Dermatologic Therapy

Volume 13(2) 2000 pp 173-182

Trichloroacetic acid peels
[Treatment of the Aging Face: Chemical Peels]

Nguyen, Tri H.; Rooney, James A.

Section Editor(s): Roenigk, Henry H. JR.

Department of Dermatology, Mayo Clinic, Rochester, Minnesota

Outline

Graphics

- Fig. 8
- Fig. 9
- Fig. 10
- Fig. 11
- Fig. 12
- Fig. 13
- Fig. 14
- Fig. 15

Trichloroacetic acid (TCA) holds an important place in the armamentarium of chemical peel agents. In low concentrations, TCA is a safe and reliable preparation for superficial peels (as are glycolic acid and salicylic acid). In higher concentration, 50% w/v, TCA may be used as the sole agent for medium-depth peels, particularly in those patients for whom phenol peel is not tolerated or desired. However, it should be noted that TCA used alone in these higher concentrations has been associated with an increased risk of adverse events, including hypertrophic scarring. As a result, it is now more often used in low concentration for medium-depth peels, but combined with a pretreatment agent to enhance the depth of penetration. This "combination peel" technique results in a similar beneficial effect when compared to 50% TCA as a sole agent, but has a better side-effect profile. As an introduction to TCA chemical peels, this article focuses on the nature of TCA as a chemical peel agent, the techniques of application, patient satisfaction, and the avoidance of complications. Combination peels are briefly discussed in this article. The combined use of chemical peels with laser treatment is discussed in a subsequent article.

Background

Many chemical agents have been used for peels, including some that are less well known today, such as sour milk, cantharidin, urine, mustard, and sulfur, among others (1). Today the workhorses of the chemical peel domain are the [alpha]-hydroxy acids (AHAs), phenol, and TCA. TCA has a particularly long history as an effective agent for rendering significant improvement in skin texture and color. It was tested as early as 1882 by P. G. Unna in Germany, and has been the prototype of chemical peel agents since it was described by Roberts in 1926 and used for acne scarring by Monash in 1945 (1). Ayres first delineated its use as therapy for aging skin in 1960 (2). With a protein dissociation constant (pKa) of 0.52, TCA is relatively stronger than the AHAs (the lower the pKa, the stronger the acid). Glycolic acid, in comparison, has a pKa of 3.83, lactic acid has a pKa of 3.86, and citric acid has a pKa of 3.13 (3). TCA likewise has a greater potential for causing injury to the skin at a medium or deep level than AHAs, depending upon the concentration and how it is applied.

A milestone in the study of chemical peels was achieved with the objective measurement of injury depth for each chemical agent used (4). Perhaps no chemical has been more studied in this respect than TCA. The terms superficial, medium, and deep were developed as a universal gauge of the amount of damage and benefit to be expected from each chemical peel agent, depending upon the type and concentration. The superficial, medium, and deep categories are important because deeper peels offer a more substantial clinical change in skin texture and color, but also generally result in a longer healing time and a greater risk of more serious complications.

Superficial peels are defined as those causing injury to the dermis and dermal-epidermal interface, and peels using 10-35% TCA as a sole agent generally fit into this category. Medium-depth peels are defined as those that penetrate to the papillary or upper reticular dermis, and peels using 35-50% TCA as a sole agent or the TCA "combination peels" generally fit into this category (Fig. 1). Deep chemical peels are those that cause destruction into the reticular dermis, and TCA as a sole agent is generally not recommended here because of potential complications. Complications of TCA peels include dyspigmentation, telangiectasias, sensitivity,

uneven texture, and scarring, among others. Recent studies showing that the reticular dermis heals with scarring offer an explanation for some of the increased risk associated with use of TCA for deeper peels (5).

Graphic
[Help with image viewing]
Fig. 1. No caption available.

Indications for TCA peels

Treatment of photoaging and rhytides, actinic keratoses, lentigines, and other pigmentary dyschromias are the principle indications for the TCA chemical peel (Fig. 2). It is also occasionally used, but is variably effective, for superficial acne scars (Figs. 3 and 4), postinflammatory hyperpigmentation, melasma, dilated pores, vitiligo, rosacea, seborrheic dermatitis, and other conditions (2). It compares favorably with 5-fluorouracil (5-FU) cream for the treatment of actinic keratoses, and the duration of benefit may be longer (Fig. 5). It has a definite role in improving the fine crosshatched facial rhytides and even moderately deep perioral wrinkles, but is not indicated for deeper rhytides caused by muscles of facial expression or lax skin (2). As with other chemical peel agents, it generally renders to skin a more pleasant, smooth, and less dry or irritated appearance and feel (Figs. 6 and 7).

Graphic
[Help with image viewing]
Fig. 2. Photodamage.

Graphic
[Help with image viewing]
Fig. 3. Post-TCA acne scarring.

Graphic
[Help with image viewing]
Fig. 4. Pre-TCA acne scarring.

Graphic
[Help with image viewing]
Fig. 5. Actinic keratoses in photodamaged skin.

Graphic
[Help with image viewing]
Fig. 6. Prepeel TCA photodamage. [up arrow]

Graphic
[Help with image viewing]
Fig. 7. Post-peel TCA photodamage. ->

Mechanism of action and histologic effects

Application of TCA to the skin causes precipitation of proteins and coagulative necrosis of cells in the epidermis. In higher concentrations it causes necrosis of collagen in the papillary to upper reticular dermis. Over several days the necrotic layers slough and the skin reepithelializes from the germinative segments of

hair follicles that were spared from chemical damage (Fig. 8). Dermal collagen remodeling after medium-depth peel may continue afterward for several months (6). The range of injury from lower papillary dermis to upper reticular dermis (medium to deep) was classically defined by treatment with 40-60% TCA (1). Stegman's (7) study in 1982 demonstrated that 40-60% TCA produced epidermal necrosis, papillary dermal edema, and homogenization to the midreticular dermis (Fig. 1).

Graphic
[Help with image viewing]

Fig. 8. Exfoliation three days post-peel.

Brodland et al. (8) showed in a porcine model that a minimum of 30% (w/v) TCA is required for complete epidermal necrosis with a single application, as would be indicated for full treatment of actinic keratoses. Eighteen percent TCA, they said, results in partial epidermal exfoliation that would be well tolerated but would also likely offer only short-term improvement (8). Higher concentrations, such as >=40% TCA, may result in middermal necrosis. Unlike phenol peels, occlusion of TCA does not result in an enhanced depth of necrosis. Rather, at all concentrations, occlusion decreases the depth of necrosis, likely due to increased "interstitial humidification" (8). Occlusion is therefore generally not used with TCA, except as a corrective measure for overtreatment.

Patient satisfaction and the preoperative consultation

The single most prevalent risk of TCA and other peels is patient dissatisfaction. In a survey of patient satisfaction after TCA peel, as many as 30% of patients expressed some disappointment with their results (9). Younger and darker-skinned patients expressed an even lower satisfaction rate-down to 33% satisfaction in some cases. The authors suggested that the dissatisfaction was likely related to unrealistic patient expectations. As with all surgical procedures, careful preoperative discussion of risks and expected benefits contributes greatly to the patient's formation of realistic expectations and their resultant satisfaction.

Potential complications of TCA as a peeling agent

It has been noted that, "TCA has a split personality: easy to use and forgiving in low (10-30%) concentrations, it becomes increasingly erratic and unpredictable at concentrations over 35%" (10). At low concentrations of 10-30%, the incidence of complications is also quite low (10). On the other hand, at the 50% concentration level-commonly used in proprietary compounds-it is more likely than many other agents to result in textural changes and/or hypopigmentation (1). It may also produce an unacceptable incidence of hypertrophic scarring, or even full-thickness tissue loss followed by contractile scars (10). The addition of emulsifiers, additives, and surfactants is not likely to reduce this risk (3). Peeling with 60-75% TCA is very risky and definitely not recommended, though spot treatments of actinic keratoses or other focal hypertrophic lesions may be effective at these concentrations (1). In general, as TCA concentration rises beyond 35% it has a decreasing benefit:risk ratio, and should be avoided by the inexperienced practitioner (10). Fortunately the advent of "combination peels" has, for the most part, obviated the need for use of TCA at concentrations above 35%. Should scarring occur despite all due diligence to prevent it, "time, support, and intralesional triamcinolone acetonide 5-20 mg/ml every three weeks" may be the treatment of choice (11). Persistent erythema with dermal induration is a warning sign for the development of such scarring, and prophylactic topical steroids have been recommended for prophylaxis should it occur (11). The importance of close follow-up cannot be overstressed. It should also be noted here that any medium-depth peels are relatively contraindicated in patients who have taken isotretinoin within the previous 12 months, due to the enhanced risk of scarring in these patients (6).

Though scarring is a rare consequence of TCA peels, other complications are more common. Pigmentary

disturbances are the most common complication in all classes of chemical peeling agents-manifested as hypopigmentation and/or hyperpigmentation, and prolonged erythema (12). Hyperpigmentation is generally postinflammatory and temporary, and often responds well to tretinoin, bleaching creams, and sun protection (12). Hypopigmentation may occur with TCA, but is more common with deeper peels and Fitzpatrick skin types IV, V, and VI (Figs. 9 and 10). Prolonged erythema of more than 90 days may respond to 2.5% topical hydrocortisone, short-term systemic steroids, oral antihistamines, or silicone gel sheeting, as well as application of green foundation under makeup base (1). Milia are fairly common after medium-depth peels, but are usually easily remedied with minor acne surgery.

Graphic
[Help with image viewing]

Fig. 9. Acne scarring hypopigmentation.

Graphic
[Help with image viewing]

Fig. 10. Post-TCA hypopigmentation.

Bacterial infections are uncommon, and when they occur are often thought to be the result of inadequate postoperative wound care (12). Wound cultures should be obtained and appropriate antibiotic treatment rendered should infections occur. Reactivation of herpes is always a possibility, and should be preempted with appropriate prophylactic treatment (12). Suppressive acyclovir at a dose of 400 mg orally twice a day for 2 days preoperatively and 5-10 days postoperatively has been recommended (6).

Use of combination peels for medium-depth peeling

Due to the risks involved with higher concentrations of TCA, the trend in medium-depth peels has been to combine a lower concentration of TCA with another less potent superficial peeling agent (3). This approach takes advantage of the differing mechanisms of action between the combination peels. The superficial peeling agent is keratolytic and disrupts epidermal cohesion, allowing deeper penetration of the TCA. Subsequent application of TCA effects coagulative protein necrosis with greater penetration depth.

The CO_2 plus TCA combination peel

Brody and Hailey (13) reported the use of solid CO_2 ice to injure the epidermal surface prior to the application of 35% TCA to promote upper dermal injury. The CO_2 plus TCA peel initially applies a hand-sized block of dry ice dipped in acetone and alcohol to cause epidermal injury, and is then followed by the application of 35% TCA to extend injury into the dermis. Histologic studies have shown that this results in damage through the papillary dermis (1,3). The peel has been shown to be effective for moderate actinic damage, superficial hyperpigmentation, and minor wrinkles. Because of the ability to manually focus injury with the CO_2 pretreatment at the perimeter of depressed scars, this is one of the few peel techniques that can also offer focal control of peel depth, thereby improving the contours of pitted scars (3). The incidence of scarring as a complication of CO_2 and 35% TCA is less than 0.25% (12).

The Jessner's solution plus TCA combination peel

Dr. Max Jessner combined 14 g each of resorcinol, salicylic acid, and 85% lactic acid with enough ethanol to make 100 ml of an effective superficial peeling agent. After pretreatment of the skin with this solution, 35% TCA can be applied to extend injury into the dermis, again without the unpredictability of the 50% TCA preparation. It, too, is useful for moderate actinic damage, pigmentary dyschromias, and minor wrinkles, and

also shows superior results for the blending of margins when used in conjunction with deep peels or laser resurfacing (4). Histologically, Jessner's plus 35% TCA resulted in a thinner grenz zone and smaller elastotic band than the CO_2 plus 35% TCA combination (2). In one large series, Jessner's solution and 35% TCA was associated with no scarring complications (12).

The glycolic acid plus TCA combination peel

A 70% glycolic acid superficial peel, followed by 35% TCA to extend injury into the dermis, is another combination peel that is effective for medium-depth penetration. It has also been found useful for moderate actinic damage, pigmentary dyschromias, and minor wrinkles. Histologic studies show comparable improvements with the Jessner's plus TCA peel, with a more narrow grenz zone and elastotic band (2). The technique of application is different, however, in that no cleansing or degreasing procedure is used prior to the application of the glycolic acid, and the glycolic acid is neutralized with water prior to the application of TCA (4).

Procedure for TCA peels

Preparation of the TCA solution

It is critical to standardize the preparation of TCA solutions. Inconsistent preparations have resulted in inadvertently strong concentrations of TCA solution and resultant scarring (14). The weight/volume approach has become the standard in the published literature and should be used in almost all circumstances (3). It is important that this method not be confused with the weight/weight, weight/100 ml, and dilution of saturated TCA methods of preparation, as these methods may lead to a higher concentration of the active ingredient than was intended (3).

The weight/volume method requires that the desired concentration in grams of United States Pharmacopeia (USP) TCA crystals be mixed with enough distilled water to make 100 cc of solution (1). For example, a 35% TCA solution is prepared by diluting 35 g of TCA crystals in distilled water to make a total volume of 100 cc. In contrast, adding 35 g of TCA to 100 cc of water or 35 g to enough water to make 100 g of solution are both examples of incorrect preparation methods. Once prepared, the solution is stable for at least 6 months at either room temperature or refrigerated (1). TCA should be stored in a glass container because it is corrosive to many plastic containers as well as wax paper covers. Amber or clear glass can be used, since TCA does not seem to be light sensitive. TCA should not be left uncovered, because evaporation may cause an increase in concentration of the solution. Premixed commercial solutions of TCA are available, as are paste formulations, but they do not seem to offer any advantage to the correctly prepared TCA crystals in solution.

Eye protection

Because chemical peel solutions are caustic to vital structures of the eyes, it is often recommended that the eyes be protected prior to initiation of the treatment with ophthalmic ointment, gauze pads and tape, or goggles (6), and monitored intermittently throughout the procedure. If a peel is performed directly to skin around the eyes, great care must be taken in positioning the angle of the head and in application of the solution so that inadvertent seepage of the chemical into the eyes is avoided. The head of the patient may be elevated to a 30 degree angle and a semidry applicator used to apply the solution within 2-3 mm of the eyelid margin (4). A container of sterile water should always be available to rinse the eyes in the event of accidental exposure.

Precleansing

Because facial oils and compact keratin form a barrier to penetration of the peel solution, vigorous cleansing

and degreasing is necessary for uniform penetration of TCA into the skin and for an even effect. Despite its flammability, acetone continues to be the most commonly used degreasing agent, though rubbing alcohol and other scrubs may be equally effective (Fig. 11). The patient should remove makeup, cleanse the face with an antibiotic scrub such as chlorhexidine gluconate, and perform an initial acetone scrub with gauze. This is rarely sufficient, however, and the physician or nurse should perform an additional scrub with acetone-soaked gauze pads until sebaceous oils have been thoroughly removed from the face (6). A small fan should be used to disperse acetone fumes during these steps, and all sources of heat and flame should be kept at a distance.

Graphic
[Help with image viewing]
Fig. 11. Acetone preparation.

Application of TCA

The TCA is applied evenly with cotton-tip applicators or saturated 2 in. × 2 in. gauze pads with smooth strokes (Figs. 12 and 13). The pads should be wrung out sufficiently to prevent a splash effect that could be injurious to the eyes or cause treatment of unintended areas of skin. The hand that is holding the TCA gauze should be gloved and dry gauze should be held in the other hand to absorb any excess drip and to avoid inadvertent application of the chemical. Since the patient will feel a moderate sting when TCA is applied, cool compresses may be applied to each area as it is treated and a small fan may be held and directed by the patient to the uncomfortable area (6). To relieve some anxiety, the patient can be reassured that once the stinging and burning begins, the sensations are already nearing their peak and a denouement should gradually begin. Preoperative sedation is generally not necessary, though light sedation with a benzodiazepine or narcotic can be used preemptively for an apprehensive patient.

Graphic
[Help with image viewing]
Fig. 12. TCA application with gauze.

Graphic
[Help with image viewing]
Fig. 13. TCA application with Q-tips.

Anatomic subunits of the face are peeled sequentially, with feathering into the hairline and at the treatment margins. One pattern may begin from the forehead to the temples and cheeks, followed by the lips, nose, and eyelids (4). Often, broad strokes of 2 in. × 2 in. TCA-soaked gauze are used for even application to larger regions, and wide strokes with cotton-tip applicators are used for smaller areas (4).

The endpoint of treatment

As the skin is treated, a white color change or "frost" results from epidermal and dermal protein coagulation (Fig. 14). Some authors feel that monitoring this frost (e.g., color intensity and time to clear or fade) is a reliable indicator of peel depth. Others suggest that the depth of injury cannot be appreciated from color alone, and that this indicator is unreliable (1). Nevertheless, diffuse redness with light cloudy-white frosting that clears in 10-15 minutes indicates superficial injury (epidermis) and is generally the desired endpoint of TCA concentrations of less than 35%. A more uniform white frost is indicative of epidermal and papillary dermal injury and is the endpoint for 35-40% TCA peels, and also clears over 10-15 minutes. A dense, white, uniform frost is indicative of deep papillary to reticular dermal injury and is the endpoint for medium-depth peels with 50% TCA alone. This deeper frost usually clears in 40-45 minutes (9). A yellow-gray frost

represents deep injury to the mid- to deep reticular dermis and forecasts a prolonged healing time. It generally does not clear even after 40 minutes. After TCA is applied, a dry gauze pad should be used to blot (not wipe) the excess from the skin (6).

Graphic
[Help with image viewing]

Fig. 14. TCA frost 35 percent.

Reapplication of TCA during the same and subsequent patient visits

When using 50% TCA as a sole agent for medium-depth peels, reapplication during the same patient visit is usually not recommended, since the effects are already somewhat unpredictable. Although the decision is sometimes made to reapply TCA to areas with less apparent frost, this results in increased protein coagulation and wounding, and is generally unnecessary if the area was not missed with the first application (1). Reapplication can be useful, however, in selected sun-damaged areas with impaired penetration, such as those areas with actinic keratoses (1). Reapplication on a subsequent visit should not be performed for at least 6 months, and most patients do not require re-treatment for several years.

For superficial peels using 10-35% TCA, an even redness or light whitish film is sought, and reapplication to uneven or unresponsive areas during the same visit is appropriate (1). One practitioner suggests that several repeat applications of 15-25% TCA may be performed at 3-minute intervals during the same visit to induce more erythema and frost, and improved clinical results (1). These superficial peels may safely be repeated at 1- to 2-week intervals, and are often applied in a series of about six treatments, beginning with low concentrations and increasing the strength of TCA as tolerated.

Postpeel care

Postoperative care for medium-depth TCA peels involves the application of a thin coat of antibiotic or Vaseline/Aquaphor ointment three to five times per day after gentle cleansing (Fig. 15). Beginning at day 4-5, wet dressings applied twice a day after cleansing may aid in the exfoliation. Application of ointment between wet dressings should be continued, and at no time should a crust be allowed to form. Reepithelialization should be complete in 7-10 days, after which application of ointment may be discontinued. Thereafter, gentle cleansers, moisturizers, and exfoliation with routine application of tretinoin or glycolic acid-based maintenance creams are continued. Sun protection must always be stressed to minimize postinflammatory hyperpigmentation.

Graphic
[Help with image viewing]

Fig. 15. Postoperative wound care.

Postoperative care for superficial TCA peels is minimal, and consists of routine gentle cleansing. Patients can usually return to their normal activities promptly, and may use moisturizers and cosmetics to conceal the erythema. Tretinoin usually should not be applied for the first 3-7 days to avoid further irritation of the healing skin (1).

Conclusion

The preoperative consultation is essential for assessing and guiding patient expectations, as well as determining the appropriateness of chemical peels for the patient's skin. More than one technique and peeling

agent is available to achieve the desired depth and benefit. TCA is a valuable agent for both superficial and medium-depth peels, and its effectiveness has been well demonstrated. Used properly, TCA peels continue to be a safe and reliable method for rendering histologic and clinical improvement to the skin. TCA is particularly safe when used as a superficial peel or in "combination peels" of medium depth. As a sole agent in higher concentrations, its predictability is less certain and should generally be avoided by the novice practitioner. Since all resurfacing techniques are quintessentially operator dependent, it is important to develop a thorough understanding of and comfort with the peeling agent. This is best accomplished both by a careful review of the literature and, if possible, by the personalized attention of an experienced practitioner.

References 

1. Brody HJ. Chemical peeling and resurfacing, 2nd ed. St. Louis: CV Mosby, 1997: 1-14, 60-78, 109-136. [Context Link]

2. Roenigk RK, Resnik SS, Dolezal JF. Chemical peel with trichloroacetic acid. In: Roenigk RK, Roenigk HH, eds. Dermatologic surgery: principles and practice, 2nd ed. New York: Marcel Dekker, 1996: 1121-1145. [Context Link]

3. Coleman WP, Brody HJ. Advances in chemical peeling. Dermatol Clin 1997: 15: 19-26. Bibliographic Links [Context Link]

4. Monheit GD. Medium depth chemical peeling. In: Coleman WP, Lawrence N, eds. Skin resurfacing. Baltimore: Williams & Wilkins, 1998: 57-70. [Context Link]

5. Hayes DK, Berkland ME, Stambough KI. Dermal healing after local skin flaps and chemical peels. Arch Otolaryngol Head Neck Surg 1990: 116: 794. Bibliographic Links [Context Link]

6. Otley CC, Roenigk RK. Medium-depth chemical peeling. Semin Cutan Med Surg 1996: 15: 145-154. Bibliographic Links [Context Link]

7. Stegman SJ. A comparative histologic study of the effects of three peeling agents and dermabrasion on normal and sundamaged skin. Aesthetic Plast Surg 1982: 6: 123-135. Bibliographic Links [Context Link]

8. Brodland DG, Roenigk RK, Cullimore KC, Gibson LE. Depths of chemexfoliation induced by various concentrations and application techniques of trichloroacetic acid in a porcine model. J Dermatol Surg Oncol 1989: 15: 967-971. Bibliographic Links [Context Link]

9. Dinner MI, Artz JS. The art of the trichloroacetic acid chemical peel. Clin Plast Surg 1998: 25: 53-62. Bibliographic Links [Context Link]

10. Duffy DM. Alpha hydroxy acids/trichloroacetic acids: risk/benefit strategies. Dermatol Surg 1998: 24: 181-189. Bibliographic Links [Context Link]

11. Kotler R. Chemical rejuvenation of the face. St. Louis: CV Mosby, 1992: 136-179. [Context Link]

12. Ragland HP, McBurney EI. Complications of resurfacing. Semin Cutan Med Surg 1996: 15: 200-207. Bibliographic Links [Context Link]

13. Brody HJ, Hailey CW. Medium depth chemical peeling of the skin: a variation of superficial chemosurgery. J Dermatol Surg Oncol 1986: 12: 1268-1275. [Context Link]

14. Bridenstine JB, Dolezal JF. standardizing chemical peel solution formulations to avoid mishaps. great fluctuations in actual concentrations of trichloroacetic acid. J Dermatol Surg Oncol 1994: 20: 813.

Bibliographic Links [Context Link]

Accession Number: 00066678-200001320-00006

Full Text LinkBrowse Search ResultsFull Text Link | Titles Display | Main Search Page | Full Text LinkBrowse Table of ContentsFull Text Link | TOC