Original Article

Effectiveness of Combined 10,600 nm Fractional CO_2 and 1540 nm Erbium GaAs Laser Therapy on Acne Scar Score Alteration in Patients with Atrophic Acne Scars

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Abstract

Aim: The aim of this study is to determine the effectiveness of combined 10,600 nm fractional CO_2 and 1540 nm erbium GaAs laser therapy on atrophic acne scars. **Subjects and Methods:** The design of this study was pre- and post-test on patients with atrophic acne scars before and after receiving the combination laser therapy of fractional CO_2 and erbium GaAs. The sample size consisted of 20 medical records. The Acne Goodman-Baron Scar Score was used to score acne scars, which included morphology, quantity, depth, and width of the acne scars. The therapy was administered three times at 1-month intervals. The power and wavelength of the laser were adjusted based on the degree of the severity of the acne scar in each patient. The data were analyzed the hypothesis statistically using the Wilcoxon test, using the SPSS for Windows program, version 16.0. **Results:** There were significant differences ($P = 0.007$) between the means of the Goodman–Baron acne scar scores before and after combined 10,600 nm fractional CO_2 and 1540 nm erbium GaAs laser therapy. Side effects occurred in 50% of patients, where 35% experienced erythema and 15% experienced pruritus. **Conclusion:** The combination of 1540 nm erbium GaAs and 10,600 nm fractional CO_2 laser therapy can be effective for treating atrophic acne scars on the face, with minimal side effects. However, longer therapy sessions are required for better results.

Keywords: Acne scar, erbium GaAs laser, fractional CO_2 laser, Goodman–Baron score

Introduction

An atrophic acne scar is a physical disability that results from complications of acne vulgaris. Acne vulgaris is a chronic inflammatory disorder of the pilosebaceous unit.[1-3] The postacne scar is a result of the disruption of collagen production, causing a topographical depression. A scar is a fibrous tissue that replaces normal skin after trauma to the skin. A scar results from the biological process of wounds on the skin and other tissues such that scars represent a process of interference in wound healing.[4,5] Scar acne can cause substantial psychological effects; thus, it is important to examine various therapies to handle the acne.[6,7] Based on research conducted in the UK, 77% of men who suffer from Vulgaris have experienced atrophic acne scars, whereas 58% of women have experienced atrophic acne scars. In research conducted at RSUP Dr. Kariadi Semarang, of 136 patients with acne vulgaris, 59 (43.4%) of them experienced acne scars. There are various therapeutic modalities for the management of atrophic acne scars, including operative techniques (punch graft, punch excision, and subcision), resurfacing techniques (dermabrasion, ablative laser therapy, and chemical surgery/chemical peeling), nonablative laser, autologous fat transfer, and dermal filler injection.[8]

Resurfacing fractional CO_2 laser combines the concept of fractional photothermolysis with an ablative wavelength of 10600 nm. This technology is effective for wrinkle

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therapy, photodamage, and acne scars.[9] The erbium GaAs laser is a nonablative laser with a wavelength of 1540 nm. This therapeutic modality has the advantage of having low complication rates and fast or no downtime recovery compared to ablative resurfacing, peeling or chemical surgery, or dermabrasion. The erbium GaAs laser can be used to treat fine wrinkles and atrophic scars on the face.[10,11]

The combination of ablative resurfacing laser therapy using a 10,600 nm fractional CO_2 laser and a 1540 nm erbium GaAs nonablative resurfacing laser is expected to be efficacious in repairing atrophic acne scars, with minimal side effects.[12]

Several researchers have investigated the effectiveness of a single fractional CO_2 laser therapy for atrophic acne scars and the effectiveness of a single erbium GaAs laser therapy for atrophic acne scars. The effectiveness of combining both laser therapies as a scar therapy has been studied but not specifically for atrophic acne scars. Therefore, this study aimed to investigate the effectiveness of combined fractional CO_2 laser therapy with erbium GaAs laser for atrophic acne scar.

Subjects and Methods

Research design

This study was a pre- and post-test design. The samples were based on medical records of patients with atrophic acne scars who received the combined treatment of fractional CO_2 laser and erbium GaAs laser therapy in three sessions at Kariadi Hospital Semarang. The inclusion criteria were ages 18–40 years and mild-to-severe scar degree. The exclusion criteria in this study were a medical record sample whose data were incomplete. The registered ethical clearance number for this study is No. 646/EC/FK-RSDK/X/2017.

The selection of patients was performed by consecutive sampling based on the medical records of patients with atrophic acne scars on the face treated at Kariadi Hospital Semarang in November 2017 until the number was fulfilled, which was 20 medical records. The formula used for the sample calculation method is as follows:

$$n = \left[\frac{(Z\alpha + Z\beta)\, S^2}{X_1 - X_2} \right] \quad (1)$$

$$n = \left[\frac{(1.64 + 0.842)\, 1.24^2}{(4.7 - 4)} \right] = 18 \; samples \quad (2)$$

The calculated sample number was 18. Anticipating a 10% dropout rate, 20 medical records were selected for this study.

Secondary data were taken from outpatient medical records at Kariadi Hospital Semarang, which included age, body mass index, acne scar score data before and after receiving combined CO_2 fractional and erbium GaAs laser therapy, and side effects observed during therapy. The patients were given therapy at a wavelength of 1540 nm with the following settings: power 8.0 W, pulse width 5.00 ms, and energy 40.0 mJ, while the settings at the 10,600 nm wavelength were as follows: power 25.0 W, pulse width 0.25 ms, and energy 6.2 mJ. The power and wavelength of the laser were adjusted based on the degree of the severity of the acne scar in each patient. The short procedure of administering therapy was to first cleanse the patient's face, then apply a topical anesthetic for 30 min. After the anesthesia cream was cleared, the patient was positioned; the operator used protective glasses, masks, and gloves. The laser was administered; both waves were transmitted together according to the settings of the laser machine. Afterward, the patient was compressed using NaCl, and then an antibiotic cream was applied. The therapy was administered three times at 1-month intervals. The Acne Goodman–Baron Scar Score was used to score the acne scars.

Statistical analysis

We collected the data until they were complete and correct. Then, we coded, tabulated, and inserted them into the computer. Numeric scale data were expressed as mean and standard deviation. They were analyzed statistically using Wilcoxon test. The difference was considered statistically significant with a $P \leq 0.05$, with a 95% confidence interval. Statistical analyses were carried out with the SPSS for Windows program, version 16.0. (IBM Corporation, Chicago, USA).

Results

This study was a pre- and post-test design. The samples included 20 medical records of patients with atrophic acne scar who received a combination treatment of fractional CO_2 laser and erbium GaAs laser therapy in three sessions at Kariadi Hospital Semarang. Secondary data were taken from outpatient medical records at Kariadi Hospital Semarang, which included age, body mass index, acne scar score data before and after receiving the combination of CO_2 fractional and erbium GaAs laser therapy, and side effects found during therapy. The Acne Goodman–Baron Scar Score was used to score acne scars.

Table 1 shows that the majority of the participants were male (65%). The mean age was 30.35 years, with the youngest age being 18 years and the oldest was 40 years. Most of the subjects had an undergraduate education (75%). The majority of the participants work as private employees.

Table 2 shows that the lightest body weight was 49 kg and the heaviest was 95 kg, while the shortest height was 155 cm and the tallest was 183 cm. The mean body mass index was 24.015, where the lowest was 19.1 and the highest was 30. The mean duration of having acne was 6.05 ± 2.114 years, and the mean duration of having acne scars was 3.63 ± 2.033 years.

Table 3 displays that the participants with an undergraduate education had more moderate or severe acne scars, but this was not significantly related ($P = 0.13$). The majority of the private employee subjects had mild and moderate acne scars, while the number of those with severe acne scars was the same as the college students and civil servants, but this was not significantly related ($P = 0.52$).

As shown in Table 4, all participants had the boxcar scar type, three had a mild degree, six had a moderate degree, and eleven had a severe degree. A moderate degree of the icepick scar type was observed in two participants with a moderate degree, while a severe degree was observed in eleven participants.

The results in Table 5 indicate that the data were not normally distributed. Therefore, a nonparametric test was performed using the Wilcoxon test.

Table 1: The demographic characteristics of the subjects (*n*=20)

Characteristic	*n* (%)
Sex	
Male	13 (65)
Female	7 (35)
Age	
Mean±SD	30.35±6.089
Minimum-maximum	18-40
Education level	
High school	2 (10)
Diploma	2 (10)
Undergraduate	15 (75)
Postgraduate	1 (5)
Occupation	
College student	3 (15)
Private employee	8 (40)
Civil servant	4 (20)
Medical doctor	5 (25)

SD: Standard deviation

Table 2: Characteristics of participants based on body weight, height, body mass index, duration of acne, and duration of acne scars (*n*=20)

Characteristic	Mean±SD	Minimum-maximum
Body weight (kg)	68.75±11.715	49-95
Height (cm)	168.85±7.836	155-183
BMI	24.02±2.979	19.1-30
Duration of acne (years)	6.05±2.114	3-10
Duration of acne scar (years)	3.63±2.033	1-8

BMI: Body mass index, SD: Standard deviation

Based on the results in Table 6, there was a statistically significant difference in the Goodman–Baron scores ($P < 0.05$).

A decrease in the acne score was observed in 35% of the participants, as shown in Table 7.

Table 8 shows that the duration of having acne, the duration of having acne scars, and body mass index did not correlate with the Goodman–Baron delta score. Table 9 illustrates that age did not correlate with a decrease in the Goodman–Baron score ($P = 0.530$). Some of the participants experienced side effects following treatment, namely erythema (35%) and itching (15%), while 50% of the participants did not complain of any side effects.

Discussion

The participants consisted of 20 medical records, 13 were for men and 7 were for women. Based on gender showed that men and women had an equal chance of suffering from acne scar atrophy, even though there were more men than women. Until now, there are no studies reporting that this disease is more dominant in one sex. However, a study stated that acne vulgaris as a cause of acne scar atrophy was more common in men (56%). This result was probably due to the greater level of the androgen hormone in men than women. Men also tend to ignore acne, which allows the acne to result in a scar. Men are less hygienic compared to women, which causes inflamed acne to become acne scars.[13]

The mean age of the participants was 30.35 ± 6.089 years, in which the youngest subject was 18 years of age, and the oldest subject was 40 years of age. Acne scars can form at all ages, but they usually more common in adulthood. Dermal damage has been reported to last longer in adults because of aging results in the loss of a fat layer, which increases the effect of acne scars; while at a young age, the collagen remodeling process and skin elasticity are better than in adults.[14]

Most of the participants had a bachelor's degree (75%). This level of education can be due to sufficient knowledge to go to the doctor to check the acne scar they experienced. Most of the participants worked as private employees (40%).

Table 3: Relationship between characteristics of participantsand degree of the severity of acne scars

	Mild acne scar (%)	Moderate acne scar (%)	Severe acne scar (%)	Total (%)	*P*
Education level					
High school	0	0	2 (18.2)	2 (10)	0.13
Diploma	2 (66.7)	0	0	2 (10)	
Undergraduate	1 (33.3)	5 (83.3)	9 (81.8)	15 (75)	
Postgraduate	0	1 (16.7)	0	1 (5)	
Occupation					
College student	0	0	3 (27.3)	3 (15)	0.52
Private employee	2 (66.7)	3 (50)	3 (27.3)	8 (40)	
Civil servant	0	1 (16.7)	3 (27.3)	4 (20)	
Medical doctor	1 (33.3)	2 (33.3)	2 (18.2)	5 (25)	

The mean body weight was 68.75 ± 11.715 kg, where the lightest participant was 49 kg, and the heaviest participant was 95 kg. The mean height was 168.85 ± 7.836 cm, where the shortest participant was 155 cm, and the tallest participant was 183 cm. Most of the nutritional statuses of the participants were normal, with a mean body mass index of 24.015 ± 2.9791. The nutritional status can affect the process of wound healing and re-epithelialization. In conditions of poor nutritional status (underweight), the process of healing wounds and re-epithelization becomes slower.[15]

The mean duration of having acne was 6.05 ± 2.114 years. This duration is one of the factors that cause acne scars. A longer inflammatory reaction causes damage to the dermal layer, thus forming deeper and larger acne scars.[16] The duration of having an acne scar can affect the outcome of therapy. The scars that are recently formed within a couple of months are more responsive to therapy because they are still in the remodeling phase. Moderate icepick acne scars were found in two participants, while severe icepick acne scars were found in eleven participants [Table 4.]. The icepick scar type is the most difficult to treat due to its depth, which reaches the dermis while rolling and boxcars are more superficial.

In this study, the Goodman–Baron scores before and after three treatments, at 1-month intervals, were significantly different ($P < 0.05$). The combination of fractional CO_2 and erbium GaAs laser therapy for acne scars, using a fractional photothermolysis mechanism, delivers light at the microthermal zone (MTZ), which is a column of controlled heat damage in the skin. The MTZ is surrounded by untreated skin, which causes rapid re-epithelialization through cell migration from the epidermis and adjacent follicular units. Chromophore or the intended target is water, one of the components in the skin. Warming of the dermis with laser beams emitted at these wavelengths triggers inflammatory mediators and collagenization. Repair of dermal damage is also faster because of the presence of healthy fibroblasts that can regulate collagen production, migrate to the treated dermis, and cause collagen remodeling.[17]

Table 4: Relationship of acne scar severity based on scar type

Scar type	Scar severity degree			*P*
	Mild	Moderate	Severe	
Icepick				
Yes	0	2	11	0.001
No	3	4	0	
Rolling				
Yes	0	1	7	0.052
No	3	5	4	
Boxcar				
Yes	3	6	11	

Of the 20 participants who were given fractional CO_2 and erbium GaAs combination laser therapy at the same time, only 7 (35%) experienced a decrease in the Goodman–Baron's acne score. However, there was no change in the degree of acne scar in all study participants before and after therapy. These results may indicate that more laser therapy sessions are needed to deal with those acne scars, especially for moderate-to-severe acne scars and the icepick type. Factors that may affect the outcome are the patient's compliance with medication, the patient's habit of not manipulating acne to avoid emerging new scars, and other therapies, such as other therapeutic modalities and daily skincare. In addition, to overcome acne atrophy, a combination with other therapeutic modalities is required to obtain better results.

In this study, the degree of acne scar severity was assessed using the Goodman–Baron Scale. This scale is a quantitative measurement method.[18] The measurement was carried out at every therapy session. The benefit of measuring the acne scar using the Goodman–Baron Score is that it can reflect the state of atrophy on the face qualitatively and quantitatively; however, it is limited as it cannot measure scar depth.

Half of the participants did not complain of side effects after receiving combined fractional CO_2 and erbium GaAs laser therapy, while 35% of participants complained of erythema or red spots, and 15% complained of itching. The duration of the side effect is usually about 3–5 days. Erythema occurred in participants with severe acne. The patients were treated using a laser at a wavelength of 1540 nm with the following settings: power 8.0 W, pulse width 5.00 ms, and energy 40.0 mJ, while the settings at the 10,600 nm wavelength were as follows: Power 25.0 W, pulse width 0.25 ms, and energy 6.2 mJ. However, not all participants who received laser therapy at those settings experienced erythema. Erythema is an effect that often occurs immediately after therapy. The degree of erythema is related to the depth of ablation and the magnitude of laser energy. It usually disappears spontaneously, but topical therapy can be given to reduce the degree of inflammation, such as corticosteroid cream and synchro creams.[19] In addition, compresses taken immediately after laser therapy can reduce facial erythema. Erythema and pruritus are the expected side effects of laser therapy.

Table 5: Normality test for Goodman Baron delta score data

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Significant	Statistic	df	Significant
Goodman Baron score before therapy	0.184	20	0.076	0.907	20	0.055
Goodman Baron score after therapy	0.190	20	0.057	0.880	20	0.018

Table 6: Differences of Goodman Baron scores before and after therapy

Goodman Baron Score	Mean±SD; median; minimum-maximum	*P*
Before therapy	22.55±15.028; 27.99; 2-54	0.007*
After therapy	20.55±15.609; 22.50; 2-54	

*Wilcoxon test. SD: Standard deviation

Table 7: Distribution of changes in Goodman Baron scores before and after therapy

Goodman Baron score	Frequency (%)
Decline	7 (35)
Not decline	13 (65)

Table 8: Correlation of delta Goodman Baron scores on various risk factors

	Delta score Goodman Baron (*r, P*)*
Duration of having acne (years)	−0.152, 0.521
Duration of having acne scar (years)	−0.094, 0.702
BMI	0.177, 0.456

*Pearson correlation test. BMI: Body mass index

Table 9: Correlation of age between declines and no decline in Goodman Baron score

Age	Mean±SD; median; minimum-maximum	*P*
Subjects who had declining Goodman Baron score	29.14±6.939; 29.00; 18-40	0.530*
Subjects who did not have a declining Goodman Baron score	31.00±5.774; 31.00; 24-40	

*Independent *t*-test. SD: Standard deviation

Conclusion

Based on this study, it can be concluded that a combination of 1540 nm erbium GaAs and 10,600 nm fractional CO_2 laser therapy can be used to treat atrophic acne scars on the face, with minimal side effects. However, additional therapy sessions are required to obtain better results.

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Conflicts of interest

There are no conflicts of interest.

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