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Assessment of efficacy and tolerability of fractional CO₂ laser in the treatment of axillary hyperpigmentation

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ABSTRACT

Background: Axillary hyperpigmentation is a common and troublesome complaint especially among dark-skinned women. It is believed to be a form of post-inflammatory hyperpigmentation and so far, there is no universally accepted treatment for the disorder.

Objective: The aim of this study is to assess the efficacy of fractional CO₂ laser in the treatment of axillary hyperpigmentation

Patients and methods: Thirty Egyptian females with axillary hyperpigmentation were recruited. The severity of the condition was estimated by both self-assessment and expert dermatologist before treatment. Four sessions of fractional CO₂ laser were done. Both the efficacy and complications were assessed by the patient and the dermatologist six month after the last session.

Results: There was a statistically significant difference of percentage of improvement of pigmentation before compared to one month after treatment as detected by self-assessment (p value= 0.002) and the observer's assessment (p value= 0.001).

Conclusion: Fractional CO₂ laser, in properly chosen parameters, is an effective method for the treatment of axillary hyperpigmentation.

Key words: Axillary hyperpigmentation, fractional CO₂ laser

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Introduction

The axilla is a biologically different area requiring attention and particular care. This area of skin is often subject to hair removal methods such as shaving and plucking, friction and antiperspirants. These procedures damage the skin leading to erythema and xerosis in the acute stage, and in some cases, post-inflammatory hyperpigmentation (PIH) on the long run. Axillary hyperpigmentation is a widespread difficult to manage complaint that has a great psychological impact with unknown exact frequency. [1]

Axillary hyperpigmentation is more prevalent among dark-skinned populations and this may be related to genetic factors causing liability of melanocytes to damage and/or an exaggerated reaction to inflammatory stimuli. [2, 3]

Histologically PIH is described as the occurrence of pigment leak in the dermis after stimulating the process of melanogenesis that lead to the appearance of dermal melanophages which attempt to ingest this pigment. [4]

The treatment of hyperpigmentation in Fitzpatrick skin phototypes (III-VI) represents a real obstacle for dermatologists especially in flexures where the tendency for PIH is higher. The first step of treatment equals prevention and treatment of the underlying inflammatory condition. This is followed by use of topical treatments, chemical peels, and light-based procedures. [5,6]

In fact, there is a marked limitation to laser-based devices for pigmentation for the fear of rebound pigmentation or worsening. Some authors even recommended that ablative lasers as Er:YAG 2940 nm or CO₂ 10600 nm should never be used for melasma or PIH due to the great risk of worsening hyperpigmentation. [7, 8, 9]

When treating dermal pigmentary disorders as melasma with fractional lasers, the extrusion of dermal pigment in conjunction with the resultant microthermal zones (MTZs) is the most likely mechanism. However, PIH itself is the most

common side effect that may follow this procedure [10, 11]

In this study we assessed the efficacy and tolerability of fractional CO₂ laser on the improvement of axillary hyperpigmentation in Egyptian female patients.

Patients & Methods

The current study included 30 Egyptian female patients with axillary hyperpigmentation. Informed consents were obtained from all patients. Inclusion criteria were female gender and no topical, systemic, laser, or surgical treatment in the axillary area during the month that preceded treatment. Exclusion criteria were pregnancy, breastfeeding, obesity acanthosis nigricans, and local active inflammation or infection. Detailed medical history was obtained from each patient including age, occupation, onset, hair removal methods, use of deodorant/antiperspirant, physical exercise, and cleansing methods.

Each patient was subjected to 4 fractional CO₂ laser sessions at one-month interval. The device used was the DEKA smartXide®. The power used was 10 watts, spacing between the columns of micro thermal zones was 500 micrometer, dwell time exerted was 400 microseconds, and the number of stacks applied was 1. It was used in fractional dot mode on, smart track pattern. After each session, patients were directed to applying topical mild steroid twice daily for three days to prevent inflammation. Visual Analogue score (VAS) was used to assess patients before commencing the sessions and 6 months after the last session was done. subjective assessment was carried out by self-assessment (the patients themselves) and an expert dermatologist who carefully examined the patients each session. They were asked to score the evident pigmentation upon a scale of: 0:normal, 1:mild, 2:moderate, 3:severe, and state the percentage of improvement upon a scale of: 0:0-24%, 1: 25-49%, 2: 50-74%, 3: 75-100% improvement. Adverse events were reported by patients & assessed by the treating physician. Patients were prescribed a topical

emollient for one week and a mild steroid for 2 days after each session. During the six months follow up period, patients were instructed to use moisturizers only and avoid the use of any bleaching agent or any other topical treatments. They were also informed to come for dermatological consultation in case any irritation, inflammation or pruritis developed during the follow up period.

Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 23. Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. P-values less than 0.05 were considered as statistically significant. [12]

Statistical analysis

Table 1: The severity of pigmentation before treatment by patients' and observer's assessments

The severity of pigmentation before treatment	Patient		Observer		P value
	Count	%	Count	%	
Normal	0	.0%	0	.0%	0.317
Mild	6	20.0%	4	13.4%	
Moderate	4	13.3%	14	46.7%	
Severe	20	66.7%	12	40.0%	

Table 2: The severity of pigmentation six month after the last session by patients' and observer's assessments

The severity of pigmentation after treatment	Patient		Observer		P value
	Count	%	Count	%	
Normal	12	40.0%	14	46.7%	0.131
Mild	10	33.3%	14	46.7%	
Moderate	4	13.3%	2	6.7%	
Severe	4	13.3%	0	.0%	

Table 3: Comparison of % of improvement between patients' and observer's scores

%of improvement	Patient		Observer		P value
	Count	%	Count	%	
0 %	6	20.0%	2	6.7%	0.317
0-30%	4	13.3%	6	20.0%	
30-70%	0	.0%	4	13.3%	
70-100%	20	66.7%	18	60.0%	

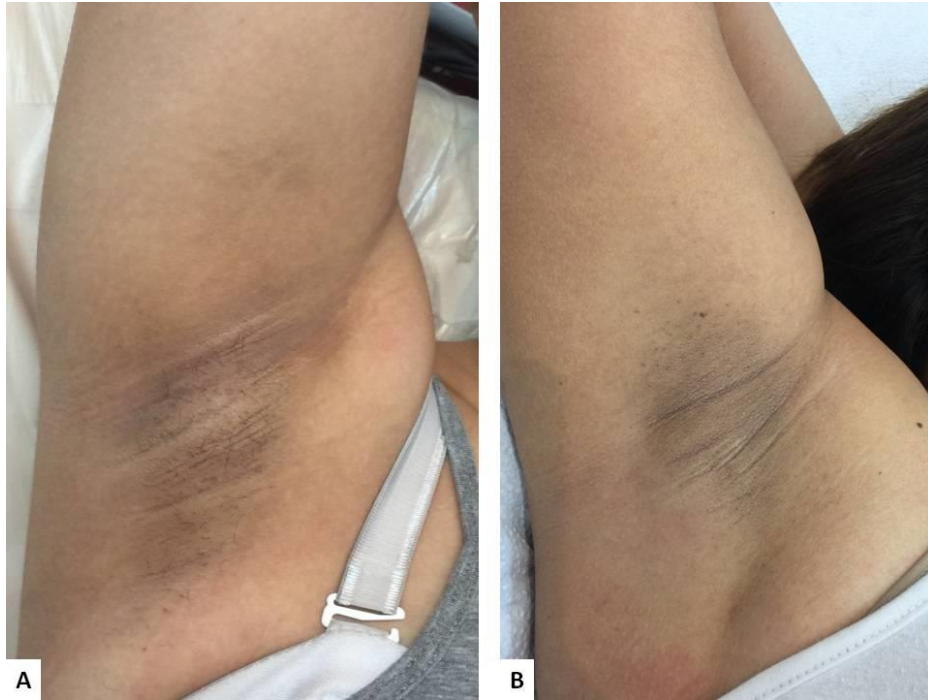


Figure 1: left: Moderate pigmentation before treatment. right: improved to mild pigmentation after treatment

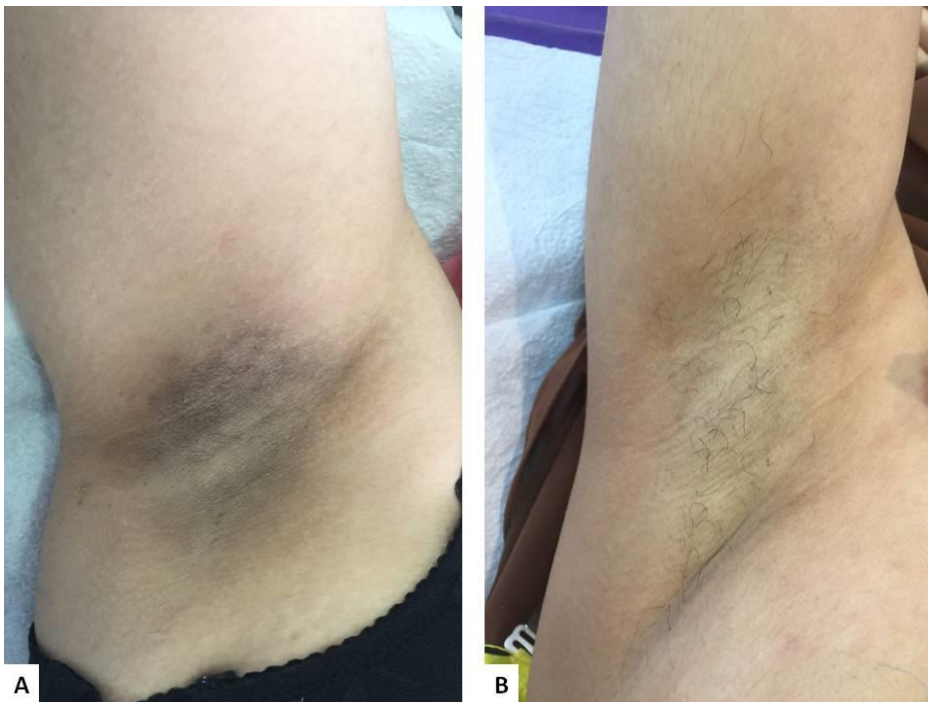


Figure 2: left: severe pigmentation before treatment. right: Improved to mild pigmentation after treatment

Results

Thirty Egyptian female patients with axillary hyperpigmentation were included in this study. Their age ranged between 15 to 50 years with a mean of 30.47 ± 8.56 years. Their skin phototypes were III (20%), IV (60%), and V (20%) according to Fitzpatrick skin phototypes.

Waxing of this area was the most prevalent hair removal method, and was used in 83 % of cases. On comparing evident pigmentation before starting the first treatment session, the study revealed no statistically significant difference between the patients' assessment and the observer's assessment. (*table 1*)

This study has also revealed no statistically significant difference between the patients' assessment and the observer's assessment when comparing evident pigmentation 6 month after the last treatment session. (table 2)

Through self assessment, there was a statistically significant improvement of pigmentation six month after treatment compared to before treatment (p value= 0.002). Regarding the observer's assessment, there was also a statistically significant improvement of pigmentation six month after treatment compared to before treatment (p value= 0.001). Regarding the percentage of improvement of pigmentation, there was no statistically significant difference between the patients' scores and the observer's scores (p value=0.317).(table 3)

Patients tolerated the sessions very well and completed the treatment period with no drop out. Complications in the form of increased pigmentation, scarring or secondary infection were not detected in any case. Only temporary discomfort and erythema after each session were reported and resolved completely in 3-5 days. The patients experienced no significant swelling or pain. Adverse events were statistically insignificant (p value=1) and included moderate pain lasting 1-2 hours after session, prolonged erythema for more than 48 hours which all resolved using the prescribed emollients

Clinical images showing the improvement following treatment are shown in Figures 1 & 2

Discussion

The axillary skin is an area that deserves a major attention due reduced skin barrier integrity and function compared to other body sites due to its increased cholesterol: ceramide ratio. [13]

Damage to the axillary skin may initiate a cascade of pro-inflammatory mediators ending in irritation, itching and erythema. With time, this inflammatory event will lead to axillary

hyperpigmentation which is a form of PIH. [14, 15, 16]

Although first-line therapy includes topical depigmenting agents, some modalities as chemical peels and laser can target the melanin elimination but has no effect on melanin production itself [17]

To our knowledge this is the first study to use fractional CO2 laser to ameliorate the pigmentation in the axillary region.

Thirty Egyptian female patients with axillary hyperpigmentation were included in this study, 80% of them had IV-V Fitzpatrick skin phototypes. This is consistent with the fact that axillary hyperpigmentation exists more among dark-skinned populations which may be related to genetic factors or abnormal response to inflammatory stimuli. [2, 3]

Waxing of the axilla was the most prevalent method of hair removal among our patients, and was used in 83 % of cases. In addition to the skin phototype, this method of hair removal could be the second major factor contributing to axillary hyperpigmentation in our patients as according to Turner et al., the axillary skin faces dramatic challenges as waxing, shaving and plucking, cleansing agents, deodorants and antiperspirants and also friction, all of which lead to repeated irritation which in turn leads to PIH. [14]

When it comes to light-based therapies in pigmentation, most of the current literature focuses on melasma and solar lentiginos with variable outcomes. [18, 19] However, when it comes to using fractional CO2 laser in treating PIH in a challenging area as the axillary area, no studies were carried out.

In this study four sessions of fractional CO2 laser (10.600-nm wavelength) treatment were performed at one-month interval. Its penetration depth is dependent on water content with no relation to either melanin or hemoglobin which provides it with the ability to treat a wide range of skin conditions. [19]

Through both self and observer's assessments, we found a statistically significant improvement of pigmentation six month after treatment compared to before treatment.

Fractional CO₂ laser produces controlled thermal damage where it delivers the laser beam through micro-channels creating microscopic thermal wounds, referred to as microthermal zones (MTZs). MTZs shows homogenization of collagen and formation of microscopic epidermal necrotic debris (MENDs) containing melanin. MENDs result from the elimination of the damaged keratinocytes with their pigment content. [20, 21]

In Melasma, fractional CO₂ was found to improve the dermal component through disruption of the dermal macrophages containing melanin, resulting in release of melanin particles and modifying their optical properties. [21]

Similarly to its action in melasma, fractional CO₂ laser may work in axillary hyperpigmentation which is considered a form of PIH with dermal melanogenesis and this may explain the improvement seen in our patients. In addition, MENDs contain damaged keratinocytes with melanin which will minimize the epidermal pigment load and will provide better cosmetic appearance [20]. This will add to the efficacy of fractional CO₂ laser in treatment of pigmentary disorders and may explain the significant improvement we detected in this study.

Apart from transient erythema and discomfort, no complications in the form of aggravation of pigmentation or scarring were detected in any patient six month after the last session. However, we must take into consideration that some authors reported that the use of fractional CO₂ laser in pigmentary conditions may lead to worsening of pigmentation and development of PIH. [17]

To guard against this paradox, we used carefully chosen parameters; the power used was 10 watts, spacing between the columns of micro thermal zones was 500 micrometer, dwell time

exerted was 400 microseconds, and the number of stacks applied was 1. This supports the fact that with fractional lasers, using low-fluencies, increased intervals between treatments, and decreased density reduces the risk of PIH. [22]

In conclusion, fractional CO₂ laser was proved to be an effective and well tolerated method in improving the axillary hyperpigmentation and enhancing the cosmetic appearance of the axillary region without serious drawbacks. Proper selection of patients and carefully chosen parameters minimize the risk of complications

Recommendations

Since fractional CO₂ laser was used previously as a drug assisted delivery system and thus enhancing the effect of depigmenting agents, further studies using CO₂ laser in combinations with other agents in the axillary area are recommended.

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