

Trichloroacetic Acid Paint for Boxcar and Polymorphic Acne Scars

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BACKGROUND Scarring is a common complication of acne vulgaris with a significant impact on the psychological well-being of patients. Focal application of high concentration trichloroacetic acid (TCA) has been proven efficacious in treating ice-pick scars, but the utility in other scar types is understudied.

OBJECTIVE The aim of this study is to evaluate the efficacy and safety of 90% TCA in boxcar and polymorphic acne scars using a novel brush applicator.

MATERIALS AND METHODS Forty-one patients with acne scars were recruited for treatment of boxcar and polymorphic scar with 90% TCA applied with a cosmetic brush. Each patient received 3 treatment sessions spaced between 7 and 9 weeks apart.

RESULTS All participants had good to excellent outcomes as per Jacob and colleagues grading. Patients with skin Type 3 to 6 had more excellent outcomes (13 patient, 59%) than patients of skin type 1 to 2 (9 patients, 41%). Two participants (5%) had postprocedural complications. Five participants (14%) were on concomitant isotretinoin with no appreciable increase in reepithelialization time or rate of complications.

CONCLUSION Focal 90% TCA with a cosmetic brush applicator is safe and effective in treating boxcar and polymorphic scars. The clinical outcome is good to excellent with low rates of complication.

Acne scarring often leads to profound psychological, social, and occupational impacts on the patient which can lead to a reduction in their quality of life.^{1,2} Acne scars are polymorphic in nature, and the morphology of the scar has profound implications in the modality of treatment that should be used.³ The classification system by Jacob and colleagues is the most widely accepted that divides acne scars into 3 main categories: ice-pick scars, boxcar scars, and rolling scars. Ice-pick scars are narrow scars (<2 mm) with deep penetration vertically into the deep dermis and even subcutaneous tissue.² Usually, the surface opening is wider than the infundibulum of the scar, but not always. Rolling scars are caused by tethering of the dermis to the subcutis as a result of scar tissues, which causes a shallow, rolling, and undulating appearance of the superficial epidermis.² Boxcar scars are round depressions with sharply formed edges and the opening of the scar and the infundibulum have the same width, unlike ice-pick scars.² In addition to this, keloid scar, atrophic scar, and scars with mixed morphology can also occur.^{3,4}

Scar severity is another important consideration in the treatment of acne.² Both quantitative and qualitative

methods have been developed to evaluate the severity of acne scarring and monitor the response of treatment.^{5,6}

Over time, a variety of treatment modalities have been developed for the revision of acne scars. The treatment needs to be individually directed based on which type of scar is present. The treatment for acne scars can be broadly divided into energy based and nonenergy based.^{3,4} Energy-based therapy includes ablative and nonablative laser, intense pulsed light, and radiofrequency ablation. Examples of non-energy-based therapy are dermabrasion, subcision, microneedling, and chemical peels.^{3,4}

Trichloroacetic acid (TCA) is a commonly used agent in treating acne scars with chemical peels. Trichloroacetic acid has the advantage of no systemic absorption which allows it to be titrated to high concentrations to achieve the depth of the peel.^{3,7} Chemical reconstruction of skin scars (CROSS), a novel technique involving focal application of high concentration TCA using a wooden application created by Lee and colleagues, demonstrated a good clinical response in patients with atrophic acne scars. Within the current literature, the most robust evidence for the efficacy of TCA CROSS is in the management of ice-pick scars.⁸

Although, the efficacy of CROSS has been demonstrated in the revision of ice-pick scars, its utility in other scar types has been inadequately explored. One study to date has explored the efficacy of TCA across boxcar scars, and no study has so far been performed in scars of undifferentiated morphology, such as partial boxcar scars or those with combined morphologies. In addition, there is limited literature regarding a cosmetic brush as an alternative application tool for TCA in the CROSS technique as a potential substitute for wooden applications. There is

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currently only 1 report in the literature by Rullan and colleagues that uses a fine paintbrush rather than a traditional toothpick.⁹

Materials and Methods

Patient Characteristics

This study was conducted with strict adherence to the principles outlined in the 1975 Declaration of Helsinki. Forty-one patients were prospectively recruited between June 2019 and August 2020. All patients had a known history of acne vulgaris with varying degrees of scarring.

Scar Selection

Classic boxcar scar less than 2 mm in diameter and partially treated broad boxcar scars (>3 mm) were included in this study. Polymorphic undifferentiated scars, namely, ones with a sharp border seen occupying 33% or greater of the scar and a sloping side edge were also included. The sloping edge was not treated to avoid scar extension. Rolling scars, hypertrophic scars, bridging scars, and saucer scars were excluded from this study. Isolated ice-pick scars were treated within the study; however, they were not included in the assessment of the treatment response because the efficacy of TCA CROSS for this type of scar has been demonstrated in previous studies.

Exclusion Criteria

Patients with a personal history of keloid scarring and treatment with adjunctive scar-directed therapy including laser, microneedling, radiofrequency microneedling, subcision, and dermal fillers in the preceding 6 months or during the study period were excluded.

Procedure

Before commencing the procedure, digital photography was performed of the patient's cheeks and temples bilaterally. The same area was then photographed again after each treatment. The photographs were taken in similar lighting each time, and 1 Canon EOS 70D using the same exposure setting was used consistently through this study.

The treatment area was cleaned with acetone, and a fine surgical marker was used to deliver a reference dot adjacent to the treated scars to ensure consistency for subsequent procedures. A controlled applicator (Element Games Kolinsky Stubby Detail Brush; Figure 1) was used to deliver the TCA paint to the base of the scar. For consistency of technique, 1 dermatologist (D.L.) applied the TCA paint to all patients for all treatment sessions. A concentration of 90% was chosen because the operator had extensive experience with this concentration.



Figure 1. Element Games Kolinsky Stubby Detail Brush. TCA, trichloroacetic acid.



Figure 2. Application of TCA to boxcar and undifferentiated scars using an Element Games Kolinsky Stubby Detail Brush. TCA, trichloroacetic acid.

Trichloroacetic acid was applied directly to the base of traditional boxcar scars (scars with sharp, well-demarcated shoulders as per Jacob and colleagues). Broad boxcar scars (>2 mm) were treated with partial TCA to the margin of the scar to avoid painting a large surface area which may result in delayed healing and potential scar extension. Undifferentiated scars that do not fall within the Jacob classification were only treated on the side with the sharp border (Figure 3). The application technique involved light brush strokes with 90% TCA. Frosting was seen within 8 to 16 seconds in all scars. In rare incidences requiring a second application, the second “brush stroke” was delivered 60 seconds after the initial application of TCA (Figure 2). Each patient underwent 3 sessions spaced between 7 and 9 weeks apart with the exact protocol as described above. Isotretinoin between 0.2 and 0.4 mg/kg/d was continued in some of the patients because it is not contraindicated in focal TCA CROSS.¹⁰

The postpeel protocol involved starting white soft paraffin moisturizer 3 times per day for 6 days, Cetaphil washes (Galderma) twice a day for 6 days, and doxycycline 50 mg daily for 7 days. sun protection factor 50+ sunscreen twice daily was initiated 3 weeks before treatment and recommenced day 5 postprocedure. For patients with a history of herpes simplex infection, valacyclovir 500 mg twice daily for 5 days was started postprocedure. Hydroquinone 5% was prescribed for skin Type IV and above only to reduce the risk of hyperpigmentation.

Scar count and assessment were performed by an independent dermatologist with the pretreatment and post-treatment photographs. The initial grading of the severity of scarring was performed with the Goodman quantitative grading system for acne scarring (See **Supplemental Digital Content 1**, Figure S1, <http://links.lww.com/DSS/A963>). The improvement from treatment was based on the disappearance of lesions as excellent (more than 70% of lesions disappearance), good (between 50% and 70%), fair (between 30% and 49%), and poor (less than 30% of lesions) as per Jacob and colleagues.² Postprocedure complications such as postinflammatory hyperpigmentation, postinflammatory erythema, and extension of scars, were recorded.

Statistical Analysis

Descriptive statistics were performed on the initial severity score, treatment response grading, and postprocedural complications of the participants. Simple linear regression was not performed to assess for the statistical relationship between skin type and response to TCA CROSS because of the small sample size.

Results

Thirty-seven of the 41 patients completed the study; 3 of the patients did not receive the full 3 sessions of treatments. Fifteen (41%) of them were male and 22 (59%) were female with age between 19 and 52 years. Fifteen patients (41%) had a skin type of 1 to 2 while the remainder of 22 patients (59%) had darker skin Type 3 to 6. All patients had severe acne scarring and scores from 3 to 4 on the Goodman classification (8 had Goodman Grade 3 and 29 had Goodman Grade 4). More patients in the skin Type 3 to 6 group (6 patients) scored 3 on the Goodman classification scale than patients in the skin Type 1 to 3 group (2 patients), whereas the number of patients with Goodman Grade 4 acne scarring is also higher in skin Type 3 to 6 (16 skin Type 3–6 and 13 skin Type 1–3). Five (14%) of the patients were isotretinoin, and 32 patients (86%) were not on any retinoid medications.

The final assessment for the effect of the treatment was performed 6 weeks after the third and final treatment cycle. All of the participants had either good or excellent responses to treatment as per the scale by Jacob and colleagues. Twenty-one patients (57%) had excellent and 16 patients (43%) had good outcomes (Table 1). Patients with skin Type 3 to 6 had a higher percentage of excellent outcome (13 patient, 59%) than patients with the lighter skin type of 1 to 2 (9 patients, 41%; Table 1).

Two participants (5%) experienced complications from the procedure; 1 patient had postinflammatory erythema and 1 had postinflammatory hyperpigmentation (Figure 4) of the treatment field that spontaneously resolved 8 weeks post-treatment (Table 2). Concomitant isotretinoin therapy did not lead to longer epithelialization time or additional complications from the procedure (Table 3).

Discussion

Trichloroacetic acid has a long history of being used in chemical peels for skin resurface and scar revision.⁷ The lack of systemic absorption allows TCA concentration to be

TABLE 2. Rate of Complications

Skin Type	No. of Patients	Rate of Complications	No Complications
1–3	16	0	16
4	14	1 persistent erythema	13
5	6	0	6
6	1	1 PIH	0
Total no. of complications		2	

titrated to achieve the depth of peel as required.⁷ The application of TCA induces precipitation of proteins and coagulative necrosis of the cells in the epidermis and necrosis of the collagen bundles in the papillary and upper reticular dermis.¹¹ This allows the skin to reepithelialize from the preserved pilosebaceous unit. In human and animal studies on the effect of TCA on the skin, the clinical effects have been attributed to the reorganization of dermal volume due to increased production in collagen content.^{12,13}

Deeper peels with TCA have increased complications of scarring; therefore, the application of such agents indiscriminately to affected and healthy skin is a risky practice.⁷ Lee and colleagues proposed in a prospective study involving 65 patients the novel technique of applying high concentrations of TCA (65% and 100%) to only acne scars using a thin and pointing wooden applicator, which allowed spillover to healthy skin to be minimized. Both treatment groups achieved favorable clinical outcomes. Eighty-two percent of patients receiving 65% TCA CROSS had a good or excellent response compared with 94% in the 100% TCA arm. The rate of complication was minimal with no cases of persistent erythema, hyper or hypopigmentation, scarring, or keloids by minimizing the damage to the surrounding healthy skin. In the systemic review by Chung and colleagues,⁸ the efficacy of 100% TCA for ice-pick scars is between 73.3% and 80% for an improvement over 70%, and 93.3% and 100% for an improvement over 50%. Lower concentrations of TCA, such as 50% and 70%, have also been reported to be effective in the management of atrophic and ice-pick scars with more than 50% of patients having >50% improvement.^{10,14,15}

The most common complications of TCA are post-inflammatory hyperpigmentation and persistent erythema post-treatment, both of which are more common in patients with darker skin types.⁸ The most concerning but rare complication of TCA CROSS is scar extension which has been reported in up to 17% of patients by Agarwal and colleagues.

Although the efficacy of CROSS in treating ice-pick scars has been demonstrated in previous studies, its utility in other scar types has not been as robustly demonstrated. To this date, there has been only 2 studies involving TCA

TABLE 1. Treatment Response as per 4-Grade Scale by Jacob and colleagues

Skin Type	No. of Patients	Excellent	Good
3–6	23	13	11
1	9	6	3
2	4	3	1
Total no. of patients	37	22	15

TABLE 3. Average Reepithelialization Time in Patients With Concomitant Isotretinoin Use

	No. of Patients	Average Reepithelialization Time	Rate of Complications
On isotretinoin	5	6.4 d	0
Not on isotretinoin	32	6.2 d	2

CROSS monotherapy in the management of acne scars other than the ice-pick type. In a study involving 53 patients, Agarwal and colleagues treated a mixture of ice-pick, boxcar, and rolling scars with 70% TCA CROSS with good or excellent clinical response in 66% of the patients. The postprocedure assessment of treatment response, however, was based on overall improvement across all scar types.¹⁴ Garem and colleagues¹⁵ demonstrated in a cohort of 30 patients managed with 50% TCA CROSS a statistically significant ($p < .05$) reduction in the Goodman grading score of boxcar scars. The overall assessment of clinical efficacy was unfortunately not discriminated against each scar type. Currently, there are no studies that have assessed the selected efficacy of TCA CROSS for scar types other than ice-pick scars.

In this study, we demonstrate the outcome of TCA CROSS technique specifically in the treatment of classical and partial boxcar scars. The cohort of 37 participants treated with 90% TCA had good to excellent outcomes in all of the patients enrolled in this study. More patients with a darker skin type achieved an excellent response ($>50\%$) to treatment as per the 4-grade scale by Jacob and colleagues likely due to the more vigorous fibroblastic response seen in those skin types. The complication rate is low with only 2 patients sustaining postprocedural erythema and hyperpigmentation, both of which resolved within 8 weeks since the completion of treatment. The outcome of this study suggests that TCA CROSS could potentially be a new efficacy and cost-effective study in the management of boxcar scars compared with conventional energy-based therapy.

This study also demonstrates a potential novel medication to the existing TCA CROSS technique. Logistically, TCA CROSS is a time-consuming procedure especially

when a larger scar base area must be covered. The applicator traditionally used in the technique also suffers from a lack of tactility and accuracy. The new technique using a cosmetic brush is potentially helpful in reducing the duration of treatment and achieving more accurate coverage of the scar base without compromising the clinical response of the treatment. Interestingly, the 2 studies which reported a high scar extension rate of 17% and 13.3% both used wooden applicators.⁸ This possibly suggests that the traditional approach may cause more spillover of TCA onto healthy skin. Although this new technique has proven to be effective in the management of boxcar scars in this study, its applicability to the management of ice-pick scar and others is yet to be explored.

Isotretinoin has been historically considered to increase the risk of delayed healing and scarring in a range of dermatological procedures including chemical peels.¹⁶ The 2017 systematic review by JAMA isotretinoin and timing of procedural intervention conclude that sufficient evidence exists that superficial peel in the setting may not be associated with increased complications, although more rigorous studies need to be further conducted.¹⁶ Interestingly, the 5 patients on low-dose isotretinoin therapy did not experience any complications in this study, and the mean reepithelialization time was similar (6.4 vs 6.2 days) between those on retinoids and the rest of the cohort. To the author's knowledge, this is the first CROSS study with the inclusion of patients on isotretinoin. However, owing to the small sample size, the true implication of this finding needs to be further elucidated in higher power studies.

The limitation of this study includes small sample size, single-center, and single-operator study design. The small size of the study precluded further analysis of the data for the association between skin type and treatment response in



Figure 3. Principle of management of polymorphic scar with TCA paint to avoid potential scar extension associated with undifferentiated scars. TCA, trichloroacetic acid.



Figure 4. Postprocedural hyperpigmentation in a Type VI skin patient after 2 sessions of TCA paint for acne scarring. TCA, trichloroacetic acid.

addition to limiting the level of evidence produced by the outcome of this study. The applicability of the study outcome is limited by the scar selection which predominantly involved classical and partial boxcar scars. This technique is not indicated in other scar types such as rolling scars or saucer scars. The area of skin used in this study involved primarily the temple region and bilaterally cheeks. Scarring to the midline areas such as forehead, nose, and chin was not assessed, which may respond differently to TCA.

Conclusion

The chemical reconstruction of skin scars technique with 90% trichloroacetic acid is safe, minimally invasive, and effective in treating boxcar and polymorphic scars in patients with acne vulgaris. The clinical outcome is good to excellent with low rates of complication and may be safe with concomitant low-dose isotretinoin therapy. A cosmetic paint brush as an alternative to the traditional wooden applicator may help to reduce treatment duration and provide a more accurate application of the agent to the scar base to prevent scar extension. Further studies are recommended to clarify concurrent isotretinoin use with CROSS and the applicability of brush technique with other scar types and other cutaneous surfaces.

References

1. Taub AF. The treatment of acne scars, a 30-year journey. *Am J Clin Dermatol* 2019;20:683–90.
2. Jacob CI, Dover JS, Kaminer MS. Acne scarring: a classification system and review of treatment options. *J Am Acad Dermatol* 2001;45:109–17.
3. Kravvas G, Al-Niaimi F. A systematic review of treatments for acne scarring. Part 1: non-energy-based techniques. *Scars Burn Heal* 2017;3:2059513117695312.
4. Kravvas G, Al-Niaimi F. A systematic review of treatments for acne scarring. Part 2: energy-based techniques. *Scars Burn Heal* 2018;4:2059513118793420.
5. Goodman GJ, Baron JA. Postacne scarring: a quantitative global scarring grading system. *J Cosmet Dermatol* 2006;5:48–52.
6. Goodman GJ, Baron JA. Postacne scarring: a qualitative global scarring grading system. *Dermatol Surg* 2006;32:1458–66.
7. Lee JB, Chung WG, Kwahck H, Lee KH. Focal treatment of acne scars with trichloroacetic acid: chemical reconstruction of skin scars method. *Dermatol Surg* 2002;28:1017–21.
8. Chung HJ, Al Janahi S, Cho SB, Chang YC. Chemical reconstruction of skin scars (CROSS) method for atrophic scars: a comprehensive review. *J Cosmet Dermatol* 2021;20:18–27.
9. Rullan PP, Olson R, Lee KC. A combination approach to treating acne scars in all skin types: carbolic chemical reconstruction of skin scars, blunt Bi-level cannula subcision, and microneedling—a case series. *J Clin Aesthet Dermatol* 2020;13:19–23.
10. Fabbrocini G, Cacciapuoti S, Fardella N, Pastore F, et al. CROSS technique: chemical reconstruction of skin scars method. *Dermatol Ther* 2008;21(Suppl 3):S29–32.
11. Yag A, Lane JE, Howard MS, Kent DE. Histologic study of depressed acne scars treated with serial high-concentration (95%) trichloroacetic acid. *Dermatol Surg* 2006;32:985–90.
12. Stegman SJ. A comparative histologic study of the effects of three peeling agents and dermabrasion on normal and sun-damaged skin. *Aesthet Plast Surg* 1982;6:123–35.
13. Brodland DG, Cullimore KC, Roenigk RK, Gibson LE. Depths of chemexfoliation induced by various concentrations and application techniques of trichloroacetic acid in a porcine model. *J Dermatol Surg Oncol* 1989;15:967–71.
14. Agarwal N, Gupta LK, Khare AK, Kuldeep CM, et al. Therapeutic response of 70% trichloroacetic acid CROSS in atrophic acne scars. *Dermatol Surg* 2015;41:597–604.
15. Gareem YE, Ghabrial EH, Embaby M. Chemical reconstruction of skin scars technique using trichloroacetic acid in different types of atrophic acne scars. *Egypt J Dermatol Venereol* 2013;33:37.
16. Spring LK, Krakowski AC, Alam M, Bhatia A, et al. Isotretinoin and timing of procedural interventions: a systematic review with consensus recommendations. *JAMA Dermatol* 2017;153:802–9.