

A comparative study of skin resurfacing using a fractional Er:YAG laser versus medium-depth peeling in the management of post-acne sequelae

Fractional Er:YAG versus medium-depth peeling in post-acne sequel

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Abstract

Background: Post-acne scarring is a common permanent disfigurement to the face and various treatment modalities are available. Chemical peeling and ablative lasers have been used with varying degrees of success and complications.

Objective: In this study we compared the effects of medium-depth chemical peel by sequential use of glycolic acid (GA) and trichloroacetic acid (TCA), with a combination treatment of fractional and conventional Er:YAG lasers.

Methods: one hundred and twenty patients with post-acne scarring were randomly divided over two equally-sized groups. Group I underwent medium-depth chemical peeling and group II was treated with fractional Er:YAG laser. Patients were evaluated both subjectively and objectively during each follow-up visit.

Results: Laser therapy was more effective than medium-depth peel. Subjective evaluation showed a higher satisfaction rate of 87.5% in group II, satisfaction fell to 52.5% in group I. Objective evaluation showed "very good" to "excellent" outcome in 82.5% of cases treated in group II. In group I outcome was "good" in 47.5% and "poor" in 32.5% of cases.

Conclusion: Combined Er:YAG laser therapy had a shorter downtime, was more effective, showed a longer lasting effect and proved safer than the combined use of GA/TCA chemical peels.

Key words: Post-acne scarring, chemical peeling, Er:YAG lasers, fractional laser treatments.

Introduction:

Over the past several years, many patients have become increasingly concerned about the cosmetic appearance of their skin; especially in the face. One of the most frequent cosmetic problems is acne vulgaris (AV), of which the most common sequelae are hyperpigmentation and scarring.¹⁻³

Post-acne scars and hyper-pigmentation are very difficult to treat and various modalities for the elimination or improvement of already manifested acne scarring are in common use. A common treatment modality is chemical

peeling.⁴ There are many products currently available for chemical resurfacing of the skin, from over-the-counter superficial peeling agents to deep-peeling chemicals. The therapeutic effect of glycolic acid (GA) in acne is claimed to be through mild epidermolysis with dislodgment of comedones and unroofing of pustules that affect the follicular epithelium at the sebaceous gland level. Hence, excess keratinization of the pilosebaceous duct is avoided.^{5,6}

Medium-depth chemical peeling is defined as controlled damage to the papillary dermis.

Indications for medium-depth peel include destruction of epidermal lesions, resurfacing moderately photoaged skin, correction of dyschromias, and repair of acne scars. The classic agent for medium depth peeling is Trichloroacetic acid. TCA emerged as the leading chemical peeling agent because of the ability it offers to specifically design the depth of acid penetration according to the nature and type of problem of the skin.⁷ TCA is a peeling agent that promotes important proteic coagulation when in contact with the skin. Classically, TCA is used in concentrations between 15% and 50% for chemical peelings on the face. In its liquid form and concentration of 30%, TCA can provoke necrosis (coagulation) of the epidermis and, papillary and/or reticular dermis, consequently causing deep epidermolysis with a residual process that can last between three to eight weeks. Undesirable side effects are frequent and include post-inflammatory hyperpigmentation, hypopigmentation, infections and hypertrophic scars.^{8,9}

Laser resurfacing is another modality to treat acne scarring. Both CO₂ (10,600 nm) and Er:YAG (2,940 nm) lasers are used for skin resurfacing.¹⁰ Er:YAG laser causes less thermal damage but more intra-operative bleeding than CO₂ laser. Post-operatively however, epithelialization is rapid, erythema resolves significantly faster and the incidence of scarring is low.¹¹ The indications for use of the Er:YAG laser are continuously expanding by the recent introduction of the fractional technique, which is considered less aggressive than the more conventional ablative mode.¹²

In this study we discuss our experience and

our own protocol for post-acne facial resurfacing with the fractional Er:YAG laser, comparing the results with those of medium-depth chemical peeling.

Patients and methods:

The study was conducted at Ain Shams University and included 120 patients with complaints from post-acne scarring. Eighty patients were female, forty male and ages ranged between 25 and 45 years old. Patients were randomly divided into two groups. Group I included 60 patients treated with five to ten treatment sessions of medium-depth peeling. Group II included 60 patients treated with four to eight fractional Er:YAG laser treatment sessions. Both treatment modalities were applied at two to three weeks intervals. Informed consent, which explained the purpose, possible outcome and side effects of the study, as well as permission to document the study with medical digital photography were taken from each patient. Patients who had previous skin or eye viral herpes zoster or simplex and psychologically imbalanced patients were excluded. Oral isotretinoin intake was stopped for at least 6 month before the start of the treatment. Patients included in this study suffered from post-acne manifestations in the form of superficial elastolysis, pits, hyperpigmentation, atrophic scars, inflammatory scars, hypertrophic scars and keloids. These deformities were evaluated in respect to their severity using a 4-point rating scale: 1=minimal, 2=mild, 3=moderate, 4=severe. The severity of post-acne sequelae among the population of each group is recorded in **Table(1)**.

Table (1): The severity of post-acne sequelae in both study groups, assessed using a 4-point rating scale.

	Group 1	Group 11
Minimal	8	5
Mild	20	15
Moderate	16	15
Severe	16	25

Most of the patients were of Fitzpatrick skin types II-IV (95%), and only 5% were of type V. The relative representation of each

skin type among the population of each group is shown in **Table(2)**.

Table (2): Skin types in each group.

	Group 1	Group 11
Type II	18	8
Type III	20	24
Type IV	20	25
Type V	2	3

Patients were prepared for a two-week period prior to the treatments using 4% alpha hydroxyl-acid skin cream, and sunscreen with sun protection factor 100. Chemical peeling sessions started by cleansing the face with a normal 0.9% saline solution. GA at 70% concentration was applied for one minute followed by complete removal. TCA, at 15% solution, was then applied until white frost was achieved. A sterile cotton pad is used for application and removal in the same way and direction as application. Post-peeling management included applying topical soothing cream, sunscreen and avoiding make up for three to five days after the treatment. Pre-operative preparations for the next session were then commenced and sessions were repeated at 2-3 weeks interval. Number of sessions ranged from 5-10.

The fractional 2940 nm, Er:YAG laser treatment was administered using an XS Dualis laser system (Fotona, Slovenia), which is capable of providing fractional ablative,

fractional non-ablative and conventional full-field ablative Er:YAG modalities. Fractional treatments are based on variable square pulse (VSP) and pixel screen technologies; the fractioned laser beam's pulse durations ranges from 100 μ s for very short pulse (VSP) mode to 1.500 μ s for extra long pulse (XLP) mode. Combinations of different pulse durations, namely VSP, short pulse (SP), long pulse (LP) and XLP, were used with fluencies reaching up to 1200 J/cm², spot size approximately 3-7 mm, pulse frequency 3-4 Hz and pixel level 3-4 on the handpiece. The number of passes ranged from 4-11 per session and the number of sessions ranged from 4-8 sessions according to the case, with a 2-3 week interval. Conventional, full-field Er:YAG laser treatments were started on the 3rd to 4th session. The use of Er:YAG treatment modalities, treatment pulse durations and number of passes applied are summarized in **Table(3)**.

Table (3): Number of passes per treatment modality and selected laser pulse duration mode for use individual.

Laser session	Fractional Er:YAG				Traditional ER:YAG	
	VSP	SP	LP	XLP	VSP	SP
1 st session.	2 passes	2 passes	none	none		
2 nd session.	2 passes	2 passes	1 pass	none		
3 rd session.	2 pass	2 passes	none	1 passes	1 pass	
4 th session.	1 pass	3 passes	none	2 passes	2 passes	
5 th session.	1 pass	3passes	none	2 passes	2 passes	
6 th session.	1 pass	3passes	none	2 passes	2 passes	1passes
7 th session	1pass	3passes		2 passes	2 passes	2 passes
8 th session	1pass	3passes		3passes	2 passes	2passes

Post laser treatment management included topical application of fucidic acid ointment for 3-5 days, soothing cream and sun block with sun protection factor 100. Pre-operative preparations for the next session were then commenced.

Follow-up visits were conducted for up to 2 years at 1-2 month intervals after the end of the last session. Patients were evaluated both subjectively and objectively during each visit. Subjective evaluation was based on both patient satisfaction and surgeon opinion. Patient satisfaction was rated as “very satisfied”, “satisfied” or “dissatisfied”.

Objective evaluation was conducted on the basis of evaluation of pre- and post-treatment photos by an independent physician. The objective evaluations were rated as either “excellent”, “very good”, “good”, “fair” or

“poor”. Any complications during treatment or after, such as infection, scarring, or pigmentary changes, were observed and recorded. **Figure(1a, 2a, 3a)** in group I and **Figure(4a,c, 5a ,6a,c)** in group II

Results:

During the course of our study we treated 120 patients of both sexes suffering from post-acne sequelae and with skin types ranging from Fitzpatrick type II to type V. Laser therapy was more effective than medium-depth peel.

Subjective evaluation showed a higher satisfaction rate of 87.5% in the laser treatment group (group II), with patients claiming to be “very satisfied” and “satisfied”. Satisfaction fell to 52.5% in the chemical peel group (group I), with 28 patients claiming to be “dissatisfied” **Table(4)**.

Table (4): Showing percentage of patient satisfaction in both groups.

	Group I		Group II	
	No	%	No	%
Very satisfied	11	17.5 %	22	37.5 %
Satisfied	21	35 %	30	50 %
Dissatisfied	28	47.5	8	12.5 %

The objective evaluation showed “very good” to “excellent” outcome in 75.5% of cases treated in group II based on surgeon opinion and documented photos. In group I,

the medium-deep chemical peel group, outcome was “good” in 47.5% and “fair” in 32.5% of cases **Table(5)**. **Figure(1b, 2b, 3b)** in group I and **Figure(4b,d, 5b, 6b,d)** in group II

Table (5): Results of objective evaluation of the clinical end results in the chemical peel and laser treatment group.

	Group I		Group II	
	No	%	No	%
Excellent	3	5 %	18	30 %
Very good	9	15 %	27	45.5%
Good	29	47.5 %	15	24.5%
Fair	20	32.5 %	0	0 %
Poor	0	0 %	0	0 %

Apart from recording a case of bacterial infection in group I and a case of Herpes Simplex in group II, no other complications or unwanted side effects were recorded and both treatment modalities were deemed safe. Patients reported a higher degree of aggravation during and immediately after laser treatment than in the chemical peeling group. This was due to the higher incidence of pain during laser

treatments, and erythema, edema and scabbing immediately after treatment sessions. Medium-depth peeling required more sessions to reach the clinical end-point and was associated with a higher incidence of pigmentary changes, scarring and acne flaring, which required modification of the post-treatment therapy, than in the laser treatment group **Table(6)**.

Table (6): Treatment-related complications in the laser treatment and chemical peel groups.

	Group I		Group II	
	No	%	No	%
Pain	11	17.5 %	45	75 %
Erythema	12	20 %	60	100 %
Blisters	-	0 %	-	0 %
Scabbing	9	15 %	12	20%
Swelling	5	7.5 %	22	37.5 %
Hyper-sensitivity	9	15 %	-	0 %
Hyper pigmentation	8	12.5 %	3	5 %
Scarring	1	1.7%	-	0 %
Bacterial infection	1	1.7%	-	0 %
Viral infection	-	0 %	1	1.7%
Hypo pigmentation	3	5 %	-	0 %
Acne flaring	-	0 %	-	0 %

Cases of both groups are illustrated as follows:



Figure (1A):Before (lt.Side).



Figure (1B):After (lt.Side).

Figure (1): Chemical peeling (combined peeling).

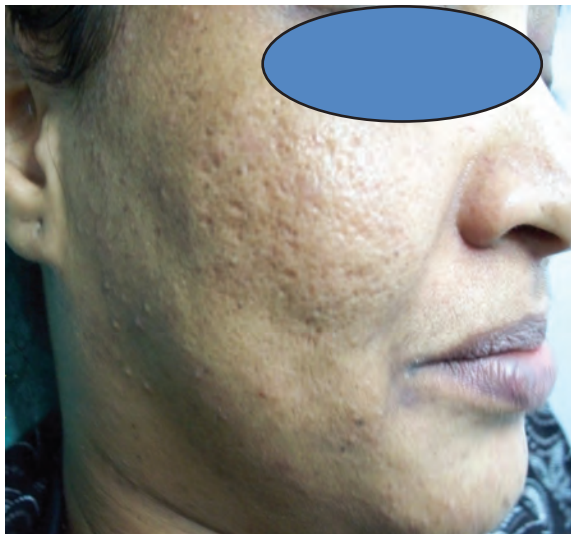


Figure (2A):Before.



Figure (2B):After.

Figure (2): Combined Peeling.

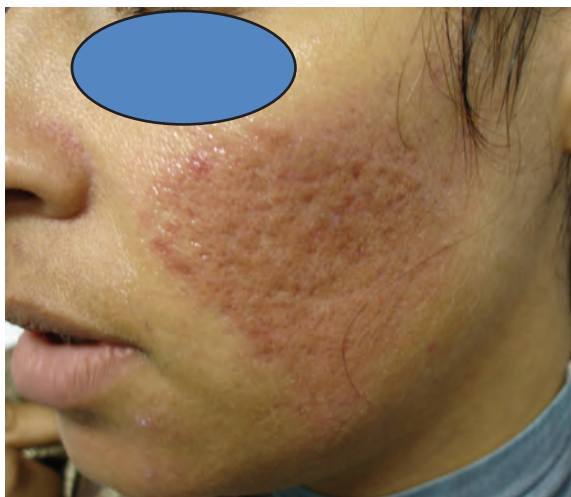


Figure (3A):Before.

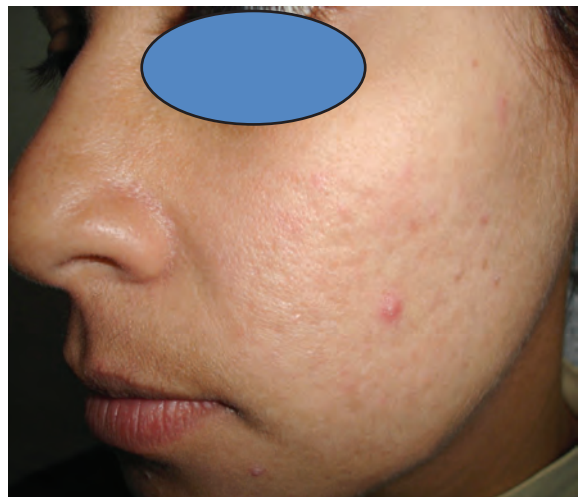


Figure (3B):After.

Figure (3) : Combined Peeling.



Figure (4A):Before (Rt. Side).

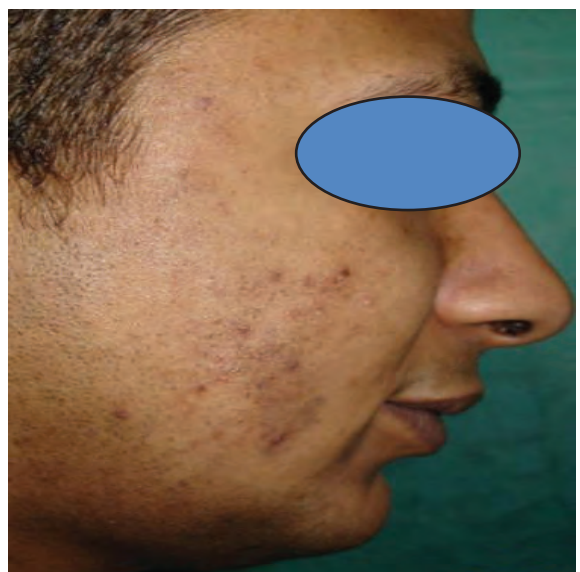


Figure (4B):After (Rt. Side).



Figure (4C):Before (Lt. Side).

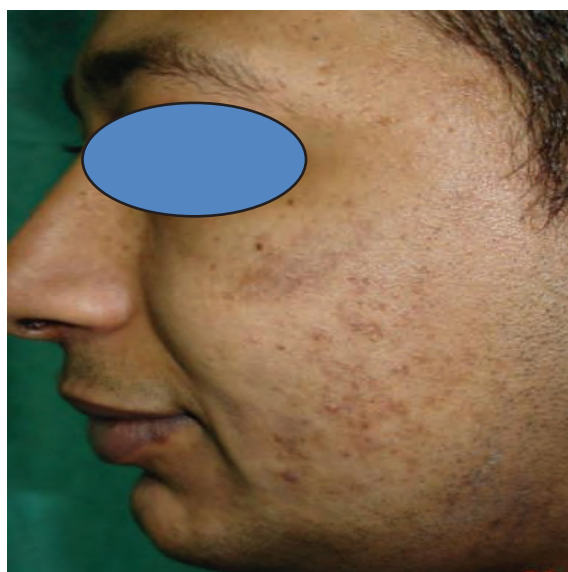


Figure (4D):After (Lt. Side).

Figure (4 A,B): Right side of the face and (C,D) left side: Combined fractional and Er: YAG laser.



Figure (5A):Before.



Figure (5B):After.

Figure (5): Before and after left side of the face : Combined fractional and Er: YAG laser.



Figure (6A):Before (Lt. Side).



Figure (6B):After (Lt. Side).



Figure (6C):Before (Rt. Side).



Figure (6D):After (Rt. Side).

Figure (6 A,B): Left side before and after and (C,D) right side of the face before and after: Combined fractional and Er: YAG laser.

Discussion:

Acne vulgaris carries with it significant psychosocial morbidity, social withdrawal and clinical depression in addition to the potential for long-term scarring and disfigurement.¹³

Many systems have been developed for the classification of acne scars so that the morphology of each scar can be assessed and

treatment designed accordingly. Jacob et al.¹⁴ divided atrophic acne scars into ice pick, rolling and boxcar scars. Kadunc and Trindade de Almeida¹⁵ classified acne scars into elevated, dystrophic and depressed. Depressed or atrophic scars are contour or volume defects that may be distensible or non-distensible depending on the underlying attachment.

Acne is one of the most frequent inflammatory chronic dermatoses. More than 80% of teenagers of both sexes are affected and up to 20% of adults have persistent acne lesions. Post-acne hyperpigmentation and scarring are among the most common sequelae of acne vulgaris. They are cosmetically and psychologically distressing, especially for women.¹⁶ In our study, 67% of patients were females. We classified patients according to the severity of their post-acne sequelae as minimal, mild, moderate or severe deformity. This allowed us to study the effect of each modality in individual cases.

Several surgical techniques have been investigated to treat post-acne scarring including punch excision, scar subcision and dermabrasion.¹⁷ Depth control is difficult to attain with dermabrasion and scar subcision may need to be combined with laser resurfacing.¹⁸⁻²⁰ Resurfacing is one of the most widely used techniques. It involves removing the outer layers down to the level of the papillary dermis, which induces re-epithelialization and new collagen formation, creating a smoother, even-toned and more youthful appearance.²¹ Resurfacing can be achieved by means of chemical peeling or ablative lasers.

Chemical peeling produces a controlled partial-thickness chemical burn of the epidermis and the outer dermis. Regeneration of peeled skin from follicular and eccrine duct epithelium results in a fresh, orderly and organized epidermis. In the dermis, a new 2 to 3 mm band of dense, compact and orderly collagen is formed between the epidermis and the underlying damaged dermis. This reduces wrinkles, scarring and pigmentation.²²⁻²⁴ Different types of chemical peelings are now being used in medical practice. Phenol produces deep peeling effects that need long periods of healing and may be associated with serious complications including nephrotoxicity, hepatotoxicity and cardiac arrest.^{23,26} Glycolic acid (GA) is a superficial peeling agent. Multiple superficial peels with GA are recommended to improve post-acne scars.²⁶ This stimulates dermal fibroblasts to produce collagen decreasing the risk of tissue necrosis and reducing the size of the follicular pores.²⁷

Nevertheless, treatments can fail when a superficial peeling agent is used alone.

Trichloroacetic acid (TCA) is another peeling agent. It can produce peelings of medium depth without the serious risks of phenol^{23,25} and thus remains the gold standard in chemical peeling. It is maximally effective in Fitzpatrick's skin types I-III. In darker skin types, even TCA 15% or 20% can be fraught with post-peel complications. Undesired side effects such as post-inflammatory hyperpigmentation and hypopigmentation, infections and hypertrophic scars are frequent. A new form of using TCA, as a selective peeling agent, is in association with GA which helps to promote a greater efficacy in the penetration of TCA. Chelation of the TCA molecule (linking the TCA to aminoacids), on the other hand, does not allow this molecule to penetrate deep into the skin, and because of this, unnecessary necrosis of the dermal layer can be avoided.²⁸ The combination of TCA with GA maximizes the peeling effect and diminishes the side effects of using each alone. Addition of GA improves the absorption of lower TCA concentrations and reduces the risk of complications.²⁴

In this study we performed combined peeling on 60 randomly selected patients, using first GA 70% followed by TCA 15% depending on skin type and thickness. This technique enabled us to induce medium-depth peeling with the least possible side effects and good results. El-Ammawi²⁶ used rising concentrations of GA 20%, 35%, 50% and then 70%. Unlike post-acne hyperpigmentation, the acne scarring did not continue to improve after discontinuing the peeling regime using GA.²⁶

Wang et al.²⁷ recommend repetitive peelings to improve scars. The degree of clinical improvement is proportional to the number of peeling courses with either GA³ or TCA.²⁹ Waiz MM and Al-Sharqi³⁰ and Saleh et al.³¹ attributed the higher degree of improvement with TCA 35% with increasing number of sessions to the deeper penetration of TCA because the skin did not return to the pre-peel thickness in the short interval between sessions. In this study we used medium-depth peeling with GA 70%, followed by TCA 15%. The

therapeutic result is equivalent to TCA 35% without its adverse effects.²⁸ We agree with previous studies that the effect is strongly attributed to the number of sessions; in some cases we performed up to 10 sessions. The main drawbacks of peeling are the poor patient compliance because of the long treatment period and low persistence of post-peeling effects over time.

Both non-ablative and ablative lasers are used in the treatment of post-acne scarring. Non-ablative Nd:YAG laser stimulates new collagen production by producing localized thermal injury to the dermis, which initiates a wound healing response.³²⁻³⁴ Recently a Nd:YAG Accelera technology was developed that produces a three dimensional fractional thermal injury pattern in the epidermis and dermis. Thermal damage islands located predominantly at the sites of skin imperfections.^{21,35-37} CO₂ (10.600 nm) and Er:YAG (2.940 nm) are ablative lasers used for treatment of post-acne scars through the process of skin resurfacing.^{10,38} Both lasers are well absorbed by water, but Er:YAG laser has a higher water absorption coefficient and thus higher affinity for water. The cutaneous absorption of the Er:YAG laser energy by water is 10 fold more efficient than that of the CO₂ laser allowing for more superficial tissue ablation. It produces less thermal damage but more intraoperative bleeding than CO₂ laser. However, post-operative epithelialization is rapid, erythema resolves significantly faster and the incidence of scarring is low.^{11,35,38,39}

Recently the fractional technique was introduced based on a concept of producing an array of microscopic wounds on the skin surface that are rapidly re-epithelialized by the surrounding healthy tissue.^{40,41} Some fractional Er:YAG lasers have variable pulse durations allowing the effect of the laser to be selected from cold ablation peeling to deeper thermal coagulation for the treatment of atrophic scars, such as acne scars.^{12,42}

The incidence of complications in resurfacing procedures is generally related to the depth of ablation and patients' pigmentation problems. Pulse width is a key factor that determines the heating depth. If the laser is delivered in a very short time, ablation occurs

before significant heat diffusion. The Er:YAG laser has the largest range of coagulation depth control.¹²

In the laser group (group II) we followed a specific protocol that combines ablative and non-ablative modes with differing fluences and pulse durations. Starting at the 3rd session, we added the conventional Er:YAG mode. This protocol acted both superficially on the epidermis, through the conventional mode that works by variable square pulse (VSP) technology, and deep on collagen remodelling through the fractional mode that works with pixel screen technology (PST) with almost no side effects. We used ablative modes for pigmentation and to smooth scar edges, also when we started with ablative modes this removed superficial skin layers which allowed controlled deeper penetration of non ablative modes and better results.

The well-tolerated, fewer sessions and the short, well controlled downtime together with the efficacy and speed of procedures made this technique popular with patients. Patient satisfaction was better, complications were fewer and therapeutic result was long-lasting through the 2-year follow-up period. Patient satisfaction indicated 37.5% "very satisfied" in group II in comparison with 17.5% in group I.

Saleh et al.³¹ compared the results of TCA peeling with conventional Er:YAG laser resurfacing. Their results revealed that the overall improvement (irrespective of the degree) was equal in both groups (60%). Our study showed 30% "excellent" results in the laser group compared to 5% in the peeling group, and 45.5% "very good" results in the laser group compared to 15% in the peeling group.

Conclusion:

Skin resurfacing with medium-depth chemical peel, using GA followed by TCA was compared to the combined use of fractional and conventional Er:YAG laser in patients with post-acne scarring. The addition of GA in our peeling protocol increased the depth of penetration of the low concentration TCA solution, thus minimizing its potential complications and improving its controlled

absorption. The combined Er:YAG laser therapy markedly improved the results of resurfacing postacne scars and minimized the complications in our dark skin types population. The parameters and regimen recommended in this study were very effective in the management of post-acne sequel and results were more superior and long lasting than with medium-depth chemical peeling.

Authors have no financial interests to disclose.

Abbreviations:

CO₂ is carbon dioxide laser,
Er:YAG is Yttrium Aluminum Garnite laser.

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