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Comparative Study between the Combination of Nano Fat Grafting with Fractional Carbon Dioxide Laser, versus Nano Fat Grafting Alone in Treatment of Facial Atrophic Acne Scars

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Abstract

Background: Post Acne scars are challengeable cosmetic problems causing psychological distress. Nano fat has gained a lot of interest in management of facial scars. Fraction carbon dioxide laser is one of the most common modalities used in management of acne scars.

Objective: This paper aims to evaluate the efficacy of combining nano fat with fractional CO_2 laser versus nano fat alone for the treatment of post acne facial scars in a randomized, split-face clinical study.

Patients and Methods: This prospective, randomized, split-face study was done on 25 patients, above 16 years old, both sexes were included, suffering from atrophic facial acne scars grade 2 and 3 according to Goodman and Baroon scale. Nano fat grafting was performed on both cheeks and fractional CO_2 laser on one cheek in a randomized pattern to all patients.

Results: Patient satisfaction showed no significant difference between both sides. Erythema was significantly higher in nano fat grafting with CO_2 laser, than in nano fat grafting alone (p<0.05). Degree and clinical improvement were significantly better in nano fat grafting combined with CO_2 laser than nano fat grafting alone (p<0.05). Baseline thickness showed no significant difference between both sides, while epidermal thickness during follow-up was significantly higher in nano fat grafting combined with CO_2 laser than nano fat grafting alone (p<0.05).

Conclusions: The combination of autologous nano fat injections and fractional CO_2 laser therapy stands as a promising solution for management of facial scars induced by acne.

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Introduction

Post acne scars appear after resolution of the inflammation caused by acne **[1]**.

Acne scars can be divided into: Atrophic, hypertrophic and keloidal. Atrophic acne scars being the most common **[2]**.

Multiple techniques have been implicated for reducing the appearance of atrophic acne scars, like subcision, excisions and other methods such as autologous fat transfer, injection of dermal fillers, dermabrasion, chemical peels, and laser therapy (non-ablative and ablative). However there is still no gold standard treatment **[3-5]**. Fractional carbon dioxide (CO_2) laser therapy emerged as a prominent treatment for acne scars, offering a minimally invasive approach to skin resurfacing. This technique utilizes laser energy to create controlled micro-injuries in the skin, stimulating natural healing processes and resulting in the development of healthier skin tissue **[6]**. Autologous fat grafting (AFG) has emerged as a promising technique in scar management, leveraging the regenerative properties of stem cells to enhance tissue repair and improve scar appearance. This approach involves harvesting a patient's own fat tissue, processing it to concentrate ADSCs, and injecting it into scarred areas to promote healing and rejuvenation **[7]**.

Fat grafting has been shown to be useful in many aesthetic treatments, not only for its lipofilling ability, but also for its regenerative properties and skin texture improvement [8,9].

Nano fat injection is a relatively new concept in the regenerative medicine which seems to be a suitable option for treatment of scars. To ensure a smooth fat injection a through thinner injection needles up to 27 gauge are used. The aspirated fat must be processed mechanically to provide a liquid fat emulsion, and passed through filters of .05mm thickness; that emulsified liquid is known as nano fat [10].

Multiple studies showed different advantages of different modalities in treating post acne scars, but not many studies exist about combining different modalities in the management of post acne scars [11].

This paper evaluates the efficacy of combining nano fat with fractional CO_2 laser versus nano fat alone for the treatment of post acne facial scars, in a randomized, split-face clinical study.

Patients and Methods

This study included 25 patients, above the age of 16, both sexes were included 10 males and 15 females, with bilateral facial acne scars grades 3 and 4, according to Goodman and Baron Qualitative scar grading system [12]. Approval from the Ethical Committee of Assiut University Hospitals, Assiut, Egypt was obtained, on 25/9/2023; Code IRB.no 04-2023-200393. Informed written consent from the patients was collected.

Exclusion criteria: Patients who were pregnant or lactating, or who suffered acne active lesions, or received filler injections in the past 6 months, or susceptible to form keloid or with history of hypertrophic scar formation, or those with isotretinoin administration within the preceding 6 months, or with history of bleeding tendency, or suffered recurrent episodes of viral infection by herpes zoster or simplex; or those with unrealistic expectations were excluded from the study.

Prior to the procedure, areas suitable for fat graft collection, including the lower abdomen, flanks, hips, and thighs, were marked. Approximately 20 cc of a solution consisting of 0.9% NaCl, 1% lidocaine, and 1/100,000 adrenaline was injected into the donor site 15 minutes before performing liposuction. A 3-mm Coleman's aspiration cannula was then employed to extract the adipose tissue using manual negative pressure. The extracted fat was placed into 10-cc syringes and emulsified mechanically by transferring it back and forth between two 10-cc syringes connected with a 0.05mm female-to-female Luer-Lock connector. After 30 passes, the fat was fully emulsified. The final fatty liquid (7 cc) was then transferred into 1-ml syringes, ready for injection into soft tissue deformities using 19-gauge cannulas [11].

Fractional carbon dioxide laser resurfacing:

One day before the treatment, patients received prophylactic antibiotics and antiviral medications, continuing for a week. A topical anesthetic cream was applied one hour prior to the CO_2 laser procedure [12]. The treatment was carried out on post acne scars on the face, based on a randomized sequence. Two additional laser sessions were scheduled one month apart. The laser settings included a pulse energy of 42–45mJ, a spot density of 100 spots/cm^2, and a depth level of 1–2, covering a 1cm^2 area [13].

After the treatment, patients were lectured about the importance of avoiding direct sun exposure and the usage of sun protection. They were also advised to use a topical moisturizer daily for one week post-treatment. If inflammatory acne lesions appeared during the treatment period, oral doxycycline or 1% topical clindamycin cream was prescribed as needed.

Clinical assessment:

At the initial clinical evaluation, patient's name, age, sex, skin type, duration of acne scars, and any previous treatment of each patient was recorded. Patients were evaluated every month for three months with an additional follow-up visit at the end of 6 months. Clinical assessment of baseline acne scar and post-treatment scars was done using Goodman and Baron Scale at 3 months of treatment completion.

Digital photographs were taken at several points: Before the treatment began, at each treatment session, and three months following the final laser procedure. Two independent, blinded observers evaluated the before-and-after photos for each side of the face and graded the degree of treatment effect using a quartile scale: Poor (<25% improvement), fair (25%-50% improvement), good (51%-75% improvement), and excellent (>75% improvement). At the last visit, patients expressed their degree of satisfaction through a scale: 0 for unsatisfied, 1 for slightly satisfied, 2 for satisfied, and 3 for very satisfied. Adverse events, including erythema, edema, crusting, pigmentary changes, ecchymosis, and scarring, were documented.

Histological evaluation:

Skin biopsies of 2mm were taken from each side of the face before start of treatment and 30 days after the third appointment. The samples were preserved in formalin, embedded in paraffin, and sectioned into serial cuts. These slices were then stained with Hematoxylin and Eosin (H&E) for analysis before and after the treatment.

Statistical analysis:

Data analysis was conducted using SPSS v26 (IBM Inc., Chicago, IL, USA). Continuous variables were reported as mean values with standard deviations (SD) and compared between the two groups using an unpaired Student's *t*-test. Categorical variables were presented as frequencies and percentages, and analyzed using the Chi-square test or Fisher's exact test when appropriate. A two-tailed *p*-value of less than 0.05 was considered statistically significant.

Results

Baseline data and predominant scar type and severity of disease of the studied patients are enumerated in this table. Table (1).

Table (1): Baseline data of the studied patients.

	N=25
Age (years)	24.04±2.03
Sex:	
Male	15 (60.0%)
Female	10 (40.0%)
Skin type:	
Type III	7 (28.0%)
Type IV	18 (72.0%)
Duration of acne scars (months):	16.96±4.51
<18	13 (52.0%)
≥18	12 (48.0%)
Predominant scar type:	
Rolling	9 (36.0%)
Ice pick	3 (12.0%)
Box car	13 (52.0%)
Severity of scars:	
Grade II	3 (12.0%)
Grade III	12 (48.0%)
Grade IV	10 (40.0%)

Data is presented as mean ± SD or frequency (%).

Patient satisfaction showed no significant difference between both sides. Erythema was significantly higher on the side treated by nano fat CO_2 fractional laser than the nano fat only treated side (p<0.05), while other adverse effects were insignificantly different between both sides as seen in Table (2).

Table (2): Satisfaction and adverse effects of the studied patients.

	Nano fat (n=25)	Nano fat + CO_2 laser (n=25)	*p*
Patient satisfaction:			
Slightly satisfied	10 (40.0%)	–0.227	0.161
Satisfied	10 (40.0%)	–0.180	
Very satisfied	5 (20.0%)	–0.134	
Adverse effects:			
Erythema	0 (0.0%)		0.00001*
Bruising	16 (64.0%)		0.765
Edema	9 (36.0%)		0.089
Pigmentation	1 (4.0%)		0.098

Data is presented as frequency (%).

* Significant *p*-value <0.05.

Degree and clinical improvement were significantly better on nano fat and laser side than nano fat alone side (p<0.05). Table (3).

Table (3): Degree and clinical improvement.

	Nano fat (n=25)	Nano fat + CO_2 laser (n=25)	*p*
Degree of improvement:			
One degree (Good)	22 (88.0%)	1 (4.0%)	0.000*
Two degrees (Excellent)	3 (12.0%)	24 (96.0%)	
Clinical improvement:			
Fair	2 (4.0%)	0 (0.0%)	0.0001*
Good	20 (90.0%)	3 (12.0%)	
Excellent	3 (6.0%)	22 (88.0%)	

Data is presented as frequency (%).

* Significant *p*-value <0.05.

Baseline thickness was insignificantly different between both sides, while epidermal thickness during follow-up was significantly higher in the nano fat and laser side than nano fat side alone (p<0.05). Table (4).

Table (4): Histopathological results among the studied groups.

	Nano fat (n=25)	Nano fat + CO_2 laser (n=25)	*p*
Baseline thickness	126.60±42.54	127.98±30.9	0.88
3-months follow-up	255.40±90	290.20±83.4	<0.081*

Data is presented as frequency (%).

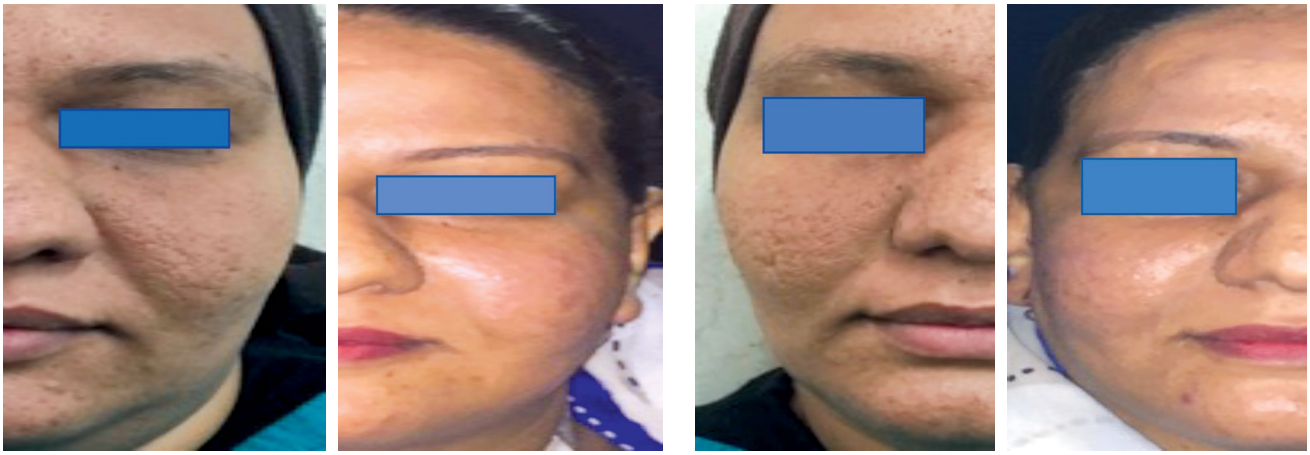
* Significant *p*-value <0.05.

Case (1): A 23-years old male patient receiving split face treatment with fractional CO_2 laser + nano fat grafting vs nano fat grafting only. Fig. (1).

Case (2): A 33-year-old female patient receiving split face treatment with fractional CO_2 laser + nano fat grafting vs nano fat grafting only. Fig. (2).

(A) (B) (C) (D)

Fig. (1): (A,B) Left side of face treated with nano fat grafting/fractional carbon dioxide laser, (C) and (D) Right side of face treated with nano fat grafting only.



(A) (B) (C) (D)

Fig. (2): (A,B) Left side of face treated with nano fat grafting/fractional carbon dioxide laser, (C) and (D) Right side of face treated with nano fat grafting only.

Discussion

Acne scars are a challenging aesthetic issue, often requiring a combination of treatments to achieve satisfactory outcomes **[14]**. In our study, we found no statistically significant difference between simple nano-fat and nano graft combined with fractional CO_2 laser in the participants suffering bilateral post acne scarring. This finding is consistent with Eitta et al., who found mild significant difference between the two treatment modalities **[15]**. In addition Azzam et al., reported that patients showed significant improvement when treated by nano fat, than those who were treated with fractional CO_2 laser **[16]**. Our findings align with those of Kwon et al., who conducted a split-face study and found that treatment with adipose exosomes resulted in greater improvements and fewer adverse effects compared to the control sides **[17]**.

In our study, according to physician global assessment (improvement), we found no significant difference between nano-fat alone side and nano graft combined with fractional CO_2 laser in the studied group. In the nano-graft group there was 4% poor result, 25%-50% fair results, 32% good

and 56% excellent. In nano graft and fractional CO_2 laser there were 0% poor, 0% fair, 20% good and 80% excellent. According to patient satisfaction, there was no significant difference between nano-fat alone and nano graft combined with fractional CO_2 laser in the studied group. Our results supported by Piccolo et al. **[18]** reported that there was no significant difference between the studied groups regarding patients' satisfaction.

In our study, we found that rolling scars had the best clinical response compared with other scar types. The result seemed better on the side where nano graft injection after subcision and fractional CO_2 laser had been performed and this is in line with Sardana and colleagues **[18]**.

In the present study, regarding adverse effects between the two-treatment side in the studied group, our results showed that in nano-fat group, there were 32% edema, 32% pain, 36% Bruising, 0% erythema, 0% Erythema + Oedema. In Nano graft and fractional CO_2 laser group, there were 0% Edema, 0% pain, 0% bruising, 76% erythema, 24% erythema and oedema, there was insignificant difference regarding adverse effects in the compared groups (p<0.001). Fang et al. **[19]** in their study showed that the side effects secondary to fractional carbon dioxide laser, were mainly erythema and hyperpigmentation.

The limitations in our study were mainly related to the relatively small sample size which was conducted in a single center. Moreover, the patients follow-up time interval was relatively short. The subjective nature of some assessment tools used, such as patient satisfaction scores may be incorrect. Incorporating objective measures like 3D imaging and quantitative scar analysis would enhance the precision of outcome evaluations and provide more definitive evidence of efficacy.

Conclusions:

The combination of autologous nano fat injections and fractional CO_2 laser therapy stands as a promising advancement in the field of dermatology, offering a potent solution for atrophic acne scars. This study highlights the transformative potential of integrating regenerative medicine with advanced laser technology, paving the way for more effective, patient-centered treatments. As the body of evidence supporting this approach continues to grow, it is poised to become a cornerstone of modern dermatological practice, offering new hope and improved quality of life for individuals affected by acne scars. Future research and clinical innovation will undoubtedly refine and expand these applications, solidifying their place in the therapeutic arsenal against scarring and advancing the standards of care in dermatology.

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Conflict of Interest: Nil.

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