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The Efficacy of Low Energy Fractional Carbon Dioxide Laser Therapy in Management of Post-Surgical Hypertrophic Scars

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ABSTRACT

Background: Hypertrophic Scars result from abnormal wound healing due to an inflammatory process within the wound and are mainly constituted of fibroblasts formation, neoangiogensis and substantial deposition of collagen. HS likely arise during a few months in high tension area and can persist along the margins of the original wound. Hypertrophic scars arise after various injury mechanisms such as traumatic skin injury, skin burns, surgical wounds, skin injections and dermatitis. Among which, surgeries are considered to be one of the major causes of Hypertrophic Scars.

Aim of Study: The aim of this study was to evaluate the efficacy of low energy carbon dioxide laser therapy in management of hypertrophic surgical scars in comparison to the standardized high energy modes in regards of scar ablation and patient satisfaction.

Patients and Methods: This study is a prospective and a comparative that compared traditional High energy with Low Energy fractional CO_2 laser in treatment of Hypertrophic post-surgical scars. This study was conducted between April 2021 to March 2022 at the Laser Unit attached to plastic, Burn and Maxillofacial Surgery Department at Faculty of Medicine, Ain Shams University. The study included 40 patients (N=40), all of which were complaining of post Abdominoplasty Hypertrophic scars and were divided blindly into 2 groups. In group I (n=20), they were treated by standard high energy fractional CO2 laser therapy Light FX: Energy (70-150mJ), density (5-10%), and frequency (150-250Hz), Deep FX: Energy (15.5-25.5mJ), density (5-15%) and frequency (300-600Hz), Active FX: Energy (100-150mJ), density (5%) and frequency (200-250Hz). In group II (n=20), they were treated by lower energy modes than group I, Light FX: Energy (50-120mJ), density (5%), and frequency (100-200Hz), Deep FX: Energy (12.5-22.5mJ), density (3-10%) and frequency (200-400Hz), Active FX: (80-125mJ), density (3%) and frequency (100-150Hz). Both groups were treated by Syneron/CANDELA CO2RE® laser machine and both groups were evaluated by, 3 different observers using the VSS score once before starting sessions and twice on two separate occasions after completion of sessions. Patients in both groups also evaluated themselves using the POSAS score. Results of both groups were compared in regards to mean age, history of Abdominoplasty, history of massive weight loss, post session complication, skin quality, mean POSAS score before and after, and mean VSS before and after.

Conclusion: After review of both groups; we have concluded that high frequency fractional CO_2 laser offers greater results in regards to scar ablation which could be notably measured by the VSS variables at the cost of longer recovery times and potentially more irritation to the patients. On the other hand, the low frequency fractional CO_2 laser scar ablation is likely to offer moderate results, and an easier and shorter recovery times thus may contribute to greater patient satisfaction. Overall, this selection of frequencies allows the physician options to customize the appropriate care for their patients according to their patients' needs and circumstances.

Key Words: *Ablative – Postsurgical – Keloids – Resurfacing – Rejuvenation.*

Disclosure: No conflict of interest.

INTRODUCTION

Hypertrophic Scars result of abnormal wound healing due to an inflammatory process within the wound and are mainly constituted of fibroblasts formation, neoangiogensis and substantial deposition of collagen. HS likely arise during a few months in high tension area and can persist along the margins of the original wound. Hypertrophic scars arise after various injury mechanisms such as traumatic skin injury, skin burns, surgical wounds, skin injections and dermatitis. From which, surgeries are considered to be one of the major causes of Hypertrophic Scars **[12]**.

While hypertrophic scars are cosmetically disturbing, they have also proven to have negative effects on physical health, psychological health and social well-being for both patients and their families. Nonetheless, studies have shown that hypertrophic scars and keloids cause mental and

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emotional impairment as much as major systemic illnesses. Additionally, the high cost of treatment and the strict commitment on follow-up and patience until tangible positive outcome is achieved also adds financial burden on both governments funded health care plans and families of the patients **[29]**.

Moreover, Fractional lasers were first described by Manstein et al., 2004 **[13]**. It maintains the selectivity of photothermolysis by targeting specific wave lengths of molecules, while creating microscopic holes or microholes in epidermis and dermis termed microscopic treatment zones. Microholes are areas of controlled widths, depths and densities surrounded by islands of normal tissue for rapid regeneration and repair by scar remodeling and neocollagenesis **[19]**.

Although it has proven to be effective and safe at the recommended high energy modes, there have been many reports of pain and burning sensation enough to require combining pain management and post session burn reduction applications **[28]**. Such an unpleasant experience urges us to investigate the efficacy of lower energy modes too in comparison to standard high energy modes to achieve good aesthetic outcome and less painful sessions for hypertrophic post-surgical scars management.

PATIENTS AND METHODS

This study is a prospective and a comparative that compared traditional High energy with Low Energy fractional CO_2 laser in treatment of Hypertrophic post-surgical scars. This study was conducted between April 2021 to March 2022 at the Laser Unit attached to plastic, Burn and Maxillofacial Surgery Department at Faculty of Medicine, Ain Shams University.

Ethical consideration: Consent was obtained from all participants. This study was approved by the Research Ethics Committee of Faculty of Medicine, Ain Shams University.

Inclusion criteria: In this study, adults age between 20 to 40 years old complaining of Hypertrophic Post Abdominoplasty scar within the first six months of the surgery with BMI of 35 or less with no active viral infection near the scar.

Exclusion criteria: In this study, adults ages below 20 or above 40 with other hypertrophic scars than Abdominoplasty more than six months of the surgical intervention, BMI of more than 35, Patients with active viral infection near the scar site.

Procedures: As regards of protocol of the laser unit, all patients in both groups will receive 3 sessions of laser treatments, 4 weeks apart (total of 3 sessions on 12 weeks) **[18]**. Fractional CO_2 light scan was used according to individual patient and scar characteristics. The initial pass (light FX) in both groups of the laser was performed in the treatment mode in which the laser beam penetrates skin up to a depth of 4mm to target the deeper layers of scars. The second pass (Deep FX) was done to treat more superficial layers of scars up to a depth of 1mm. A third pass (Active FX) is for superficial ablation to smooth out irregular areas. It will only be used in patients with superficial irregularities in surface and discoloration and would be used after the other two modalities as a single pass.

Participants in the study were divided blindly as follow:

Group one (High energy, n=20) Fractional Carbon Dioxide Laser parameters was as following **[8]**:

- Light FX: Energy (70-150mJ), density (5-10%), and frequency (150-250Hz).
- Deep FX: Energy (15.5-25.5mJ), density (5-15%) and frequency (300-600Hz).
- Active FX: Energy (100-150mJ), density (5%) and frequency (200-250Hz).

Group two (Low energy group/Experimental group, N=20), Fractional Carbon Dioxide Laser parameters was as following **[26]**:

- Light FX: Energy (50-120mJ), density (5%), and frequency (100-200Hz).
- Deep FX: Energy (12.5-22.5mJ), density (3-10%) and frequency (200-400Hz).
- Active FX: (80-125mJ), density (3%) and frequency (100-150Hz).

Both groups were treated by Syneron / CANDELA CO2RE® laser machine and both groups were evaluated by, 3 different observers using the VSS score once before starting sessions and twice on two separate occasions after completion of sessions. Patients in both groups also evaluated themselves using the POSAS score. Results of both groups were compared as regards to mean age, history of Abdominoplasty, history of massive weight loss, post session complication, skin quality,

mean POSAS score before and after, and mean VSS before and after.

Scar care and follow-up:

Topical Lidocaine application was applied to skin before the session to mitigate the pain **[17]**. and emollient applications was applied twice daily for the first 3 days post session to mitigate the post session burn **[24]**.

Statistical analysis:

The data was analyzed by SPSS (statistical package for social science) version 26.0 on IBM compatible computer (SPSS Inc., Chicago, IL, USA). The qualitative data was described as number and percentage and analyzed by using Chi square test and Fisher's exact test. Quantitative data were tested for normality using Shapiro-Wilks test, assuming normality at $p>0.05$. Quantitative data was described as mean, standard deviation, using Student's "*t*" test, and one way ANOVA test. The accepted level of significance in this work was started at 0.05 ($p<0.05$ was considered significant).

RESULTS

This study showed no statistically significant difference found between Group I and Group II in regards to age, time of surgery, history of massive weight loss, post operative complications, skin quality, scar self rating before the sessions and the VSS before the sessions with *p*-value=0.493, 0.693, 0.342, 1.00, 0.327, 0.978, 0.477 respectively. However, the study showed highly significant statistical differences between the two groups in the patient self rating score and the VSS after completion of the sessions with *p*-value=0.013 and 0.007. These data regarding age and clinical findings were declared in Table (1).

The study shows high significance between the two groups in regards to the self rating (Fig. 1) and the Vancouver Scar Scale scores after the study (Fig. 2). We, expectedly, found that the observer's mean VSS score for group 1 are better than group 2 after the study was completed, however, patients' mean self rating score in group 2 were better than group 1 (Table 2), likely, owing to the less painful sessions and less recovery time due to the lower frequencies used on the second group.

Table (2) showing a comparison between Group 1 and 2 regarding self rating scales before the procedure and after 6 months. Patients in group 1 had a highly significantly higher Patient Self-Rating Scale after 6 months than group 2 (*p*-value =0.013). Patients were evaluated by 3 different observers on two separate occasions, after analyzing the scores and calculating the overall mean average of the 3 different observers on the two separate occasions we found that patients in group 2 had a highly significantly higher Vancouver Scar Scale after 6 months than group 1 (*p*-value=0.007).

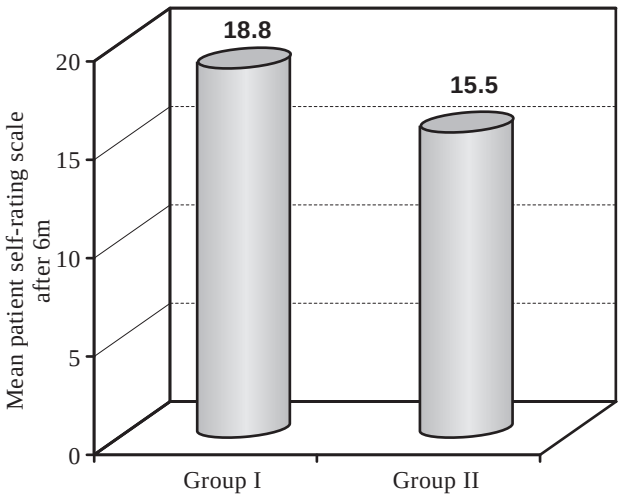


Fig. (1): Bar chart displaying the mean value of patient self-rating scale after 6 months in both groups.

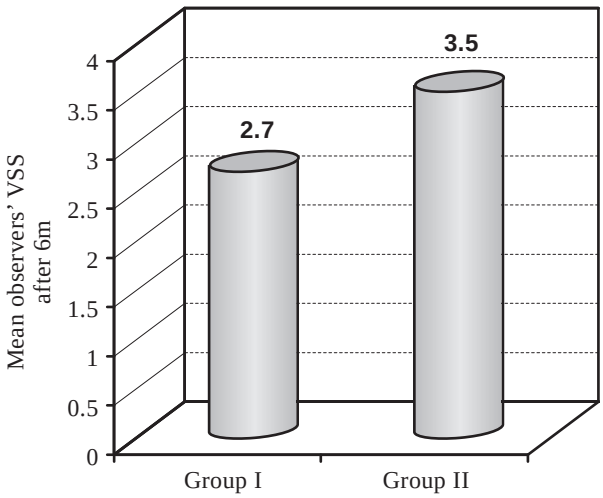
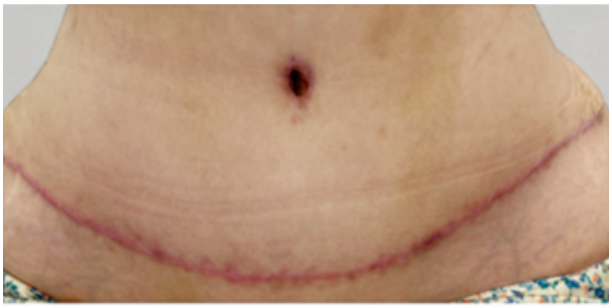


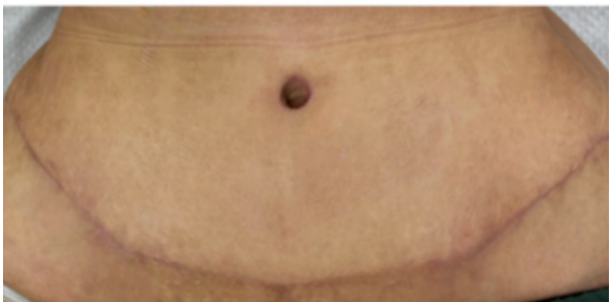
Fig. (2): Bar chart displaying the mean value of the overall observers' Vancouver scar scale after 6 months in both groups.

(A)

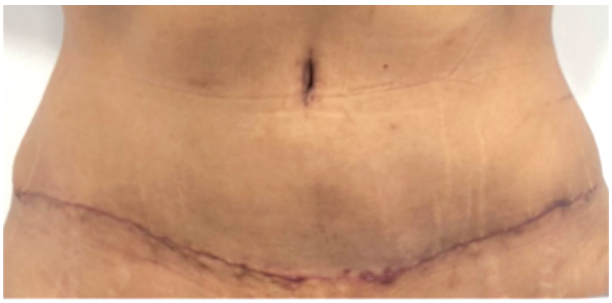


(A)

(B)



(B)



(A)

(A)

(B)

(B)

Fig. (3): Shows 4 different participants in group I. (A) Before beginning the study. (B) After completion of the study.

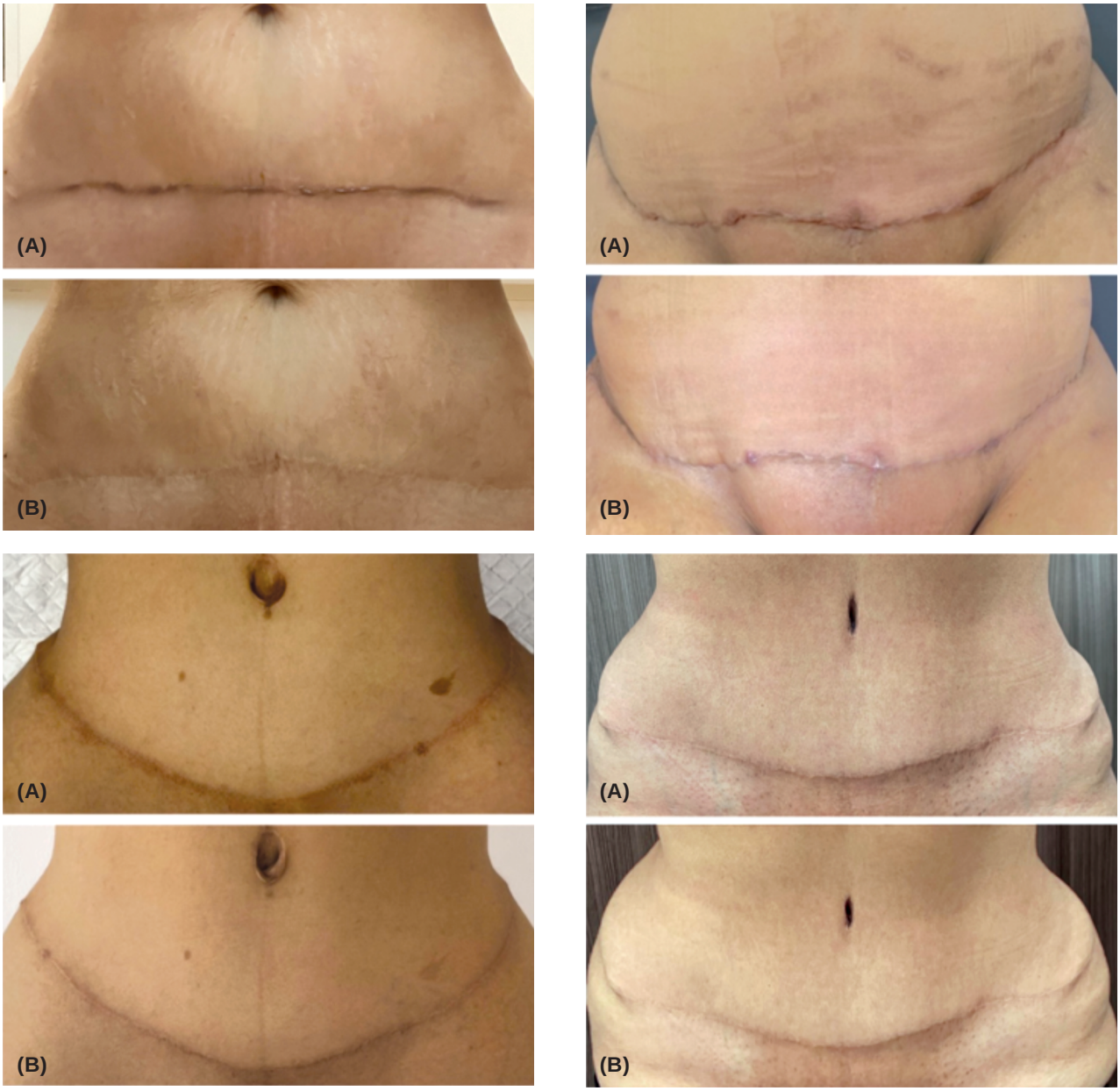


Fig. (4): Shows four different participants in group II. (A) before beginning the Study. (B) after completion of the study.

Fig. (5): Syneron/CANDELA CO2RE ® laser device.

Table (1): Showing a Comparison between high frequency fractional CO_2 ablative laser group (Group I) and Low frequency ablative laser group (Group II) regarding age and clinical data.

	Group I No.= 20	Group II No.= 20	*p*-value	Sig.
Age (years):				
Mean ± SD	30.0±4.9	28.6±6.0	0.439	NS
Clinical data:				
Time of Abdominoplasty:				
Mean ± SD	2.9±1.4	2.8±1.4	0.693	NS
History of massive weight loss:				
Yes	11 (55%)	8 (40%)	0.342	NS
No	9 (45%)	12 (60%)		
Post operative complication:				
Yes	7 (35%)	7 (35%)	1.00	NS
No	13 (65%)	13 (65%)		
Skin quality:				
Poor	5 (25%)	6 (30%)	0.327	NS
Stretch marks	6 (30%)	4 (20%)		
Inelastic	1 (5%)	1 (5%)		
Good	5 (25%)	9 (45%)		
Massive laxity	3 (15%)	0		
Scar Self rating (before study):				
Mean ± SD	41.90±5.6	41.85±5.6	0.978	NS
VSS (before study):				
Mean ± SD	9.0±1.1	9.2±1.0	0.477	NS
Scar Self rating (after study):				
Mean ± SD	18.8±4.5	15.5±3.5	0.013	HS
VSS (after study):				
Mean ± SD	2.7±1.0	3.5±0.7	0.007	HS

p-value >0.05: Non significant. *p*-value <0.05: Significant. *p*-value <0.01: Highly significant.

Table (2): Rating scales of the studied patients (N=40).

	Group I No.=20	Group II No.=20	*p*-value
Patient Self-Rating Scale before study:			
Mean ± SD	41.90±5.6	41.85±5.6	0.978
Patient Self-Rating Scale after 6 months:			
Mean ± SD	18.8±4.5	15.5±3.5	0.013
Observers' Vancouver Scar Scale before study:			
Mean ± SD	9.0±1.1	9.2±1.0	0.477
Observers' Vancouver Scar Scale after 6 months 1st time:			
Mean ± SD	2.7±1.0	3.5±0.8	0.005
Observers' Vancouver Scar Scale after 6 months 2nd time:			
Mean ± SD	2.7±1.0	3.4±0.7	0.010
Overall observers' Vancouver Scar Scale after 6 months:			
Mean ± SD	2.7±1.0	3.5±0.7	0.007

DISCUSSION

Treatment options for post-surgical hypertrophic scars are various, however, no one specific option is considered to be superior over another. Numerous studies have suggested both the efficacy and the safety of Fractional Carbon dioxide laser resurfacing for ablation of hypertrophic scars **[1,2,5,7]**. Fractional carbon dioxide laser ablation is reported to have successfully treated post burn hypertrophic scars and pathological scars **[3,6,8,14,21,28]**. A like restorative benefit is expected in post surgical

hypertrophic scars since the mechanism underlying behind all these etiological types of scars is basically similar **[5,10,15]**. High frequency fractional CO_2 laser has been shown to be effective in patients with either light or dark skin types **[3,4]**. Studies have documented significant improvement in Vancouver scar scale (VSS) and Patient self observer assessment scale (PSOAS) after high frequency fractional CO_2 laser resurfacing on hypertrophic scars **[7]**. Scars that results from surgical incisions are likely hypertrophied in their constitution and is known to be slightly more challenging to treat than other types of scars.

To evaluate the gravity of post-surgical hypertrophic scars and their response to therapy various evaluating scores are suggested like the Vancouver Scar Scale (VSS) and the Patient Observer Scar Assessment Scale (POSAS) **[2,7,21]**.

These scoring scales are very helpful mainly in evaluating the degree of severity of the hypertrophic scars. Many studies have applied these scoring systems in evaluating the degree of the scar severity and also their response to therapy. We utilized the same variables as instructed in POSAS score while evaluating our outcomes but we excluded the observer's variables in our scoring scale **[7]**. This was done because we used the VSS as the mean of evaluation done by an observer. Observer-based assessment using the VSS included four variables of skin pliability, pigmentation, vascularity and height of scar. We noticed improvement in all of these variables before and after fractional CO_2 laser ablation. Enhancement in skin texture was noted by a soft and a more even in appearance and feeling (Figs. 3,4). Scar softening and the near normal skin texture were the earliest variables to show an notable response with both patients and evaluators in both groups noticing enhancement even after the very first session (Figs. 3,4). Scar's Pigmentation has also improved dramatically and this also added to change the gross appearance of the scar. Nonetheless, the low frequency groups VSS was slightly higher than the high frequency group with (p-value=0.007). On the other hand, the low frequency group self rating score showed slightly more improvement and overall satisfaction owing to the less painful sessions and less downtime of recovering between sessions.

Limitations:

The study was performed on one type of surgical wound scars, Abdominoplasty scar, within the first six months post operatively which is relatively a recent scar. Also the study has evaluated the scars by only two variables; the patient self rating (POSAS) and observers' evaluation by the (VSS). Thus, the study needs to be performed on different types of scars whether surgical or traumatic and to include older than six months scars. It will be of greater benefit if histological assessment could be added to the measured variables in the study.

Conclusion:

After review of both groups; we have concluded that high frequency fractional CO_2 laser offers greater results in regards to scar ablation which could be notably measured by the VSS variables at the cost of longer recovery times and potentially more irritating to the patients. On the other hand, the low frequency fractional CO_2 laser scar ablation is likely to offer moderate results, and an easier and shorter recovery times thus may contribute to greater patient satisfaction. Overall, this selection of frequencies allows the physician options to customize the appropriate care for their patients according to their patients' needs and circumstances.

Disclosure:

The authors didn't receive any funds or grants neither they received any recognition by any commercial nor profitable organizations regarding this work and has no issue to declare.

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