipitated epidermal proteins, which subsequently protects against deep dermal penetration [45]. At 50%, phenol is a potent keratolytic responsible for deep dermal injury. Additionally, fewer drops of the vesicant croton oil limit the penetration by decreasing the epidermolytic or drying effect.

Obagi et al. emphasize the blue peel, which uses concentrations of 15% and 20% TCA and can be used to achieve a medium-peel depth if a higher volume is used [42]. This suggests that the previous classification of peel depth cannot be determined merely by TCA concentration. One coat of a 15% TCA blue peel is said to exfoliate the stratum corneum while four coats of the same agent can peel down to the papillary dermis. This color-coded peel employs all of the properties of traditional TCA with the addition of an FDA-approved blue dye that allows even the inexperienced physician to accomplish uniform application of the peeling agent. The end points for the blue peel can be gauged by the appearance of the skin following its application. Epidermal penetration (exfoliation) is characterized by an even blue appearance without evidence of a sustained frost. The physician assumes that the papillary dermis has been reached when a frost, described as a "thin, organized, transparent sheet," becomes visible, with the evidence of the color pink in the background ("the pink sign"). Penetration to the immediate reticular dermis is confirmed when the pink background to the frost lessens or disappears completely, giving way to a solid white sheet. This is the maximum depth recommend for the blue peel on facial skin [42].

4.8.2 Indications

Medium-depth chemical peels are best suited for the treatment of superficial epidermal lesions, lentigines, actinic keratosis, pigmentary dyschromias, textural irregularities due to acne scarring, and mild to moderate rhytids associated with photoaging [49]. This level chemical peel is also used as an adjunct to laser resurfacing or deep chemical peels, to blend the lines of demarcation between treated and untreated skin. In patients with more significant periorbital and perioral rhytids, the deeper penetration of laser may be indicated for improvement, but medium-depth peels may be sufficient for the intervening areas of facial skin [53, 54, 55]. Moderate inflammatory acne, acne scarring, AK, warts, and facial skin aging are among the conditions treated successfully by the pyruvic acid peel [48]. Chun et al. utilized the focal application of TCA at concentrations of 10–65% to safely remove or improve benign pigmented lesions, including seborrheic keratoses, lentigines, freckles, and melasma in dark-skinned patients [56]. By combining these therapeutic options, the patient's healing time and risk of posttreatment morbidity are both reduced [49].

4.8.3 Patient Selection

The key to high patient satisfaction and low postoperative complications is appropriate patient selection. Patients with mild to moderate facial rhytids and minimal pigmentary disturbances achieve the best outcomes with medium-depth peels [52]. The Glogau classification system for photoaged skin can be quite useful when deciding the appropriate peel type and depth for a particular patient (Table 4.3). Mild atrophic acne scarring and diffuse AK have been consistently improved with peels of this depth, as well. Traditionally avoided in darker skin types, medium-depth chemical peels are now being safely and successfully performed in these patients with some pre- and posttreatment precautions. Although these agents are applied safely to isolated lesions, full-face, medium-depth chemical peels are still, however,

best avoided in very dark skin types (Fitzpatrick VI) because of the possibility of postpeel hyper- or hypopigmentation.

4.8.4 Treatment and Clinical Management

4.8.4.1 Preprocedure Rejuvenation Regimen

Retinoic acid, hydroquinone, glycolic acid, or lactic acid and sunscreens are among the products used in the pre- and posttreatment phase of medium-depth chemical peels. Their effects on corneocyte adhesion, the stratum corneum and melanin production help ensure even absorption of the peel and reduce postoperative hyperpigmentation. In addition, the use of oral prophylaxis for herpes simplex before the peel and throughout the period of re-epithelialization has become the standard, even in patients without a known history of herpetic infection. Although some degree of variation in clinical management between cosmetic surgeons exists, the basic treatment protocol is similar. Patients are instructed to avoid excessive sun exposure and wear sunscreen 3 or more months in advance of their first peel. Retinoic acid 0.5–1.0% and hydroquinone 2–8% are usually applied daily to the area to be peeled starting from 2 to 12 weeks prior to the procedure. As a keratolytic agent, retinoic acid thins the stratum corneum, increasing the depth of the peel and allowing for more uniform absorption. As mentioned earlier, retinoic acid also speeds epidermal healing and independently has a pronounced effect on collagenesis [49]. Because hydroquinone interferes with tyrosinase, the enzyme responsible for the conversion of tyrosine to L-dopa (a melanin precursor) [52], the end result is stabilizing melanin production. The end effect is limiting the amount of postinflammation pigment from the chemical peel's dermal inflammatory reaction. This is particularly important in darker skin types (Fitzpatrick III and higher) but also in lighter skin with dyschromia.

The day of the peel, most patients are advised to start antiviral prophylaxis (some are instructed to start 2 days before the peel) and continue for 7–10 days. In some cases, the patient is also given a prescription for an antibiotic (i.e., Cephalexin) and advised to start taking whole-food supplements [52]. Patients are to avoid any procedure that may alter the penetration of the peeling agent, such as waxing, microdermabrasion, electrolysis, or laser hair removal, for 2 weeks prior to the peel. The wait following isotretinoin therapy can be anywhere from 12 to 24 months.

4.8.4.2 Application of the Wounding Agent

Before application of the peeling agent, patients are usually given a short, active sedative (i.e., Valium 5–10 mg) and a mild analgesia (meperidine and hydroxyzine hydrochloride). Frequently, aspirin is given before the peel and continued throughout the first 24 h, not only to relieve pain, but also to combat swelling. The area to be peeled is cleansed vigorously with an antiseptic cleanser using a 4 by 4 gauze pad, and residual facial oil is removed with acetone. The peeling agent is then applied with either cotton-tipped applicators or 2-inch by 2-inch gauze, usually with one or two coats to achieve a light frosting in the case of Jessner's solution [49]. Once frosting is achieved, the Jessner's solution is no longer active.

Upon complete drying, the skin is now ready for the 35% TCA peel. The depth of penetration can be influenced at this stage by the method of application. Using large cotton-tipped applicators allows for more solution application and, therefore, absorption. Repeat rubbing with 4-inch by 4-inch gauze or the application of multiple layers are two techniques for enhancing penetration. TCA is typically applied to one cosmetic unit, allowed to reach an end point, diluted with cool saline compresses, then applied to the next cosmetic unit. The activity of TCA ceases upon complete frosting, which is noticeable at 30 s to 2 min. The sequence of application is typically from forehead, to temple, to cheeks, and lastly to lips and eyelids [49]. Judicious placement of the peeling agent to eyelids and lips in imperative, and having an assistant to

protect the ocular canthi and stretch the skin over the lip along the vermillion is essential. The end point for medium-depth peels can be selected based on the level of actinic damage or lesion type being treated. Frosting represents keratocoagulation and may take several different forms as defined by Rubin (see below). It can serve as a guide, indicating areas not adequately covered, but it is advised that 3–4 min should pass before a second coating or "touch-up" of TCA is applied to an area of uneven frosting [49]. Many still rely on the level of frosting to estimate the depth of penetration attained although this measure is thought by others to be unreliable and not supported scientifically [57]. Rubin's level 0 frosting is described as pink or erythematous skin. During level 1 frosting, the skin is still pink, but white speckles have begun to appear. Level 2 frosting refers to skin that is frosted but with background pink skin intervening. Level 3 frosting is defined by opaque, solid-white skin that appears blanched and is thought to represent a depth of penetration in the reticular dermis [58]. This level of frosting is usually avoided, except in fair skin where blending of the upper neck may be desired [59].

Most people experience an intense burning during the peeling process, but this sensation subsides as the frosting is completed. [49] In a split-face study comparing the usefulness of topical anesthetic agents EMLA versus ELAMAX cream applied after 70% glycolic acid but before the application of 35% TCA, Koppel and colleagues demonstrated a significant reduction in pain between the anesthetized areas and the control side (unanesthetized). There was no difference, however, between the two types of topical anesthesia used or in the histology of the sides treated and untreated with anesthetic cream [60]. The activity of the TCA peel is completed once the frosting has occurred, but persistent mild discomfort is not unusual [61]. Cool saline compresses can offer relief, as well as aspirin or other nonsteroidal anti-inflammatory agents in the immediate postoperative period

Similar steps are taken in the case of glycolic acid pretreatment, except in the case of glycolic acid peels there is no associated frosting to indicate reaction cessation. Glycolic acid peels need to be timed, and with longer duration of peel contact and higher concentration of glycolic acid, the operator can adjust the intensity of effect. Cook et al. reported the findings of high patient satisfaction and low rate of complications in a series of 3,100 patients treated with a combination of 70% glycolic acid gel with 40% TCA used on facial and nonfacial skin to treat photodamage, striae, and pigmentary abnormalities [59]. These clinicians used 70% glycolic acid gel instead of liquid to act as a partial barrier to the TCA solution, which was applied immediately after. The end point of this technique was a Rubin's level I or II frosting, and the peeling agents were neutralized with 10% sodium bicarbonate solution [58]. Cook et al. coined the term "total body peel" for this type of peel, not because the peel is applied to the entire body, but because it can be used on most parts of the body. Accordingly, their most impressive results were seen on the hand, neck, and chest of patients with actinic damage.

4.8.4.3 Postpeel Management

Similar to superficial peels, the postpeel regimen is geared toward maximizing the benefit and minimizing adverse effects. Postoperative day one, the patient is instructed to soak with 0.25% acetic acid solution four to five times a day and apply a bland emollient (petrolatum based) until re-epithelialization has occurred. After 24 h, a mild, nondetergent cleanser can be used on the face. At this point, the brawny desquamation that replaced the frosting is more visible and sloughs over the next 5–10 days, leaving behind bright erythema characteristic of new skin formation. The process of re-epithelialization is generally complete 10 days out, at which point the patient may discontinue the antiviral prophylaxis and begin to wear makeup, if desired. Again, many physicians counsel patients to avoid smoking in the postoperative period fearing that tobacco use may lessen the peel effect and increase risks [47]. Sun exposure should be avoided for 6 weeks postprocedure to reduce the risk of dyschromia and limited thereafter to minimize the recurrence of photodamage.

8.5 Adverse Effects

Complications and risks of medium-depth peel are fewer with the advent of the combination peel, but they still exist. The most common complication following a TCA peel is hyperpigmentation, and the most common factor responsible is early sun exposure [52]. Patients are routinely instructed to avoid significant sun exposure in the weeks leading up to and following a medium-depth peel. A sunscreen with a UVA/UVB block is to be worn faithfully, and some doctors recommend their patients abstain from oral contraceptives (2 months before and after peeling) because their use may incite pigmentary changes [52, 44]. Pretreatment with retinoic acid and hydroquinone can reduce the risk of postoperative hyperpigmentation, but those with darker skin types and or those being treated for pigment problems are at even greater risks. If it arises, postpeel hyperpigmentation can be managed with retinoic acid, hydroquinone products, midpotency topical steroids, and follow-up peels (approximately 3–6 months later) until a lightening effect is achieved [44, 52]. Postpeel hypopigmentation is less frequently a problem, but its treatment options are few and less reliable. Although previously thought only to be a complication of deep peels, hypopigmentation has been reported following blanching with 20% TCA and 35% TCA chemical peels [44]. In darker skin types, this potentially permanent side effect can be devastating.

Hypertrophic scarring is a rare but is a disastrous complication of TCA peels. Those at increase risk include patients who have undergone facial plastic surgery, including a rhytidectomy, blepharoplasty, and deep-plane face lift in close proximity to peeling. Resnik et al. recommend a 6-month waiting period after these procedures before attempting a dermal peel. Additionally, patients who have taken isotretinoin should wait a minimum of 1 year before having a medium-depth peel although many clinicians prefer to wait 18–24 months [44]. Obagi et al., however, conducted a large controlled study and reported that hypertrophic scarring did not result from past, current, or postoperative use of isotretinoin as long as the peel depth did not extend beyond the papillary dermis [62]. Misplacement of the chemical and the depth of penetration in excess of the operator's expectation are features of peeling that might be avoidable. Special care in not allowing the agent to drip or be drawn into unwanted areas is of critical importance. Maintaining a container with water and 10% sodium bicarbonate close at hand to neutralize glycolic acid and TCA, respectively, can tighten the control one has over how long and where the agent contacts the skin. Conditions that predispose to delayed healing may also be responsible for the development of hypertrophic scarring in certain patients. Chronic medical illnesses, prior radiation, chemical or thermal burns, and medication known to delay wound healing may all play a role in predisposing to scarring. The areas most vulnerable to this disfiguring effect are the jaw line, skin overlying the zygomatic arch, and the perioral perimeter. Treatment options include massage, compression bandages, topical/intralesional steroids, and silicone gel sheeting [44, 63, 64].

Herpes simplex infection reactivation is a risk of any skin-resurfacing procedure. Because the consequences of a herpes outbreak following a medium-depth peel can be diffuse facial dissemination and scarring, patients are routinely prophylaxed with antiviral medication. The regimen may include any of the accepted oral antiherpetic medications beginning from 2 days before the peel (or started on the day of) and continued until re-epithelialization is complete (postoperative days 7–10). If an acute infection erupts in spite of prophylaxis, the medication is usually continued but at a higher dose. With early intervention, scarring is frequently avoided [52]. The risk of bacterial infection is reduced by the frequent acetic acid soaks (1 tablespoon of white vinegar/1 pint of water) recommended following the peel, which is not only antimicrobial against pseudomonas and other gram-negative organisms but acts as a debridement. Candidal infection may result from prophylactic antibiotics [47].

Less serious but more common side effects reported include milia, acne flares, and cyst formation [47] and keratoacanthomas [62] following chemical peeling. The use of occlusive oint-

ments following the peeling process has been implicated as a possible cause. Bland emollients are a necessity in order to protect the newly laid epithelium and promote would healing. Persistent erythema beyond the accepted 60 days may indicate an incipient scar, contact dermatitis, or infection, and warrants careful proactive management in most cases [47].

4.8.6 Outcome

In most cases of actinic damage, the medium-depth peel has been effective, as evidenced by a diminution of AK and lessening of fine lines and wrinkles. Tse et al. accepted the challenge of comparing two different medium-depth combination peels, 70% glycolic acid/35% TCA versus Jessner's solution/35% TCA, with respect to clinical and histological effects on facial skin [66]. Thirteen patients with AK, fine wrinkling, and lentigines were treated prospectively with both combination peels, each one applied randomly to either the left or right side of the face. Patients were evaluated at postoperative intervals of 7, 30, and 60 days using photographs and preauricular skin biopsies taken at each of the three postoperative visits. Clinically, both peeling combinations were effective at treating solar lentigines and AK, with the glycolic acid/TCA demonstrating a slight advantage in eliminating AK. Neither peel was significantly effective at treating fine wrinkles. Recovery time for both agents was comparable at 7–10 days, but the Jessner's/TCA combination created more postoperative erythema (30–60 days). Additionally, discomfort with the glycolic combination was slightly greater. Histologically, a more prominent periappendageal infiltrate was detected on the Jessner/TCA side, but greater neoelastogenesis on the side treated with the glycolic/TCA sides. An increased thickness of the grenz zone was noted on the glycolic acid/TCA side, a finding that was, however, statistically insignificant [66].

Advanced photoaging (Glogau level III) is characterized dyschromic skin with obvious keratoses and demonstrable wrinkles at rest (Table 4.3). These patients are thought to typically fall into the age range of 50–60 years, but there is variation based on history of sun exposure, ethnicity, and Fitzpatrick's classification of skin types (Table 4.2). In a study evaluating these types of patients with severe facial actinic damage, Witheiler et al. demonstrated that medium-depth peels can be equal in efficacy to 5-FU chemexfoliation in the treatment of AK, but reappearance of these lesions in both groups during a 12–32 month follow-up confirmed the need for regular follow-up [67].

Pigmentary dyschromias, including postinflammatory hyperpigmentation, and melasma, have both been treated successfully with medium-depth peels. The epidermal component of these pigmentary aberrations is responsive to superficial and medium-depth chemical peels, topical bleaching agents, and laser therapy. The dermal component can also be responsive to medium-depth chemical peeling agents albeit the response is less. In addition to removing the epidermis (and offending pigment), medium-depth peels also affect the melanocytes in the pilar apparatus during the process of re-epithelization [49]. This mechanism, along with pre/posttreatment regimens with retinoic acid and hydroquinone, allows for a reduction in the risk of rebound hyperpigmentation when treating these pigmentary problems in nonwhite skin.

A combination medium-depth peel using Jessner's/35% TCA was used to treat 15 Iraqi brown-skinned patients with acne scars classified as "crater-like form" and "pitted (ice-pick)," with enhanced treatment around the edge of the scar with 50% TCA beginning at the time of the second of three total peels [68]. The interval between peels was 1 month, and clinical response was documented by serial photographs and patient self-assessments. At an evaluation 3 months following the final peel, moderate improvement was achieved in eight of the 15 patients (53.3%) and minimal to no response in one patient each. In spite of pretreatment with bleaching aids, posttreatment hyperpigmentation was recorded in nine patients (73.4%) but completely resolved by the 3-month follow-up. Patients with primarily atrophic scars faired better than those with predominantly pitted scars, but the overall level of patient satisfaction with the outcome of their treated acne scars was 80%.

Cook et al. reported that in their series of 3,100 patients treated with a 70% glycolic acid gel and 40% TCA combination peel, approximately 10% were treated on their abdomen. In many cases, they found that abdominal striae distensae can be greatly improved, even if hypopigmented and atrophic. Understanding that the appearance of striae distensae frequently improves with time, irrespective of treatment, the authors warn that in those patients who did not observe improvement after the first peel, subsequent peels would likely be of no benefit.

By focally applying TCA at concentrations ranging from 10% to 65%, Chun et al. safely treated a host of benign pigmented lesion in 106 dark-skinned patients. The chemical peeling agent was applied to the affected area with a sharpened wooden applicator and allowed to remain until frosting. The concentration selected was based on the desired depth of penetration required to target each given lesion. The results revealed that 42 of 49 (86%) patients with solar lentigines, 19 or 23 (83%) patients with seborrheic keratosis, eight of 14 (58%) patients with freckles, and 11 of 20 (55%) patient with melasma experienced a good clinical response without significant complications [56]. A study involving 20 patients with Fitzpatrick skin types II–III and mild to moderate photoaging were treated monthly with four pyruvic acid 50% facial peels. Postoperative evaluation was based on this agent's ability to improve the classic signs of photoaging and revealed smoother skin texture, less-apparent fine wrinkles, and lightening of freckles and lentigines [48]. Patient acceptance was high overall for this procedure due not only to the success in clinical improvement but also the low risk of complications and limited postpeel discomfort.

4.8.7 Ethnic Skin Considerations

In Fitzpatrick skin types IV–VI, medium-depth peels can be used for many of the same indications for which superficial peels are employed in this group (Table 4.2). The lesions requiring this form of therapy in white skin, however, may be less prevalent in ethnic skin by virtue of the latter's response to and extent of sun damage. The medium-depth peeling agents used in patients with darker skin are the same as those used in their white counterparts. The chemical percentage, combinations, and even the vehicle chosen, however, may be different. Roberts describes a technique of using glycolic acid 70% gel in place of solution before applying TCA 25% solution for the treatment of acne scars in darker skin. Although the glycolic acid enhances the effect of the TCA, the gel vehicle limits the harshness of this second product, allowing for more control of the peeling process [22]. This author also emphasized that the TCA should not be allowed to frost completely but, rather, be neutralized with 10% sodium bicarbonate after 2–4 min, depending on the lesion being treated. For areas of postinflammatory hyperpigmentation, Roberts recommended "spot peel," using TCA 25% salicylic acid or Jessner's solution on discreet areas in combination with or without full-face peeling. Attempts at treating dermal pigment should be avoided because of the inherent risk of permanent depigmentation and hypertrophic scarring in this class of patients. Stringent control of peel depth is basic to achieving a successful outcome in skin types IV–VI because in this population, the treatment of pigmentary and scarring disorders can lead to results worse than the original problem.

4.9 Deep Chemical Peeling

- Primary effects extending to the midreticular dermis
- Suitable for Fitzpatrick skin types I–III
- High risk of postoperative complications

4.9.1 Scientific Background

Deep chemical peels create an injury through the papillary dermis into the upper reticular dermis and may extend into the midreticular dermis (0.6 mm). Deep peeling agents include phenol-containing preparation, or TCA in concentrations above 50%. Because of the risks as-

sociated with 50% TCA, such as scarring, TCA at these concentrations are not recommend for deep chemical peeling. Therefore, solutions containing phenol is the agent of choice for deep chemical peels [34]. In this section, the focus will be phenol-containing deep chemical peels.

Baker-Gordon phenol formula, occluded and unoccluded, is the most commonly used deep chemical peel. It is composed of a mixture of 3 ml 88% phenol USP, three drops of croton oil, eight drops of Septisol, and 2 ml of distilled water [43]. The mixture of ingredients is freshly prepared and must be stirred vigorously prior to application due to its poor miscibility. Phenol at 80% or higher concentrations precipitates epidermal proteins, thus forming a barrier hindering dermal penetration, while phenol diluted to 50% is keratolytic, allowing increased dermal penetration and hence greater dermal injury. Croton oil is an epidermolytic agent that augments phenol penetration. Septisol increases surface tension and is thought to slow the penetration of phenol [69]. The phenol peel can be applied under occlusion using waterproof zinc oxide nonporous tape or left unoccluded. Occlusion increases the penetration of the phenol by promoting tissue maceration and preventing the agent's evaporation [70]. The unoccluded technique as modified by McCollough involves more cleansing of the skin and the application of more peel solution [71]. This may enhance the efficacy of the solution but without penetrating as deeply as in an occluded peel.

The reaction following application of phenol is characterized by keratocoagulative necrosis of the epidermis extending into the papillary dermis and by a marked inflammatory reaction. Epidermal regeneration begins within 48 h and is completed within 1 week. Dermal regeneration takes longer than epidermal healing and is characterized by rigid, compact collagen in the upper dermis replacing the disorganized collagen seen in elastosis [72].

4.9.2 Indications

Deep peels involve the use of chemoexfoliants that penetrate to the midreticular dermis [45]. Indications for the use of deep peeling agents include deep rhytids secondary to photoaging (Glogau type III or IV), treatment of severe or extensive AK, and solar lentigines (Table 4.2). Although the practice is not universally accepted, some physicians use deep peels for acne scarring and melasma [43].

4.9.3 Patient Selection

There are many relative contraindications to deep chemical peels, which depend on the patient's Fitzpatrick skin type and medical history (Table 4.2). Therefore, patient selection is critical in deep chemical peeling. The ideal patient is a fair-complexioned female with thin, dry skin and fine wrinkles, that is, Fitzpatrick skin type I or II and Glogau type III or IV [43].

It is important to remember that phenolic peels pose systemic risks so that patients with a preexisting history of cardiac, hepatic, or renal disease should not undergo a deep chemical peel (Table 4.3). Patients with active herpes simplex labialis infections are not candidates for this type of peel. Also, if a patient has a prior history of HSV infections, they should be prophylactically treated with acyclovir, valacyclovir, or famciclovir prior to the peel and continue until re-epithelialization is completed.

Patients with Fitzpatrick skin type IV–VI are not candidates for deep chemical peels secondary to the increased risk of pigmentary changes, especially hypopigmentation and scarring [44]. Male patients are less favorable candidates for deep chemical peeling, not only because of their unwillingness to use cover-up makeup to camouflage postoperative pigmentary changes, but also because their thick, sebaceous skin does not respond well [43].

Also, patients with diminished or absent normal dermal appendages (e.g., previous radiation treatment or taking Accutane) are poor candidates [5]. Because epidermal regeneration is dependent on migration of epithelium from skin adnexa, in their absence, wound healing is delayed and can result in atrophic and scarred skin with abnormal color and texture. Normal skin topography, including the number of vellus hairs, usually indicates that the epidermis is

capable of re-epithelializing after a chemical peel [40]. Also, deep chemical peels should be delayed a minimum of 2–3 months in patients who have had recent rhytidectomy, blepharoplasty, or deep-plane face lifts.

4.9.4 Treatment and Clinical Management

4.9.4.1 Preprocedure Rejuvenation Regimen

The preprocedure rejuvenation regimens used in deep chemical peeling are identical to those used for superficial chemical peeling.

4.9.4.2 Application of the Wounding Agent

On the day of the procedure, the patient cleanses their face, does not apply any cosmetics, and should be fasting prior to the procedure. Since anesthesia is generally required for deep chemical peels, a thorough preoperative history and physical must be completed prior to beginning the peel. In addition, intravenous hydration with a liter of lactated Ringer's solution should be given prior to the procedure as well as another liter during the procedure. Cardiac monitor, pulse oximetry, and blood pressure monitoring with full resuscitation capabilities are mandatory for full-face deep peeling with phenol, even if the anesthesia is restricted to light intravenous sedation or local nerve blocks with 1% lidocaine. After thorough cleansing and degreasing of the skin, the chemical agent is applied sequentially to six aesthetic units: forehead, perioral region, right cheek, left cheek, nose, and periorbital region, proceeding from one segment to the next after an interval of 10–15 min between each cosmetic unit, allowing 60–90 min for the entire procedure [19, 43].

Of importance, the Baker-Gordon solution must be prepared at the time of the procedure and repeatedly stirred to keep the various components evenly mixed. After mixing, the solution should be kept in a glass bowl or basin with a broad bottom so the solution can be gently agitated or stirred without danger of spilling or splashing. One to two cotton-tipped applicators are used to stir the solution and to apply it to the skin. The patient's eyes must be kept closed throughout the procedure. The applicator tip is stroked quickly and with moderate pressure over the cosmetic unit while watching for a whitening frost that appears within 10 s. The cosmetic segment is considered "painted" once an opaque white frost is observed. After each segment is evenly frosted, dry cold compresses and fanned air are used to help minimize the burning sensation. Also, ice packs can be used to symptomatically cool the skin [43]. It is important to remember that diluting phenol compound with water may increase the depth of penetration of injury, so tears spilling onto treated areas must be avoided, and if the eyes need to be flushed in the event contact occurs, mineral oil rather than water should be used [34].

After the entire face is treated, at the physician's discretion, waterproof zinc oxide tape may be placed on the skin to create an occlusion peel. The tape is left in place for 24 h, at which time the normal exudates and edema that follow injury cause the tape to spontaneously separate from the skin. The tape is then removed by the patient in the shower. Taping is thought to result in extra penetration of the wounding agent to the applied areas to achieve optimal cosmetic results, particularly areas of deep rhytids such as the perioral areas, glabella, and lateral crow's feet. For untaped peels, petrolatum is applied, and a biosynthetic dressing is used for the first 24 h.

4.9.4.3 Postprocedure Management

Postoperative management varies depending on the physician's preference and experience. Most physicians follow a modified wet or semi-occlusive technique. Patients are instructed to soak their face with plain water several times a day, which is best done by standing in the shower and letting the water fall on the crown and then run down the face for several minutes. This allows the debris and serous exudates to

be gently removed from the treated area. Fingertips and gentle soap can also be used, but abrasives should be avoided. After cleansing the face, a bland emollient (petrolatum) or antibacterial ointment is then applied generously to the entire face. This regimen should be repeated three to five times during the day. It helps to avoid heavy crust formation and allows for rapid re-epithelialization, usually within 12 days [43].

Once epithelialization is complete, the patient is instructed to use green-tinted foundation makeup to minimized erythema. Daily sunscreen is resumed and continued indefinitely. Patients should be instructed that the residual erythema might take several months to subside. Also, hydroquinone and tretinoin therapy may be resumed after epithelialization is complete to reduce postinflammatory rebound hyperpigmentation.

Postoperative visits are scheduled 48–72 h after the peel to confirm that proper postoperative care is being strictly followed. The patient is then seen at the 12-day mark for instruction in makeup, sunscreen, retinoids, and hydroquinone usage. Then the patient is usually seen 4 weeks postoperatively. It is critical to ensure appropriate follow-up to confirm that healing is occurring at the expected rate and to evaluate for possible superinfection or irritation secondary to the ointments used. To avoid potential complications, any deviation from the norm should be address and treated promptly [43].

4.9.5 Adverse Effects

The most notable complications include hypertrophic scarring, textural changes, and pigmentary disturbances. If hypertrophic scarring is suspected and at any sign of erythema with firmness or textural induration, the physician should be notified and the overnight application of silicone gel sheeting (Epiderm, Biodermis, Las Vegas, NV, USA) should begin, as well as weekly assessment of the patient. Early hypertrophic scarring can be successfully stopped by aggressive intervention with the silicone gel sheeting. If no improvement is seen within the first week, the area can be treated by alternating Cordran tape at bedtime with the silicone sheeting during the day. If no response is seen within 1–2 weeks of this therapy, then intralesional dilute triamcinolone acetonide 2–4 mg/ml applications are made on an every-other-week schedule while continuing the silicone gel sheeting and the Cordran tape at bedtime. Once the erythema has begun to subside, the Cordran tape is stopped to avoid atrophy, and the silicone gel sheeting is continued until the erythema has completely resolved [43].

Permanent pigmentary changes can occur as a complication of phenol peels. Clinically, hypopigmentation occurs when susceptible Fitzpatrick skin types III–VI undergo deep peeling. Because deep phenol peels may lead to irreversible hypopigmentation, hyperpigmentation, scarring, or keloid formation, it is not advised for dark-skinned patients with Fitzpatrick skin types IV–VI [73]. Temporary hypopigmentation is common and predictable, and the final skin color cannot be discerned until all the postpeel erythema has resolved. However, if the erythema has resolved and the hypopigmentation is still present, the pigmentary change is irreversible. Hyperpigmentation is a common postoperative sequelae in darker-skinned patients but usually resolves spontaneously with time, topical tretinoin, and hydroquinone therapy [43].

Infectious complications secondary to bacterial or viral infections and flat warts can be seen. Bacterial infections are usually the result of improper, inadequate, or infrequent cleaning. *Pseudomonas aeruginosa* is treated by using equal parts of water and distilled vinegar to the effected areas several times a day. *Staphylococcus* and *Streptococcus* infections are rare and must be treated with antibiotics. Toxic-shock-like syndromes have been reported following peels [74]. Viral infections secondary to HSV are treated with acyclovir, valacyclovir, or famciclovir. Flat warts (verruca plana) can occur secondary to autoinoculation. Treatment with salicylic acid, liquid nitrogen, topical tretinoin, or even re-peeling is usually successful [43].

The systemic complications of phenol peels are well documented. Phenol has extensive systemic absorption, is directly cardiotoxic

[75], is inactivated by conjugation in the liver, and is 80% excreted by the kidneys [76]. Therefore, phenol peels are contraindicated in patients who have a history of cardiac, hepatic, or renal disease. The cardiotoxicity of phenol is well documented and has been shown to occur within the first 30 min of application [44]. The use of continuous cardiac monitoring, pulse oximetry, blood pressure monitoring, and intravenous hydration before and during the procedure to promote phenol excretion are mandatory and help to prevent toxicity. Additionally, the treatment of small cosmetic units with resting periods of 10–15 min between applications minimizes potential systemic complications [77, 78].

Uncommon complications include induction of pemphigus vulgaris in one patient after a phenol peel [79] and laryngeal edema, seen in three chronic smokers after phenol peels. Their respiratory symptoms resolved 48 h after inhalation therapy [80].

4.9.6 Outcome

Deep peeling with phenol solutions can significantly improve or even eliminate deep rhytids and furrows as well as other textural and pigmentary irregularities associated with severe photoaging in Glogau groups III and IV. But it is critical to select the appropriate patient as the risks and complications associated with phenol peels can be devastating if the physician lacks expertise and if the patient is not an appropriate candidate. A remarkable degree of improvement is the expected result of deep chemical peeling when performed properly on the appropriate patient [34].

4.10 Microdermabrasion

- Primary effects on stratum corneum and epidermis
- Safe for any skin type
- Solo use and as primer for chemical peels

With more than two dozen products by different manufacturers on the market, microdermabrasion has gained much popularity in Europe, Australia, and the United States since its development in Italy in 1985. The various machine types can be divided into the higher power physician's model and the lower power aesthetician's model. The physician's model is capable of creating pressures up to 70 mmHg, affecting deeper layers of skin, and requires the supervision of a physician [81]. No matter what type of equipment is being used, the technique of microdermabrasion relies on two basic functions: (1) superficially abrading the skin with fine, sharp crystals (aluminum oxide, salt, or sodium bicarbonate) via positive- or negative-flowing pressure, and (2) a vacuum closed-loop suction device to remove the crystals, along with dead skin, oil, and surface debris [81, 82].

4.10.1 Scientific Background

Aluminum oxide crystal particles (corundum crystals) are composed of white-fused alumina and bauxite. These particles are inert, water insoluble, and approximately 100 μm in diameter. The abrasive effect of these crystals results from their sharp edges, coupled with the flow generated by the positive stream of crystals flowing via a hand piece with vacuum suction [81]. The vacuum suction collects the crystals in a container that allows for their neat and safe disposal. The depth of penetration is controlled by the level of suction, the duration of time the suction hand piece is held in contact with the skin, and the number of passes. Typically, microdermabrasion treatments exert direct effects on the stratum corneum and epidermis. With high-pressure settings, more aggressive treatment regimens have reportedly affected the reticular dermis in some cases. The exfoliating effect is responsible for the improvement seen in clogged pores. Improved skin texture is a direct effect of removing superficial skin layers, [81] and, although somewhat controversial, the theory of microdermabrasion stimulating dermal collagen deposition is supported by at least one study evaluating the histology of three patients before and after six treatments

[83]. In that study, posttreatment biopsies revealed an increase of collagen deposition in the papillary dermis thought to result from repeated intraepidermal injury. Significant epidermal thickening from 103 microns to 148 microns was demonstrated histologically in one study that evaluated the effects of 8 weekly microdermabrasion treatments. Photograph assessment of baseline and posttreatment photos of this same group of 17 patients revealed a rating of improved pigmentation as reported by all 30 evaluators, but improvement of fine wrinkling was noted only by the 14 nonmedical observers [84]. Tan et al. described a slight abrasion of the stratum corneum following four passes of microdermabrasion at an aggressive setting (65 - mmHg). Clinical erythema, however, persisted for 5–6 days posttreatment and was thought to represent a biologic response. This response may help explain the mechanism behind the diminution of fine rhytids following microdermabrasion of photodamaged areas. In the treatment of depressed scars, formation of granulomas in the upper dermis due to retained aluminum oxide crystals is hypothesized, a histologic finding not typically found after traditional dermabrasion. Microdermabrasion may prove to be better than traditional dermabrasion in treating atrophic scars for this reason [85].

4.10.2 Indications

As an alternative to laser resurfacing, chemical peels, and dermabrasion, microdermabrasion is indicated for similar skin issues but with the limitation of having relatively superficial results. Microdermabrasion, described as a "skin polishing," is used for atrophic acne scars, mild facial rhytids, clogged pores, traumatic scars [81], enlarged pores, brown spots, stretch marks [86], melasma, keratosis pilaris, and to improve skin texture [81]. Hernandez-Perez admitted to less-than-satisfactory results when treating melasma [87]. Microdermabrasion has also been used to prime the skin for superficial chemical peels by stripping the stratum corneum to ensure more even absorption [81]. When used in conjunction with microdermabrasion, traditional superficial chemical peeling agents can help many physicians achieve medium-depth chemical peel results with fewer side effects. Anatomic sites treated safely and successfully include face, hands, neck, chest [86], and back [81].

4.10.3 Patient Selection

With predictably superficial results, microdermabrasion has been safely done on all skin types. The concerns of hyperpigmentation limiting many patients from elective resurfacing procedures are greatly reduced in microdermabrasion. If present, posttreatment hyperpigmentation is short lived. The key, in part, to patient satisfaction is in choosing the type of patient who can most likely benefit from this procedure. In a telephone survey including the opinions of 43 patients with a mean number of 4.51 treatments, the overwhelming reason these patients chose the procedure was for the treatment of fine lines plus wrinkles [88]. In this group, satisfaction with the procedure was correlated with an increased number of treatments (three or more). People whose expectations for dramatic change are high, or photodamage and/or acne scars are too extreme, would not be appropriate for microdermabrasion as a sole therapy. Contrary to the opinion of Hernandez-Perez et al., who stated that patients on isotretinoin can be microdermabraded, most authors recommend abstaining from microdermabrasion for at least 1 year following isotretinoin [87]. Other poor candidates include those with cutaneous malignancies, recent herpes outbreak, warts involving the treatment area, flared rosacea, draining acne vulgaris, unstable diabetes, and autoimmune disorders [81].

4.10.4 Treatment and Clinical Management

The technique of microdermabrasion is noninvasive and quite simple. Prior to treatment, the area is cleansed and allowed to dry completely. Vacuum level and crystal pressure may be determined by testing an area of nonfacial skin,

but patient tolerance can also dictate an adjustment in the power setting. The first pass is performed by allowing gentle suction of the skin into the hand piece as it is made to glide along the skin surface. The surface area being treated is stretched taut by the clinician's free hand to avoid excessive suction in any one area, which can cause an abrasion or pinpoint bleeding. A second pass is made at a right angle to the first, and if more passes are required, they should continue to follow this alternating pattern to avoid streaking [81]. Reducing the level of suction and or number of passes may be necessary around the eyes and other delicate areas of the face. The intensity of the treatment, as determined by the number of passes and level of suction, is chosen based on the condition being treated. When the treatment is completed, the residual crystals should be gently brushed off the skin in the direction away from the eyes so as to prevent eye irritation. The skin can then be rinsed with tepid water and a moisturizer with adequate sunscreen applied. Patients are instructed to avoid keratolytic agents, including retinoids, alpha-hydroxy acids, and benzoyl peroxides 3 days before and 3 days following the treatment. They are asked to avoid waxing, electrolysis, and laser hair removal 1 week before treatment, and excessive sun exposure 2 weeks before treatment. All patients are given prophylaxis for HSV 1 day before and 2 days following the treatment using standard oral antiviral therapy.

4.10.5 Adverse Effects

Complications from microdermabrasion are few and avoidable with a proper patient history. Unlike traditional dermabrasion, the risk for scarring and hyperpigmentation is quite low. Reviewing 2 years of microdermabrasion treatments involving 126 patients, Freeman reported that there were no instances of hypopigmentation, scarring, or postoperative wound infections. In 2 referred cases, the same author reported abrasive injuries from treatments thought to be due to impurities in the aluminum oxide crystals. These injuries resulted in a detectable groove upon healing [89]. Because microdermabrasion breaks in the integrity of the skin barrier, many physicians preoperatively treat patients prophylactically with antiviral medication to avoid flaring of quiescent HSV [90].

Although a very well-tolerated procedure, the noncutaneous complications of microdermabrasion warrant precautions. The risk of eye irritation and corneal abrasion [82] from the crystals has many technicians and patients using protective eye wear during the procedure. Pulmonary fibrosis and tracheal and laryngeal papillomas have been linked to aluminum oxide dust exposure [91]. The presence of aluminum in the brain senile plaques of Alzheimer's patients has raised the question of the risk of chronic exposure to aerosolized aluminum oxide, which places patients and technicians at increased risk of cognitive impairment in the future. The particle size of the aluminum oxide crystals used for microdermabrasion are significantly larger than those for dental use (100–120 μm versus 24–50 μm), and the smaller particles used for dental air abrasion have not been found to pose a significant health hazard [92]. The larger particles used in microdermabrasion are inert and too heavy to become aerosolized and are not likely to pose a risk to the respiratory or cognitive systems [82].

4.10.6 Outcome

Critics of microdermabrasion will agree that among the risks associated with this procedure, "disappointment" should be included. Because microdermabrasion was approved by the FDA as a type 1 device, the manufacturer does not have to establish performance standards for the machine, only to manufacture the device using good manufacturing practices (GMP) guidelines. With the 1998 issuance of "exempt" status, there is no need for a clearance letter from the FDA in order to sell the instrument in the United States [82]. The effects are described as superficial in most cases, although the physician can reach the level of the dermis with a machine capable of positive pressure crystal delivery. Evidence that the epidermal-dermal junction has been reached may present clinical-

ly as punctate hemorrhage. Re-epithelialization is usually complete within 1 week, but erythema may persist just beyond 2 weeks. More uniform punctate bleeding may indicate reaching the papillary dermis, and treatments extending to the reticular dermis are marked by full-face bleeding [92]. With variation in the depth of penetration, the anticipated results depend greatly on the treated lesions.

Tan et al. treated ten volunteers on the face with Fitzpatrick skin types I–III with Glogau scale II–III photodamage once a week for five to six treatments. Assessments immediately before and after the first, second, and fifth visit, and a final evaluation 1 week following the last session, were performed. The vacuum pressure was maintained at 30 mmHg for four passes full face and 15 mmHg for two passes periorbitally. An increased roughness consistent with mild abrasion and a slight flattening of wrinkles were detected immediately following the treatment but did not last in the majority of patients beyond 1 week. A significant but transient decrease in sebum production was also noted. Increased skin compliance and decreased skin stiffness was noted on the cheeks, a finding that persisted for 1 week following the final treatment. Seven of the ten patients reported clinical improvement in their photodamage as a result of the microdermabrasion treatments. The three patients without any improvement were classified as Glogau group III photodamage. Histologic evaluation was performed on preauricular 2 mm punch biopsies of 2 volunteers at baseline and following the final session. A slight increase in orthokeratosis, and a diminished epidermal rete ridge pattern were noted superficially. Vascular ectasia, a perivascular mononuclear cell infiltrate, and edema were seen in the reticular dermis. Two additional healthy males received 3-mm forearm punch biopsies before and immediately following four passes at 65 mmHg (aggressive setting). Results demonstrated thinning of the stratum corneum and slight dermal edema but no epidermal change. No significant change was seen in the content of collagen or elastin [82].

In another study by Hernandez-Perez et al., seven women (median age 45 years) underwent five microdermabrasion treatments at weekly intervals. A 3-mm punch biopsy was taken from the malar area before the first treatment and following the fifth, which showed the most dramatic change in epidermal increase thickness – a change that was statistically significant. Clinically, there was a moderate to excellent improvement in oily skin and dilated pores in all patients. In 86% of the patients, the improvement in fine wrinkles was good and in 14% only moderate [87]. Histologically, improvement in inflammation, telangiectasias, and edema were noted. Collagen fibers in the dermis were reportedly more fibrillar and less basophilic, and an improvement in the elastotic material was detected. With such dermal effects, some have compared the outcome of microdermabrasion to medium-depth chemical peels [86]. Others have declared that even ten serial microdermabrasion treatments cannot achieve the results possible with one papillary dermis peel [93].

Comparing microdermabrasion with glycolic acid peels in terms of efficacy and patient satisfaction, Alam et al. treated ten female patients (mean age 43) split face with six consecutive weekly 20% glycolic acid peels and mild-setting microdermabrasion. Comparative reviews were composed of patient ratings, investigator ratings, and photographs before any treatments and 1 week following the last treatment. Skin features under review included redness, brown spots, smoothness, softness, and wrinkles. Investigators' ratings revealed no significant treatment-specific differences when evaluated by photographs or in person. Patient ratings, however, revealed some marked differences between the two procedures. With respect to skin texture, four of the ten patients favored the glycolic acid peels, two favored microdermabrasion treatments, three found that both procedures improved the skin texture equally, and one felt no significant change from either intervention. Fine wrinkles were improved more by glycolic acid peels in four patients, by microdermabrasion in one patient, and equally in five patients. Skin color was improved more by glycolic acid peels in four patients, by microderm abrasion in one patient, equally in three patients, but not at all in two patients. An overall preference for glycolic acid peels was stated by

seven of the ten patients while, of the remaining three, one preferred microdermabrasion and two revealed no preference [94].

Chemexfoliation and superficial skin resurfacing continue to be two essential techniques in the arsenal allowing cosmetically oriented physicians to be competitive in the anti-aging war. From the most superficial chemical peel agents to those more deeply penetrating, the dermatologist is able to implement for the patient a treatment regimen targeted to meet specific goals but tailored to individual lifestyles. Chemical peels and microdermabrasion will likely remain among the most popular "cosmetic procedures" of younger generations whose early intervention may afford them the luxury of preventive rather than therapeutic practices.

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