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Influence of the Fractional CO_2 Laser on Immunohistochemical Expression of Smooth Muscle actin in Keloid and Hypertrophic Scars

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Abstract

Background: Wound healing is a set of elaborate and complex mechanisms including period of oscillation of inflammation, granulation tissue production, and tissue remodeling, which culminates in the restoration of tissue structural stability and injury. That study purposed to evaluate clinical and histopathological changes of keloid and hypertrophic scars before and after CO_2 laser treatment. Methods: That interventional research was carried out on individuals with keloids and hypertrophic scars attending the Out-patient Clinic of Dermatology in Hospital of Benha University. Participants were exposed to historical analysis, Local Dermatological inspection, Tissue biopsy, Treatment course by fractional CO_2 laser, follow up after treatment. Results: A statistically critical decrease in size of the lesion when comparing among pretreatment and post-treatment [$p<0.05$]. Vancouver scale score results were considerably higher pre-treatment than post-treatment [$P<0.05$]. Conclusion: From the previous results we can conclude that Fractional CO2 laser is a viable therapy option for keloid and hypertrophic scars since it reduces clinical signs such as colour, thickness, and pruritus in addition to improvement at the cellular level.

Keywords: Fractional CO_2 Laser; Immunohistochemical Expression and Keloid; Hypertrophic Scars.

1. Introduction

Wound healing is a set of elaborate and complex mechanisms including period of oscillation of inflammation, granulation tissue production, and tissue remodeling, which culminates in the restoration of tissue structural integrity and injury [1].

Keloid scars are caused by trauma or inflammation to the skin and may grow years after the original injury [2]. Scar tissue grows further than initial injured area and may be disturbing and produce psychological problems that diminish life quality [3].

Alpha-smooth muscle actin [α-SMA] is the predominant actin isoform inside smooth-muscle cells and has a crucial function in fibrogenesis process [4].

By targeting certain wavelengths of molecules, fractional lasers preserve the specificity of photothermolysis while generating minuscule holes or microholes [5].

By helping in neocollagenesis, the undamaged skin around a wound becomes a reservoir of viability. This reduces the thickness and enhances hypertrophic burn scars flexibility [6].

Ablative and non-ablative laser devices were altered and further classified as non-ablative fractional resurfacing [NAFR] vascular erbium: glass lasers with wavelengths in the range from 1540 nm to 1550 nm or ablative fractional resurfacing [AFR] lasers with wavelengths in the range from 10,600 nm fractional CO2 [fCO2] lasers to 2940 nm. Er:YAG lasers [7].

The current research aimed to evaluate clinical and histopathological changes of keloid and hypertrophic scars before and after CO_2 laser treatment.

2. Patients and methods

That interventional research was carried out on participants with keloids and hypertrophic scars attending the Out-patient Clinic of Dermatology in Benha University Hospital. Study was done after being approve by the Research Ethics Committee and all participants provided their informed consent. That study involved 30 participants of both sex and different age groups.

Inclusion Criteria were any patient with keloid or hypertrophic scar regardless of their site or duration, resulting from burns, surgery, or any other traumatic injuries.

Exclusion Criteria were participants who accepted topical therapy over past 6 months, pregnancy and lactation, patients who refused participation or dropped out during the follow up period, oral retinoids past drug history of 6 months before the study.

All patients were subjected to Personal information and current sickness history were gathered.

Local Dermatological examination: The clinical evaluation of the scar was centered on the Vancouver scar scale [VSS]. There was photographic documentation conducted.

Tissue biopsy: A skin biopsy will be taken from the scars of both groups and prepared.

Treatment course: Patients were treated by fractional CO_2 laser [three sessions at one-month intervals].

Follow up: Photography and clinical assessment and monitoring the treatment effect based on VSS was done by two dermatologists.

Reassessment after treatment: The clinical response was evaluated. Another punch biopsy was taken from the patients after completing his/her treatment course for histopathological re-evaluation.

Statistical analysis

Using SPSS 26.0 for Windows, all data were gathered, and evaluated [SPSS Inc., Chicago, IL, USA]. Quantitative data were reported as the mean ± standard deviation and median [interquartile range], whilst qualitative data were presented as absolute frequencies [number] and relative frequencies [%]. Combined sample Student's t-test was utilised to assess pre- and post-test findings for regularly scattered variables, whilst the Wilcoxon test was utilised for non-normally distributed data. Mc Nemar test was used to evaluate proportions of categorical variables. Spearman's rank correlation coefficient was computed to evaluate the link between the variables of the research, The [+] sign suggests a direct connection, while the [-] sign implies an inverse relation. Values close to 1 suggest a strong association, whilst values close to 0 show a weak connection. All tests were double-sided. p-values less than 0.05 were deemed statistically critical.

3. Results

Table (1) Basic characteristic and clinical characteristic of the studied group [n=30]:

Characteristic		Study group [n=30]	
Age			
Mean ±SD		18.40±8.55	
Median [IQR]		16 [10-27]	
Category		**n**	**%**
Sex	Male	18	60
	Female	12	40
Characteristic		**Study group [n=30]**	
	Category	**n**	**%**
Diagnosis	Hypertrophic scar	6	20
	Keloid	24	80
Site	Sub-umbilical	3	10
	Back	3	10
	thigh	3	10
	Arm	6	20
	Chest	12	40
	Supra-clavicular	3	10

Basic characteristic and clinical characteristic of the studied group were presented in **Table (1)**.

A statistically critical change was seen when comparing pretreatment and post-treatment regarding associated symptoms [p<0.05] where post-treatment results showed lower mean values when compared to pre-treatment mean values. Ninety percent of cases pre-treatment complained of pain which decreased to 20% post-treatment. Also, there is significant decrease in pruritus.

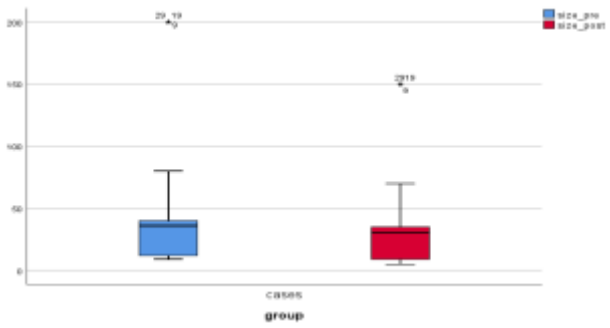

Fig. (1): Box blot illustrating size of lesion pre and after treatment in the studied group.

A statistically critical reduction was seen in size of the lesion when comparing pretreatment and post-treatment [p<0.05]. **Fig (1).**

A critical change was seen statistically when comparing pretreatment and post-treatment regarding Vancouver scale score results [p<0.05] where post-treatment results showed lower mean values when compared to pre-treatment mean values. The mean percent of change was 44.93±16.13 with median 50 [33.3-57.14].

Fig. (2): Pie chart illustrating patient satisfaction of the studied group.

Regarding patient satisfaction: 40% of cases showed good satisfaction, 30% showed excellent satisfaction and the other 30% showed fair satisfaction. **Fig. (2).**

Table (2) : correlation between percent of change and different parameters within the studied group [n=30]:

Variables		Percent of change
Age	r	-0.063
	P	0.741
Size pre	r	-0.147
	P	0.439
Patient satisfaction	r	**0.886****
	P	**0.000**

A positive critical association was seen among change percent and patient satisfaction. Increased patient satisfaction occurred with increase in the percent of change. **Table (2).**

4. Discussion

Wound healing is a complex series of processes including inflammation, development of granulation tissue and tissue remodeling, resulting in the restoration of tissue structural integrity and injury [1].

This research found significant enhancement in symptoms [p<0.05] as ninety percent of cases pre-treatment complaining of pain which decreased to only 20% post-treatment.

The findings are congruent with those of research in **[2016]** which reported decrease in pain in 54.5 % of patients and pruritus disappeared in 68.8 % of patients after treatment [8].

Our study revealed a statistically significant improvement in VSS results [p<0.05] where post-treatment results showed lower mean values when compared to pre-treatment mean values. The mean percent of change was 44.93±16.13 with median 50.

The current research's findings are congruent with those of a study from [**2022]** that used the VSS as the standard assessment instrument. Before and after fractional CO2 laser ablation, skin characters were shown to be improved [9].

The current study results go hand by hand with a study in **[2015].** 15 patients with hypertrophic scars and keloidal scars underwent three CO2 fractional laser treatments. Laser-treated hypertrophic scars [HTs] shown textural enhancement and a substantial drop in Vancouver score scale at the conclusion of the follow-up phase [P <0.05] [10].

Current study outcomes were parallel to a study in **[2006]** that revealed a statistically critical change in the clinical scores of hypertrophic scars prior to and following therapy, with improvements in symptoms, and scar characters in the involved trials [11].

A study in **[2016]** reported that the untreated region, had a substantial decline in the VSS that appeared after three months of treatment in both groups [8].

Forty individuals with hypertrophic scars were assessed in a study in **[2014]**. Every participant received four fractional CO2 laser treatments. Eight patients were biopsied before to and three months following four fractional CO2 laser treatments, along with four normal skin control biopsies. A critical change was seen statistically in VSS prior to and following fractional CO2 laser [P > 0.001]. The epidermal thickness increased significantly after laser therapy [P > 0.001] [12].

A study in **[2019]** evaluated the role of CO_2 fractional laser usage in addition to classic therapy as corticosteroids. Various aspects of scar parameters like texture and hypertrophy were improved [13].

Regarding patient satisfaction, about 40% of cases showed good satisfaction, 30% showed excellent satisfaction and the other 30% showed fair satisfaction.

A study in **[2016]** Half of the keloid patients who finished the research were dissatisfied with treatment, whereas 25% indicated high satisfaction and 25% moderate pleasure. Two of seven [28.5%] patients in the hypertrophic scar group felt that the result of treatment was outstanding [8].

5. Conclusion

Based on prior findings, we may infer that fractional CO2 laser therapy is a potential therapeutic choice for keloid and hypertrophic scars, since it enhances clinical symptoms such as color, thickness, and pruritus, in addition to cellular changes. The fractional CO2 laser is a potentially safe and successful therapy for keloids and hypertrophic scars, with clinical and histological recovery.

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Author contribution
Each author participated equally to the research.

Conflicts of interest
No conflicts of interest.

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