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Non-ablative Diode Laser for The Treatment of Post Acne Scars

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Abstract

Thirty cases of post-acne scarring have been subjected to treatment by low level energy diode laser (1450 nm) in 4-6 sessions at 3 week intervals. The duration of the study was 18 months including a follow up period of 6 months after the last session. Only 16 cases (53.3%) showed satisfactory (good to excellent) response with a relatively high incidence of post inflammatory hyperpigmentation (66.7%). Although low level diode laser seems to offer an attractive modality to deal with some dermal collagen disorders (as wrinkles and post acne scars), the technique needs to be more refined and the treatment regimens need to be more standardized so as to achieve more consistent results, to optimize the response and to minimize the incidence of side effects

Introduction

The use of lasers in dermal remodeling has started with the so-called ablative lasers or laser resurfacing especially with the use of CO2 laser and erbium YAG laser.[1, 2, 3] However, the use of such lasers has been associated with a relatively high degree of post operative inconvenience as well as high rate of long term complications especially prolonged redness, prolonged skin intolerance to irritants in addition to high incidence of dyschromias (whether hypo- or hyperpigmentation) [4, 5].

These complications besides the need of the patient to interrupt his usual activities for relatively long periods of time have paved the way for clinical trials on the use of low levels of laser so as to achieve some sort of dermal remodeling without, however, disrupting the surface epidermis or in other words to make use of the biostimulatory effect of low doses of laser rather than the ablative effect of lasers when given in high doses.[5, 6]

The aim of the study was to assess the safety and efficacy of one of these non-ablative

lasers (low level energy 1450 nm-diode laser) in the treatment of a common problem that is usually considered as a suitable indication for laser resurfacing which is post acne scarring.

Patients and methods

Thirty cases of post acne scarring of the face have been included in the study and were subjected to treatment by low level energy 1450 nm diode laser (Smoothbeam – Candela Laser Corp., Wayland, Massachusetts, USA). The patients have been collected at random from The Dermatology Outpatient Clinic – Bou Shahri Medical Centre – Kuwait, during the period from 3/2002 till 6/2002.

Excluded from the study were cases of numerous still active acne lesions, those on concomitant treatment to the involved skin area, patients who had received isotretinoin therapy in the previous 12 months, cases with history of ablative resurfacing procedures within 2 years of study initiation, patients with keloidal tendency, pregnant females, patients on photoactive or anticoagulant medications, those with concomitant photosensitive dermatoses or connective tissue disorders as well as those of Fitzpatrrick skin type V or VI or having had recent sun tan in the previous 5 months.

In all subjects, areas of scarring on the face have been subjected to 4-6 laser sessions at 3 week intervals using low level energy 1450 nm diode laser (Smoothbeam-Candela) with a spot size of 4 mm, at an energy fluence that varied between 12 and 16 joules/square cm and using the standard (built-in) triple pulse mode with a total pulse duration of 210 milliseconds. A special dynamic cooling device (DCD) has been used for protective cooling of skin surface where there are multiple bursts of cryogen spray (tetrafluoroethane, _26 °C) in the form of 10 millisecond precooling, 10 - 15 ms interpulse cooling and 10 - 20 ms posttreatment cooling (40 - 60 ms total). Chilling by DCD was adjusted to the level of 1 to 3 (corresponding to total burst duration of 40 to 60 milliseconds respectively). At each session, the areas treated were subjected to a single pass of laser pulses with no overlap. Beside the nature of the lesion and the skin type of the patient, more precise dose adjustment was carried out on the basis of a preliminary therapeutic test in the preauricular region where the proper dose was that causing mild to moderate erythema and oedema 10-20 minutes after the test with no evidence of blistering or unacceptable degree of discoloration at the initial 10 day follow-up visit.

After each session, Patients were monitored for one hour to determine any immediate side effects such as bruising, blistering or intense erythema. They were advised to apply some soothing cream (e.g. panthenol containing cream) till disappearance of all signs of inflammation (usually for few days). The patients were also asked to avoid exposure to any type of physical or chemical irritation especially direct or indirect sun throughout the period of study.

Initial and periodic clinical evaluation as well as digital imaging were carried out at each treatment and follow up visit (10 days after each session) as well as 3 and 6 months after the last session for the purpose of comparison and objective evaluation of the result and side effects.

A modified scoring method has been used in this study to describe the severity of the lesions in terms of number, nature and depth of the scars as shown in table (1):

Table (1): Scoring method of the severity of the lesions in terms of number, nature and depth of the scars

Criterion	Score		
	1	2	3
Nature	saucer	pitted	punched out
Depth	shallow	intermediate	deep
Size	<2 mm	2-5 mm	> 5 mm

The individual lesion score is defined as the score of the lesion for depth multiplied by the score of the same lesion for nature multiplied by its score for size, while **the total score** for any particular case is the sum of the individual scores of all the lesions in this patient.

Improvement was calculated as:

$$\frac{\text{Patient's total initial score - Patient's total score after treatment}}{\text{Patient's total initial score}} \times 100\%$$

The degree of improvement was defined as follows:

No response	**0%**
Weak response	**<15%**
Fair response	**15-30%**
Good response	**30-50%**
Very good response	**50-75%**
Excellent response	**>75%**

Results

The study included 30 cases (11 males and 19 females) suffering from facial post acne scars . Their age rangied between 17 and 35 years (average 24.7). Ten cases were of skin type II, 14 cases were of type III and 6 cases were of type IV.

The duration of the study was 18 months that include 6 months follow up following the last session. The total number of sessions given was 169 and the average number per case was 5.6 sessions. Table (2) shows group distribution of patients according to the initial score, the number of cases within each group and their percentage of the total number of patients. Clinical evaluation of the follow up visits is shown in Table (3) .

Table (2): Distribution of patients according to the initial score

Initial score	Number of patients	Percentage
< 30	2	6.7 %
30 – 60	5	16.7 %
60 – 90	5	16.7 %
90 – 120	8	26.7 %
120 – 150	7	23.3 %
150 - 180	3	10 %

Table (3): Clinical evaluation of follow up visits following diode laser treatment of post acne scars.

Degree Of Improvement	Number of patients 10 days after session						Number of patients	
	1	2	3	4	5	6	3 months after last session	6 months after last session
No response	27 90%	19 63.3%	14 46.7%	11 36.7%	10 33.3%	8 26.7%	7 23.3%	7 23.3%
Weak Response	2 6.7%	3 10%	4 13.3%	2 6.7%	1 3.3%	3 10%	4 13.3%	4 13.3%
Fair response	1 3.3%	7 23.3%	7 23.3%	11 36.7%	8 26.7%	7 23.3%	3 10%	3 10%
Good Response	---	1 3.3%	4 13.3%	5 16.7%	9 30%	8 26.7%	11 36.7%	10 33.3%
Very good Response	---	---	1 3.3%	1 3.3%	2 6.7%	4 13.3%	5 16.7%	6 20%
Excellent response	---	---	---	---	---	---	---	---

The overall evaluation 6 months after the last session revealed no response in 7 cases (23.3% including 2 males and 5 females), weak response in 4 cases (13.3% including 2 males and 2 females), fair response in 3 cases (10% including 1 male and 2 females), good response in 10 cases (33.3% including 2 males and 8 females), very good response in 6 cases (20%) (4 males and 2 females) and no excellent response in any case (0 %), figures(1b, 1a, 2b, 2a, 3b, 3a,, 4b, 4a).

Improvement may become evident –in exceptional cases - as early as 10 days after the first session but usually not before 10 days following the 2nd session. Atrophic scars appeared to respond better than ice-pick scars. The response is likely to continue with

subsequent sessions where cases showing any early (even weak) response were more likely to show progressive improvement in subsequent sessions than those with delayed response. Of interest is that the improvement may continue for few months after completely stopping the laser therapy especially in the first 3 months following the last session. The nature and incidence of side effects are shown in table (4)

Table (4): The nature and incidence of side effects with low energy diode laser treatment of post acne scars

Nature	**No of patients**	**Percentage**	**Special remarks**
Hyperpigmentation	20	66.7 %	-in darker skin types -with higher doses -with higher cooling (>50 msec) -usually mild, focal or incidental (not involving all the lesions treated)
Prolonged Redness (> one week)	7	23.3 %	
Blister formation	6	20 %	
Aggravation of scarring	5	16.7 %	
hypopigmentation	3	10 %	
ecchymosis	2	6.7 %	

The most significant side effect was hyperpigmentation. The latter tended to appear very early after the session (as early as few hours after disappearance of the redness). It was rather of the deep and ill-defined variety, usually of low to moderate intensity, and showed tendency to extend for few millimeters beyond the margin of the treated spot. It was more with types III & IV skin especially with high energy doses and/or high cooling settings. It tended to persist for several months and was in general, slowly responsive to different types of bleaching regimens.

Fig. 1a: Before treatment.

Fig. 1b: After treatment.

Fig. 2a: Before treatment.

Fig. 2b: After treatment.

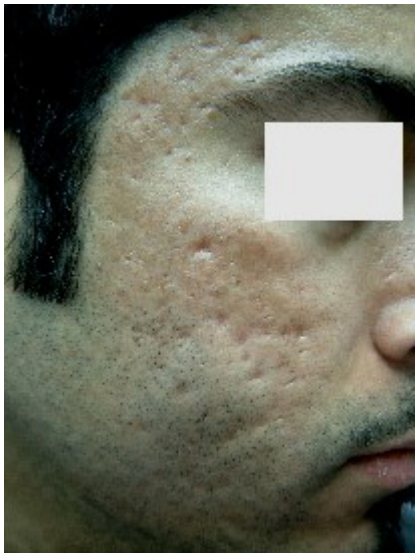

Fig. 3a: Before treatment.

Fig. 3b: After treatment.

Fig. 4a: Before treatment.

Fig. 4b: After treatment.

Discussion

Apart from long term topical applications, currently available methods for the improvement of skin texture include dermabrasion, chemical peeling and laser resurfacing (mainly with Erbium:YAG laser or CO2 laser). Among these, ablative laser skin resurfacing was at a time considered the mainstay for the so-called sculpturing of facial skin.[1,2,3]. At

standard treatment parameters, these lasers ablate the entire epidermis, part of the superficial dermis and impart varying depths of coagulative tissue necrosis in the residual tissue. Tissue ablation removes signs of superficial photodamage and together with the residual thermal damage initiates a normal healing response that affects tissue tightening and prolonged stimulation of neocollagen formation.[1,7, 8]

Although treatment with these systems consistently provides significant improvement in photo-induced facial rhytides and in atrophic scars, the typical 7-10 days during which re-epithelization takes place result in prolonged postoperative recovery and potentially troublesome adverse sequelae including prolonged redness, oedema, milia formation.[1, 9] delayed healing, postoperative pigmentary changes, infection and scarring[4].

For these reasons, research over the past few years has focused on alternative modes of facial rejuvenation. Among these, several (and optically different) non- ablative (or low energy) lasers and light sources have been developed for enhancement of scars and wrinkles without epidermal disruption[5]. In these laser or light systems, heat is generated within the zone of optimal penetration by direct absorption of light energy. Heating decreases with increased tissue depth as absorption and scattering attenuate the incident beam The exact level of dermal damage in such non ablative technique can be controlled by synchronization of surface cooling and heating by laser (or light)[6]. The heated dermis subsequently shows progressive changes in the dermal collagen through the usual wound healing response where new collagen formation and collagen remodeling occur in association with removal of abnormal dermal collagen. The thermal injury may also have a mechanical effect as it results in disruption of collagen linkage with potential collagen shrinkage and further collagen denaturation. In addition to the wound healing and collagen shrinkage effects, low grade inflammation induced by absorption of low levels of laser light with subsequent release of inflammatory mediators may result in further (but more direct and probably more rapid) stimulation of fibroblastic activity and new collagen formation [10].

Several types of laser have recently been available for such purpose that markedly vary in the wave length of the laser employed (and consequently the targeted chromophore and the depth of penetration), the spot size, the pulse duration (which -in general and with very few exceptions- is in the order of few milliseconds) as well as the protective method of surface cooling. One of these is the Smoothbeam laser which is a low level energy diode laser (wave length 1450 nm). In this type of laser, the light is taken up by water as its main absorbing chromophore. It has the theoretical advantage of rather deep penetration into the skin due to long wave length and poor absorption by other chromophores thus ensuring delivery of a sufficient energy fluence with subsequent thermal damage as low as 400 to 500 microns[6].

In earlier studies, non ablative lasers have been proved safe and somewhat effective for improving wrinkles by stimulating dermal collagen synthesis.[4,11] So, it seemed rational that they might also be used to treat atrophic acne scars.

The results of this study show that this newly emerging laser modality can achieve some improvement in post acne scarring. The improvement has been shown to progress (to a variable degree) for several weeks to months after the laser session probably indicating long-term stimulatory effect on dermal fibroblasts besides the possible direct and more rapid shrinkage, denaturation effects on dermal collagen and elastic fibres[10].

The non-ablative ambulatory nature of the technique seems to offer several advantages.

There is no prolonged post operative period in which the skin is scalded and during which the patient has to rest at home. Furthermore, there is no prolonged redness (in most cases) or skin hyperirritability.

Using an optimal train of repeated pulses in Smoothbeam laser device is far superior to a single pulse mode to confine the thermal damage to the target tissue. The delay between 2 consecutive pulses is properly adjusted so as to give a chance for the epidermis to cool down and at the same time maintain a steady state dermal temperature level where the delay should be three to five times the thermal relaxation time (TRT) of the target. Moreover, the depth of the thermal injury could be controlled by properly selecting the number of pulses in the pulse train as well as by properly adjusting energy fluence with surface cooling.

The protective effect for the epidermis provided by the peculiar dynamic cooling device (DCD) is another advantage of Smooth beam laser. A previous study could show that cryogen spray cooling is efficiently protective when used with non-ablative lasers as it was with high energy lasers.[10] However, preliminary test trials in the present study could clearly show that critical adjustment of the cooling dose was crucial as slightly higher than needed cooling was likely to result in adverse effects more or less similar to high doses of laser energy.

Moreover, the improvement expected with the low level diode laser was found to be rather inconsistent and to markedly vary from one patient to another (depending upon not yet known factors). The response was on average weak to moderate although some cases may show unexpectedly impressive or rapid results. This variable response may be explained –at least in part- by interpatient and site to site variability in the skin surface temperature necessitating a range of optimal temperatures.

There is also the problem of postinflammatory hyperpigmentation which occurred in few cases of skin types II and many cases with skin types III & IV. This hyperpigmentation was found to respond very slowly to traditional bleaching treatments and might last for several months after the procedure. Again this hyperpigmentation was inconsistent and unpredictable being variable not only from one patient to another but even from one site to another in the same patient thus compromising the predictive role of therapeutic tests.

It is not surprising that non ablative laser systems can not achieve results comparable to those of ablative lasers. Non ablative lasers appear to be ideally suited for patients who are unable to undergo an ablative laser procedure because of prolonged recovery, for cases with only mild cutaneous pathology and for those who would accept the tradeoff of a less dramatic treatment benefit.

Conclusion

Although low level 1450 nm diode laser seems to offer an attractive modality to deal with some dermal collagen disorders (as wrinkles and post acne scars), both the technology and the technique need to be more refined and the treatment regimens need to be more standardized so as to achieve more consistent results, to optimize the response and to minimize the incidence of side effects.

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