

Fractional CO₂ Laser Resurfacing Treatment of Acne Scar Comparing High and Low Energy Levels

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ABSTRACT

Background : Fractional CO₂ laser resurfacing in the treatment of acne scars, attempts to reduce the adverse effect of laser resurfacing by creating microscopic injury zones to the dermis with skipped interval areas.

Aim of the study : The purpose of this study is to compare the safety and efficacy of high pulse energy (70 mJ) and low pulse energy (45 mJ) of fractional CO₂ laser resurfacing in the treatment of facial acne scars.

Patients and Methods : Twenty patients with moderate to severe atrophic acne scars were treated with three sessions of fractional CO₂ laser resurfacing at four-week intervals with high and low energy levels applied to each side of the face separately. The severity of acne scars at baseline and after treatment was assessed using Goodman and Baron's qualitative scar grading system. Patient satisfaction score was obtained using a quartile grading scale.

Results : The severity of acne scars on both sides was comparable to each other before the treatment ($p = 0.643$). At the final assessment, both sides with high and low energy levels demonstrated an excellent response ($p = 0.000$). However, the difference between the mean final scores of both sides was not significant ($p = 0.731$). The most frequently reported side effects were crustation and erythema. Crustation lasted longer on the right side (mean = 6.75 days) whereas for the left side (mean = 5.45 days). Erythema was transient and only in four cases persisted beyond a week (right side mean = 10.5 days while left side mean = 8.75 days)

Conclusions : Both high energy (70 mJ/pulse) and low energy (45 mJ/pulse) CO₂ fractional laser resurfacing of acne scar results in satisfactory outcomes with no statistically significant differences. While the duration of side effects (crustation and erythema) was increased slightly with higher fluence.

KEYWORDS : Acne scars , treatment , laser , fractional CO₂ laser resurfacing .

علاج التجديد بالليزر CO₂ الجزئي لندبات حب الشباب بمقارنة مستويات الطاقة العالية والمنخفضة

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الخلاصة

الخلفية : إعادة تسطيح ليزر ثاني أكسيد الكربون الجزئي في علاج ندبات حب الشباب ، محاولات لتقليل التأثير الضار للظهور بالليزر عن طريق إنشاء مناطق إصابة مجهرية للأدمة مع تخطي مناطق الفواصل الزمنية.

الهدف من الدراسة : الغرض من هذه الدراسة هو مقارنة سلامة وفعالية طاقة النبض العالي (٧٠ مللي جول) وطاقة النبض المنخفضة (٤٥ مللي جول) من الظهور بالليزر CO₂ الجزئي في علاج ندبات حب الشباب بالوجه.

المرضى والطرق : مع مستويات الطاقة العالية والمنخفضة المطبقة على كل جانب من جوانب الوجه على حدة ، خضع عشرين مريضاً يعانون من ندبات حب الشباب الضامرة المتوسطة إلى الشديدة لثلاث جلسات من التقشير بالليزر الجزئي CO₂ على فترات أربعة أسابيع. تم تقييم شدة ندبات حب الشباب في الأساس وبعد العلاج باستخدام نظام تصنيف الندبات النوعي من Goodman and Baron. تم الحصول على درجة رضا المريض باستخدام مقياس الدرجات الربعية.

النتائج : كانت شدة ندبات حب الشباب على كلا الجانبين مماثلة لبعضها البعض قبل العلاج ($p = 0.643$). في التقييم النهائي ، أظهر كلا الجانبين بمستويات طاقة عالية ومنخفضة استجابة ممتازة ($p = 0.000$). ومع ذلك ، فإن الفرق بين متوسط الدرجات

النهائية لكلا الجانبين لم يكن كبيراً ($p = 0.731$) كانت الآثار الجانبية الأكثر شيوعاً التي تم الإبلاغ عنها هي التقشر والحمامي. استمر القشرة لفترة أطول على الجانب الأيمن (المتوسط = ٦.٧٥ يوماً) بينما بالنسبة للجانب الأيسر (المتوسط = ٥.٤٥ يوماً). كانت الحمامي عابرة واستمرت فقط في أربع حالات لأكثر من أسبوع (متوسط الجانب الأيمن = ١٠.٥ أيام بينما متوسط الجانب الأيسر = ٨.٧٥ يوماً)

الاستنتاجات: كلا من الطاقة العالية (٧٠ مللي جول / نبضة) والطاقة المنخفضة (٤٥ مللي جول / نبضة) ينتج عن إعادة تسطیح كسور ليزر ثاني أكسيد الكربون لندبات حب الشباب نتائج مرضية مع عدم وجود فرق معتمد به إحصائياً. بينما زادت مدة الآثار الجانبية بشكل طفيف مع زيادة الطاقة.

الكلمات المفتاحية: ليزر ، علاج ، حب الشباب ، تسطیح .

INTRODUCTION

Acne scarring results from the excessive production or loss of collagen fibers and subcutaneous fat during the healing process resulting from inflammatory acne vulgaris¹. The incidence of acne scarring has not been widely studied, but it is estimated to affect approximately 95% of acne patients². Developing acne scar creates psychological and emotional distress for the patient. Studies have also shown that suffering from acne scars is linked to reduced daily activities and impaired social interactions, poor self-esteem and unemployment³. Therefore, treatment of these scars successfully can be gratifying for the patient and rewarding for the physician⁴.

Acne scars are classified into three types: atrophic scar, hypertrophic scar, and keloid. According to their width, depth and shape, atrophic acne scars can be further divided into three subtypes: icepick scar, rolling scar, and boxcar scar⁵. Goodman and Baron's qualitative global acne scarring grading system is a practical and standard assessment tool for evaluation of severity of acne scarring. According to this qualitative global scale, atrophic acne scars are categorized into macular, mild, moderate, and severe disease based on the severity of the condition⁶. Each morphological scar type responds differently to a specific treatment modality and while one scar type responds best to one therapeutic modality, the same treatment method may not be as effective for the other types of scars⁷.

Fractional laser resurfacing is presently considered to be one of the most effective treatment modalities for facial acne scars⁸. Fractional lasers only treat a 'fraction' or a column of the damaged skin leaving interval areas of skin intact. These intact areas help in rapid re-epithelization of the skin, minimizing the chances of prolonged and serious adverse effects⁹. Atrophic scars have been treated with various degrees of success using fractional CO₂ laser resurfacing^{10,11}. Persistent post-treatment erythema, crusting, post-inflammatory hyper-

pigmentation, Purpura and even aggravation of scarring have been identified as adverse reactions to this treatment option^{12,13}.

The purpose of this study is to compare the safety and efficacy of high pulse energy (70 mJ) and low pulse energy (45 mJ) of fractional CO₂ laser resurfacing in the treatment of facial acne scars.

PATIENTS AND METHODS

A prospective case series study design was adopted and twenty patients with moderate to severe atrophic facial acne scars were treated with fractional CO₂ laser resurfacing over a period of almost 1.5 years from February 2021 to June 2022. Exclusion criteria included pregnancy, concurrent use of isotretinoin, keloid formation tendency, having active acne or any active skin infections such as herpes simplex. Prior to the treatment, the patients were advised to refrain from using any topical or systemic medications. During the therapy, patients were asked to avoid additional cosmetic treatments on their faces such as chemical peeling, needling and microdermabrasion.

An informed verbal consent in the study was taken from the patient after explanation of the study objectives and purposes and baseline photograph using adequate light and right angle at close distance was taken. Prior to the study the severity of atrophic acne scars was assessed using Goodman and Baron's qualitative scar grading system for both sides of the face separately. Then a topical anesthetic cream containing a eutectic mixture of topical lidocaine 2.5% and Prilocaine 2.5% in a cream base (Emla[®] cream 5%) was applied to the treatment area 30 minutes prior to the laser therapy to achieve an adequate anesthetic effect. After achieving satisfactory anesthesia, the treatment area was sanitized with an antiseptic chlorhexidine 2% solution.

For the present study we used fractional CO₂ laser SMAXEL IDS Ltd. Korea. The Fractional CO₂ laser treatment was applied to each side of the

face using different settings. The parameters for the right side (high energy) were 70mJ pulse energy, 144 MTZ/cm² density, and 3.0 millisecond pulse duration. The parameters for the left side (low energy) were 45mJ pulse energy, 144 MTZ/cm² density, and 1.9 millisecond pulse duration. A single pass of treatment with 10-20% overlap was applied over the entire side of the face regardless of the different morphological types of scars.

The patients were instructed to avoid sun exposure for one week following each procedure, and a topical antibiotic cream was prescribed over this period. The patients were also encouraged to use a broad-spectrum sunscreen in between the laser sessions. An oral antibiotic (Azithromycin tab 500 mg daily for 6 days) was prescribed for all patients. Only individuals with a history of recurrent herpes simplex infections, if any, were prescribed oral acyclovir.

Laser treatment was repeated every 4 weeks and a total of 3 sessions were performed for each patient. The laser parameters were kept the same for the right side (70mJ pulse energy, 3.0 ms pulse duration, and 144MTZ density) and the same for the left side (45mJ pulse energy, 1.9 ms pulse duration, and 144 MTZ density) throughout the entire study and for all the patients regardless of their initial response. Digital photographs were taken using the same distance, angle, and lighting settings at each follow-up visit prior to applying anesthetic cream to the face. The final assessment was made 3 months after the last laser treatment using Goodman and Baron's qualitative scar grading system for the right side and left side of the face separately, and the results were recorded. In addition to the clinical assessment, the patient satisfaction scores were also recorded on the final visit using a quartile scale. Satisfaction of less than

25% was labeled as "unsatisfied", 25-50-% as "slightly satisfied", 51-75% as "satisfied" and more than 75% was labeled as "very satisfied". Adverse effects and their duration were noticed and recorded at each follow-up visit.

Statistical Analysis

The data collected during the study were summarized in sheets of Microsoft Excel version 2007. The statistical analysis performed by using IBM-SPSS version 26. The normality of these data tested by Shapiro-Wilk test. Mean, standard deviation, minimum, and maximum value were estimated for age. Unpaired and paired t test were used. The fissure exact test was used to assess the significance of difference. P-value ≤ 0.05 considered as significant.

RESULTS

Twenty-seven patients were found to be eligible and enrolled in the study. A total of 20 patients with Fitzpatrick skin type (II-IV) completed the study and were selected for analysis. There were 10 men and 10 women in the final analysis. The mean age of the participants was 22.95 ± 5.50 years, and the male to female ratio was 1:1. Statistical data shows that 75% of participants were from Erbil city and 25% were from outside Erbil city. There were 6 patients (30%) with Fitzpatrick skin type 2, 9 patients (45%) with skin type 3 and 5 patients (25%) with skin type 4. Figure (1) shows socio-demographic data of the participants. The distribution of the sample according to occupations shows that half of the sample were students, and 25% were housewives. Private employees were found in 20% of the sample, while only 5% of the participants were government employees (Fig 1).

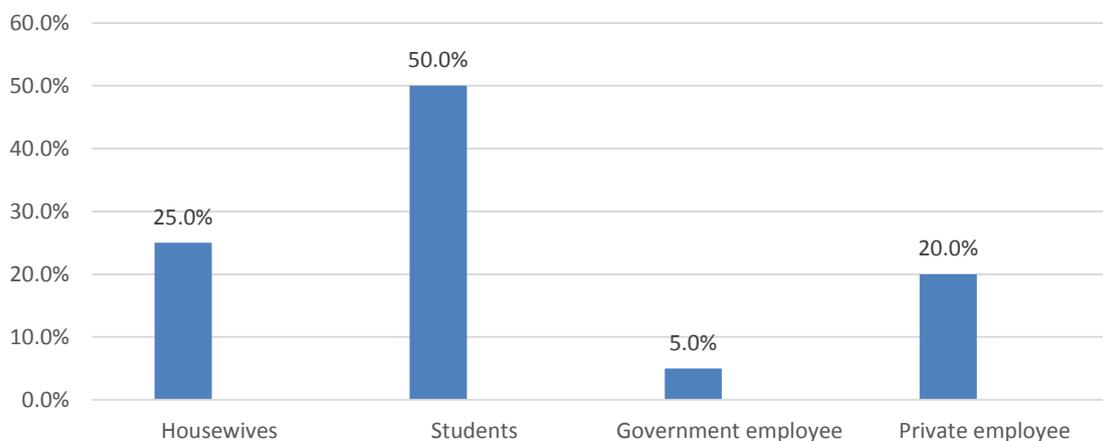


Figure (1): Distribution of the sample according to occupations.

Most of the patients had a combination of different morphological types of acne scars. All types of scars (icepick, rolling and boxcar) according to the side of the face were recorded. Figure (2) shows the types of scars according to the sides of the face.

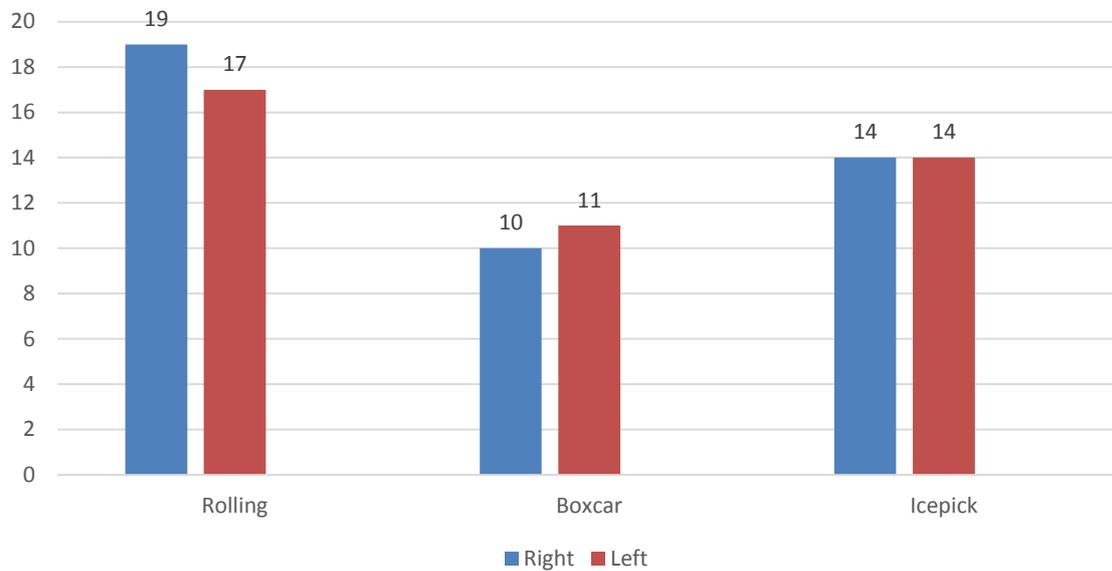


Figure (2): Types of scars according to sides.

According to the scar duration, participants were divided into 3 groups. 30% of the participants had acne scars for less than 2 years, 40% had the scars between 2-5 years and 30% had the scars for more than 5 years. (Fig. 3)

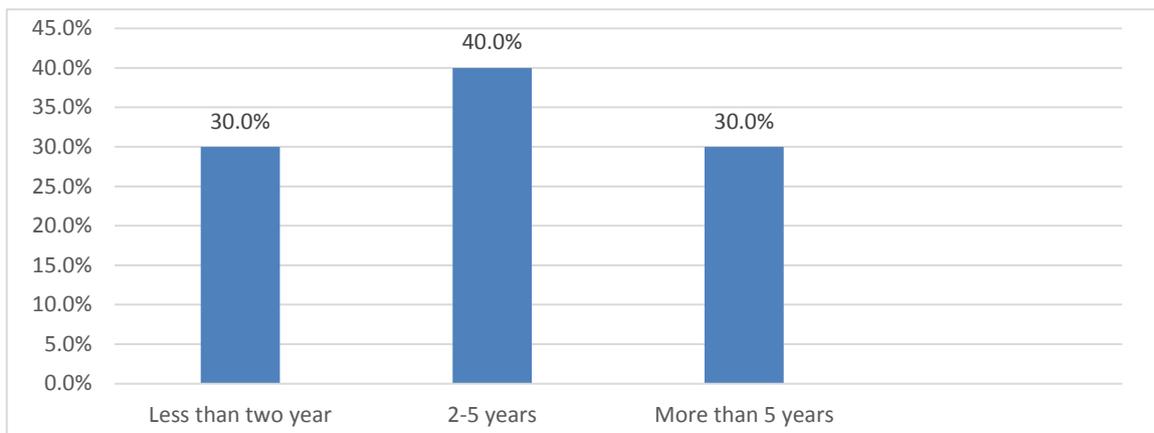


Figure (3): The distribution of the sample according to scar duration

The severity of acne scars was assessed using Goodman and Baron’s qualitative scar grading system at baseline for each side of the face. Overall, the severity of acne scars on both sides was comparable before the treatment. Table (1) shows the comparison of the mean severity scores for the right side: (3.90 ± 0.307) to the left side: (3.85± 0.366) with no significant difference between them at the baseline. (p = 0.643)

Table (1): The comparison of mean severity of acne scar at initial visit between right and left side of the face.

Severity of acne scar	Comparing mean severity of both sides before treatment		p-value*
	Right	Left	
	Mean ±SD	Mean ±SD	
Initial visit	3.90 ± 0.307	3.85± 0.366	0.643

* Unpaired t-test

All the cases had moderate to severe atrophic post-acne scars prior to the treatment (Grade 3 and 4 of Goodman and Baron’s qualitative scar grading system). Among all the patients, on the right side of the face, 18 patients had severe scars while only 2 patients had moderate scars. On the left side of the face, 17 patients had severe scars while 3 had moderate scars. (Fig 4)

Figure (4) demonstrates the severity scores at baseline for both sides and shows that on the right side 18 patients had severe scars, 2 patients had moderate scars, and no patient had mild scars, while on the left side 17 patients had severe scars, 3 patients had moderate scars, and no patient had mild scars.

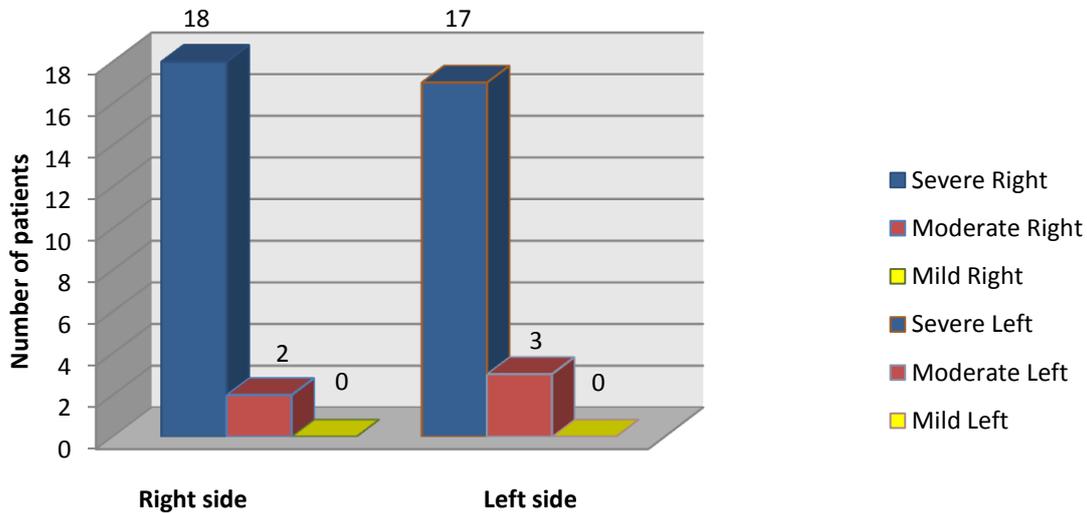


Figure (4): The severity score before treatment for right and left sides.

Figure (5) demonstrates the severity score after treatment for both sides, and shows that on the right side no patient has severe scars, 14 have moderate and 6 have mild scars, whereas on the left side no patient has severe scars, 15 have moderate and 5 have mild scars.

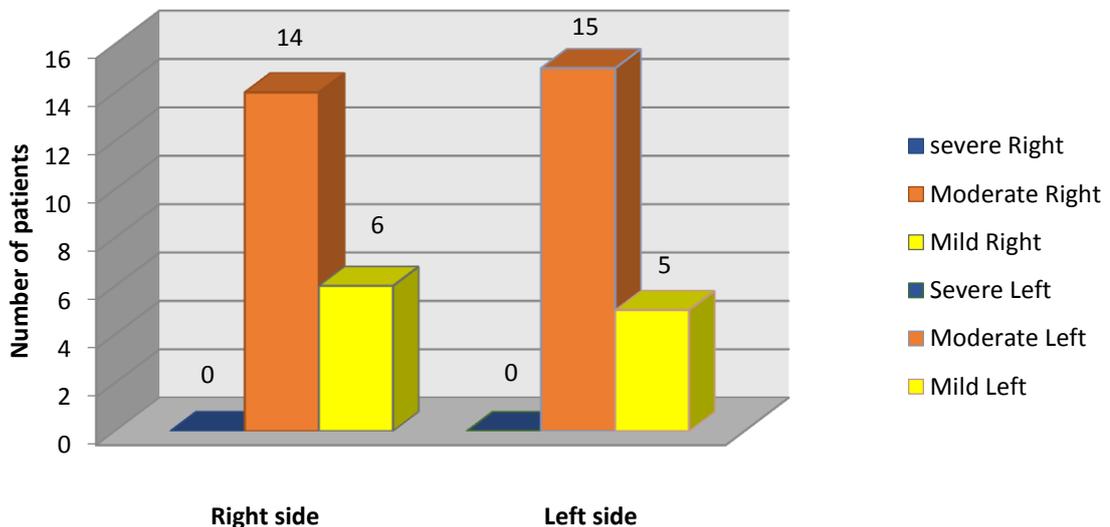


Figure (5): The severity score after treatment for right and left sides.

Using Goodman and Baron's qualitative scar grading system, the scars on both sides of the face were less severe at the final follow-up visit 3 months after the last laser treatment. (The mean of scores for the right side was 2.70 ± 0.470) and (mean of scores for the left side was 2.75 ± 0.444). The difference between the mean scores of initial and final visits was significant ($p = 0.000$) for both sides. (Table 2)

Table(2): The comparison of mean severity scores of acne scar between the initial visit and after treatment for both sides.

Face sides	Comparing mean severity scores of scars between the initial visit and after treatment		p-value*
	Before treatment	After treatment	
	Mean ±SD	Mean ±SD	
Right	3.90±0.308	2.70±0.470	0.000
Left	3.85±0.366	2.75±0.444	0.000

* Paired t-test

Meanwhile, comparing the final scores between the right side and the left side in Table (3) reveals that the improvement was proportional and there was no significant difference between the final results of the right and left sides regardless of the different energy levels applied to each side. ($p = 0.731$)

Table (3): The comparison of severity of acne scar after treatment between right and left sides.

Severity of acne scar	Comparing mean severity scores of both sides after treatment		p-value*
	Right	Left	
	Mean ±Sd	Mean ±Sd	
After treatment	2.70±0.470	2.75±0.444	0.731

* Unpaired t-test

Patient satisfaction scores revealed that 15% (3 patients) were “very satisfied”, 35% (7 patients) were “satisfied”, 35% (7 patients) were “slightly satisfied” and 15% (3 patients) were “unsatisfied” with the results. Satisfaction scores for both sides were identical. (Fig 6)

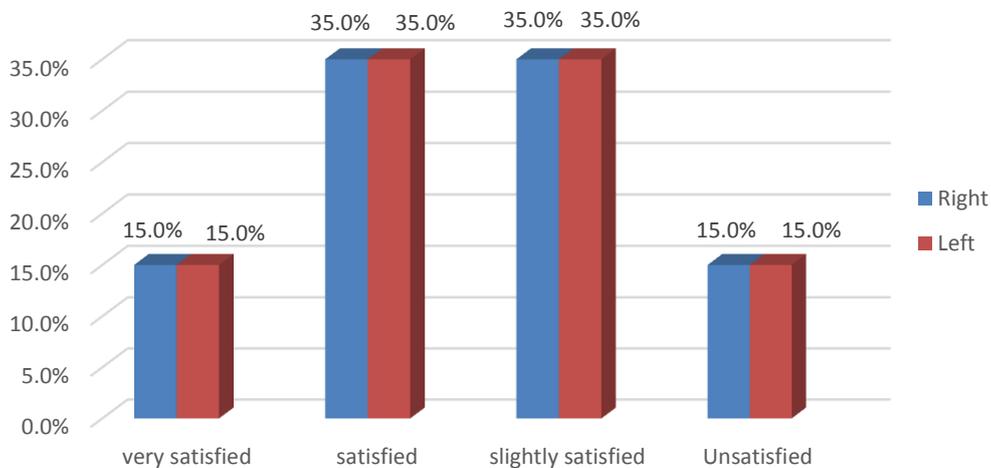


Figure (6): The patient satisfaction scores according to right and left sides.

Overall, the side effects after laser therapy were transient and included erythema that lasted for one week in most of the cases. Only in 4 patients the erythema lasted longer than a week. (The mean of erythema duration for the right side was 1.5 weeks and for the left side was 1.25 weeks). Superficial crusting lasting 3-10 days in different cases. Overall crusting remained longer on the right side where we applied higher energy (mean 6.75±1.292) compare to left side which was treated with lower energy (mean 5.45±1.276) (Table 4). Table (4) shows the comparison of crusting duration between the right and the left side and it demonstrated that there is a significant difference between them. The other side effect observed was mild post-inflammatory hyper-pigmentation which developed in one patient during the study. The pigmentation was resolved by using sunscreen and sun avoidance after 12 weeks and the patient had no complaints at the end of the study.

Table (4): The comparison of mean duration of crusting on the right side to the left side of face.

Severity of side effects	Comparing mean duration of crusting on both sides		p-value*
	Right	Left	
	Mean ±SD	Mean ±SD	
Crustation	6.75±1.292	5.45±1.276	0.000

* Unpaired t-test

Patient's photographs before and after treatment



Figure 7: Severity of acne scars before (A) and after treatment (B) on right side



Figure 8: Severity of acne scars before (A) and after treatment (B) on left side

A 20-year-old female with severe acne scars (score 4) on the right side before treatment, which improved to mild scars (score 2) after treatment (Fig. 7). The same patient has moderate acne scars (score 3) on the right side, which improved to mild (score 2) after treatment (Fig. 8).



Figure 9: Severity of acne scars before (A) and after treatment (B) on right side



Figure 10: Severity of acne scars before (A) and after treatment (B) on left side

A 21-year-old male patient with severe acne scars (score 4) on both sides of his face before treatment, which improved to moderate scars (score 3) after treatment on both sides of his face (Fig. 9, 10).



Figure 1: Severity of acne scars before (A) and after treatment (B) on right side



Figure 2: Severity of acne scars before (A) and after treatment (B) on left side

An 18-year-old female patient with severe acne scars (score 4) on both sides of the face before treatment, which improved to moderate scars (score 3) after treatment on both sides of the face (Fig 11, 12).

DISCUSSION

Different treatment modalities have been utilized in treating acne scars to achieve desired outcomes with a variable degree of success. While laser resurfacing remains the most effective treatment option for atrophic acne scars, its use is limited due to the high incidence of post-treatment adverse effects. Fractional laser photothermolysis attempts to overcome these limitations of laser resurfacing by creating microscopic zones of injury to the dermis with skipped interval areas. Fractional CO₂ laser resurfacing remains the standard treatment option for treating atrophic acne scars⁴.

The current study had 20 patients in the age range of 18–35 years. The participants were divided into three age groups: under 20 years, between 20 and 30 years, and above 30 years old. There was no difference in the treatment outcome, regardless of the energy levels applied to each side of the face, across the age range in our study population.

Gosain and Dipietro reported that in healthy older adults, the effect of aging causes a temporal delay in wound healing but not an actual impairment in terms of quality of healing¹⁴. These findings are consistent with the findings of our study, which demonstrated that the quality of healing did not differ between age groups.

In the current study, there was no significant difference in scar outcome based on age because all patients were young adults and there were no elderly patients. The present study's oldest participant was 35 years old.

In this present study, the numbers of male and female participants were equal. (Male to female

ratio was 1:1). However, there was no significant difference in scar improvement scores between men and women on both the right and left side of the face. This is in contrast to the study conducted by Hardman and Ashcroft, 2008 who reported that estrogen affects wound healing by regulating a variety of genes associated with regeneration, matrix production, protease inhibition, and epidermal function¹⁵.

Also, in their study Gilliver *et al.*, 2007 indicated that estrogen can improve the age-related impairment in healing in both men and women, while androgens regulate cutaneous wound healing negatively¹⁶.

Meanwhile, the lack of a significant difference in scar improvement between men and women in current study is likely due to the small sample size, and a larger sample size is likely necessary for a more accurate conclusion.

Fractional CO₂ laser, with a wavelength of 10,600 nm, has also been employed in the treatment of acne scars in both Caucasian as well as Asian patients. Chapas *et al.*, in their study on facial acne scars, documented improvement of 26-50% in texture and atrophy of the skin in all patients¹⁷.

In the present study, the fractional CO₂ laser resurfacing was utilized with two different energy levels (70mJ pulse energy, 3 milliseconds pulse duration for the right side and 45mJ pulse energy, 1.9 milliseconds pulse duration for the left side) and a low density of 144 MTZ/cm² for both sides. The results for both sides were excellent, and the difference between scar severity at baseline and after treatment for each side was statistically significant. (p=0.000). These findings are consistent with the research conducted by Hedelund *et al.* In a single-blinded randomized study on acne scars, Hedelund *et al.* demonstrated statistically significant improvement in skin texture and atrophy in comparison with placebo after 3 monthly laser sessions with fractional CO₂ device. The study was conducted on 13 patients and the patients were also quoted as being 'satisfied' with the treatment option. Pulse energies in the range of 48-56mJ with a treatment density of 13% were used in this study¹⁸.

In a controlled split-face trial Jung *et al.* treated mild to severe acne scars with a fractional CO₂ laser. Settings of lower-fluence, higher-density (30 mJ/puls, 250 MTZ/cm²) were compared to higher-fluence, lower-density (70 mJ/puls, 150 MTZ/cm²). On the side treated with lower-fluence, higher-density, improvements of 50–75% were found. However, the most pronounced effects were demonstrated on the sides treated with higher-fluence, lower-density with half of the patients having improvements >76%. In addition, erythema of longer duration was found on the half treated

with higher-fluence, lower-density compared to the half treated with lower-fluence, higher-density¹⁹.

In the present study; erythema lasted slightly longer on the right side (treated with higher fluence) compared to the left side (treated with lower fluence). This finding is consistent with the mentioned findings in a controlled split-face trial by Jung *et al.*

CONCLUSION

- Comparable results on the right and left side of the face were achieved in the present study.
- The dermal ablation depth with this specific device reached the superficial dermis and induced a satisfactory therapeutic effect with an energy level of as low as 45 mJ/pulse.
- The higher energy levels (70 mJ/pulse) did not improve the quality of the atrophic scar healing.
- Crustation and erythema lasted longer on the side treated with higher energy, resulting in greater discomfort. Therefore, to reduce the risk of side effects, it is suggested to use the lowest effective energy possible while treating atrophic acne scars.

Limitation of The Study

The main limitation of the study was the small sample size and the compliance of patients for the instructions.

Ethical Approval

All patients were verbally informed about the study and they were asked the permission to make them being part of the study. Data were exclusively used for the purpose of this study.

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