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ORIGINAL PAPERS

Successful treatment of traumatic scars with combined nonablative fractional laser and pinpoint technique of standard CO_2 laser

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ABSTRACT: To evaluate the use of a pinpoint irradiation technique followed by nonablative fractional technique in treatment of traumatic scars. Thirteen patients with traumatic sacrs were treated with pinpoint technique of CO_2 laser using traditional headpiece activating laser at a frequency (50 Hz) to deliver pulsed mode with power of 1 W using the focusing technique followed by 3–5 passes of the nonablative 1540 nm fractional Er:glass laser. An independent physician evaluator assessed the treatment outcomes using Vancouver scar scale (VSS) and 5-point grading scale (grade 0, no improvement; grade 1, 1–25%; grade 2, 26–50%; grade 3, 51–75%; grade 4, 76–100% improvement). After the final treatment, average percentage changes of VSS were 41.5%. Improvement was evident in terms of vascularity, pigmentation, and height, while insignificant in terms of Pliability. Based on physician's global assessment, mean grade of 2.5 was achieved. Patient's subjective satisfaction scores paralleled the physician's objective evaluation. Pinpoint irradiation technique by CO_2 laser followed by nonablative fractional laser is a safe and effective modality in treatment of scars.

KEYWORDS: scars, laser, ablation

Introduction

Scars affect approximately 4.5–16% of the general population and, depending on the degree of disfigurement, can have a profound impact on the psyche of the patient such as low self-esteem and feelings of psychosocial isolation (1). Physically, scars can impede the patient's range of motion, and can cause pain, dysesthesia, and pruritus

Scar arise from either excessive or insufficient new collagen generation during the wound healing process and may be appear as hypertrophic

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scars and atrophic scars. While hypertrophic scars often develop following surgical procedures, atrophic scars can result from traumatic injury to the tissue.

Hypertrophic scars contain inappropriate accumulation of immature fibroblasts, elastin, collagen, and other cellular components and appear as either erythematous or hypo-pigmented raised bumps (2). In contrast, atrophic scars are dermal depressions with overlying thinned epidermis which results from a loss of dermal collagen following some types of inflammation or traumatic injury such as acne, varicella, post-traumatic wounds, or postoperative scars (3).

Multiple modalities for improving the clinical appearance of scars have been attempted with varying success, including corticosteroids, lasers, dermabrasion, surgical revision, chemical peeling, silicone gel application, pressure therapy, and radiation (4–12). Lasers such as the carbon dioxide (CO_2), erbium: yttrium-aluminum-garnet (Er:YAG), and pulsed dye lasers have all been used with differing success in the treatment of scars (4). Ablative lasers used for skin resurfacing, such as the CO_2 and Er:YAG laser, can reduce various scars, but significant adverse effects limit their use, and patient downtime can be extensive (5). Owing to these potential risks, nonablative lasers have been developed as a safe alternative to ablative laser resurfacing, and have been reported to be effective and safe for scars. However, outcomes have remained unsatisfactory and require several treatments to achieve satisfactory efficacy (6).Fractional mode of ablative and nonablative lasers has become a novel strategy for the treatment of scars, and some authors have suggested that treatment with fractional lasers for various scars, such as postoperative, atrophic, and acne scars, has been demonstrated to safely improve the appearance of the scars (7). Recently the pinpoint technique using the CO_2 laser has been used for icepick and acne scars. In this technique, a conventional CO_2 laser with pinpoint irradiation is used instead of a fractional laser.

Fractional photothermolysis, introduced in 2004, lays down a matrix of energy beams to form an array of microscopic thermal wounds (microscopic treatment zones), to stimulate a therapeutic response in the dermis (8). Nonablative fractional photothermolysis at wavelengths of 1,550 and 1,540 nm has been found to be effective for the treatment of scars, but fractional ablative laser has gained popularity in the last years due to its potentially greater efficacy in the treatment of both the dermal and epidermal components of scar tissue. Using a CO_2 laser with pinpoint technique at intervals of each irradiated dot size (0.3 mm) with a single ultra-pulse mode (pulse duration of 0.01 seconds) achieved clinical improvement with minimal adverse effects in ice pick scars (9).

In this study, we attempted to confirm the effect of pin point technique of traditional CO_2 laser combined with nonablative fractional Er:glass 1,540 nm laser on traumatic scar.

Materials and methods

A total of 13 Egyptian patients (Fitzpatrick skin type II to V), who attended the laser unit of the Dermatology department, Al-Hussein University Hospital, Al-Azhar University, Cairo, Egypt and were clinically diagnosed with surgical and post-traumatic scars from August 2012 to September 2013, were enrolled in this study. Informed consents were obtained from all patients before treatment. The study protocol conformed to the guidelines of the 1975 Declaration of Helsinki.

This study included, 9 males and 4 females aged between 13 and 35 years old, 2 patients had Fitzpatrick skin type II, 4 had Fitzpatrick skin type III, 6 had Fitzpatrick skin type IV and one had Fitzpatrick skin type V. Exclusion criteria were photosensitivity, use of photosensitizing drugs, and history of keloid formation, active local or systemic infection, use of botulinum toxin A, dermal fillers in areas to be treated within the previous 4 or 6 months and use of isotretinoin, or ablative laser to target areas within the past 12 months. Treatment with chemical peels or dermabrasion within the past 3 months. Informed consent was obtained from each patient before treatment during this study.

Procedure

The treatment areas were cleaned of debris using a mild cleanser. A topical anaesthetic cream (eutectic mixture of 2.5% lidocaine hydrochloride and 2.5% prilocaine; EMLA; AstraZeneca AB, Sodertalje, Sweden) was applied to the skin for 30 minutes before the laser treatment.

Treatment was delivered to the scarring areas starting with pinpoint technique of CO_2 laser (Smartxide, Deka, Italy) using traditional headpiece activating laser at a frequency (50 Hz) to deliver pulsed mode with power of 1 W using the

focusing technique. The treated areas by pinpoint technique of CO_2 laser were followed by 3–5 passes of the nonablative 1540 nm fractional Er:glass laser (Icon 1540, Palomar Medical Technologies; Burlington, MA) using XD Micolens^{TM} compression optic (25 mB/cm^2). Treatments with the XD Microlens^{TM} were performed by applying the optic to the skin with firm pressure and firing the laser after a predetermined compression time at 50–60 mJ/microbeam (mb) and 15 ms. The application of a sunscreen continued. Topical antibiotic cream (Garamycin) was applied twice per day for 3 days following the session. All the patients were treated three to five times at 3 week interval and were asked to make a follow up visit one month after last treatment.

Assessment

The clinical assessment was objectively based on clinical photography before treatment and one month after last laser treatment session by means of clinical improvement and patient satisfaction. Side effects and complications were also recorded at each session. The improvement of the scars was evaluated by three kinds of assessment. First, two physicians independently measured the grade of pigmentation, pliability, height, and vascularity (Vancouver scar scale, VSS) Table 1 at each visit. Second, a physician evaluator also assessed the final treatment outcomes by comparing pretreatment and posttreatment clinical photographs using a quartile grading scale; grade 0 = no improvement, grade 1 = minimal improvement (1–25% improvement), grade 2 = moderate improvement (26–50% improvement), grade 3 = marked improvement (51–75% improvement), grade 4 = near-total improvement (76–100% improvement). Third, the patients were asked to scale their subjective satisfaction with the treatment on a quartile grading scale; grade 0 = no satisfaction, grade 1 = little satisfied (1–25% satisfaction), grade 2 = somewhat satisfied (26–50% satisfaction), grade 3 = satisfied (51–75% satisfaction), grade 4 = very satisfied (76–100% satisfaction).

Statistical analysis

Data were collected, summarized, and reported on data collection sheets. They were entered into computer Microsoft excel sheets with appropriate tabulation and graphical presentation using SPSS version 14. Chi-square test was used to compare categorical variables, and paired *t*-test was used to compare numerical variables. The level of significance (*p* value) was 0.05. Results are statistically significant, if *p* value was $\leq$0.05.All subjects involved in the current work were informed about the nature and the details of the work and a written consent will be obtained also approval by ethical committee was obtained.

Table 1. The Vancouver scar scale

Scar characteristic		Score
Vascularity	Normal	0
	Pink	1
	Red	2
	Purple	3
Pigmentation	Normal	0
	Hypopigmentation	1
	Hyperpigmentation	2
Pliability	Normal	0
	Supple (flexible with minimal resistance)	1
	Yielding (giving way to pressure)	2
	Firm (inflexible, not easily moved)	3
	Banding (rope like, blanches with extension of scar, does not limit range of motion)	4
	Contracture (permanent shortening of scar producing deformity, limits range of motion)	5
Height	Flat	0
	$\ll$2 mm	1
	2–5 mm	2
	$\gg$5 mm	3
Total score		13

Results

This study included 13 patients having surgical and post-traumatic scars with a broad range of atrophic and hypertrophic scars. The age of patients varied from 13–35 years with a mean of 24.2 $\pm$ 8.92 years. The study included 9 males (59.3%) and 4 females (30.7%).

At the end of the study, the average percentage changes of the VSS were 41.5%. There was remarkable improvement in scar vascularity, pigmentation and height, while improvement was insignificant in pliability. The mean VSS scores were 13.15 before treatment and 5.46 at 1 month

FIG. 1. Before and after.

after final treatment. After laser treatment, the mean VSS values decreased significantly ($p < 0.001$). Physician's global assessment showed a mean grade of 2.5 for clinical improvement. The mean patient's subjective satisfaction score was 2.4 which paralleled the physician's objective evaluation.

Among the 13 patients treated with combination of traditional CO_2 laser pin point technique and nonablative fractional Er:glass 1540 nm, 2 patients had 1–25% improvement, 5 patients had 26–50% improvement, 5 patients had 51–75% improvement and one patient had 76–100% improvement. No patients evaluated the scars to be worsened from treatment. The patient's subjective satisfaction scores paralleled the physician's objective evaluation.

Side effects were mild to moderate pain during the treatment and mild to moderate posttreatment erythema and edema that resolved in 3–5 days. There were no other adverse events including hyperpigmentation, hypopigmentation, blistering, or worsening of the scars. Photographs of some results are shown in FIGS. 1 and 2.

Discussions

This study reports for the first time the possibility of combining pinpoint technique of CO_2 laser and nonablative fractional Er:glass 1540 nm for improving the appearance and texture of scars. To our knowledge, this is the first prospective study to evaluate the effectiveness of this combo laser therapy in traumatic scars.

Fractional photothermolysis is a recently developed laser technology that creates thousands of microscopic columns of thermal damage (referred to as microthermal zones, MTZ) in the epidermis and dermis surrounded by islands of normal tissue, limiting the amount of injury and resulting in rapid epidermal repair (12).

FIG. 2. Before and after.

Although the mechanism of fractional photothermolysis in the treatment of hypertrophic scar is not known exactly, the columns of thermal injury characterized by localized epidermal necrosis and collagen denaturation may initiate a cascade of events that eventually results in a normalization of the collagenesis–collagenolysis cycle (13). Stimulation of MTZ is believed to influence the secretion of various cytokines and growth factors, which affects scar remodeling (7). The "fractional" laser avoids bulk heating of the skin, thereby reduces the risk of irreversible nonspecific thermal injury to the dermis, which may worsen scarring. Paradoxically, hypertrophic scarring has been reported as one of the possible complication of CO_2 laser treatment (14,15).

Kim in 2008 demonstrated good results similar to those of fractional photothermolysis using pinpointed irradiation with needling in treating atrophic acne scars (3). In this study, improvement results by standard CO_2 laser without needling by 26G needle were similar to those of Kim's technique. So, focusing technique could alone be used without needling.

In this study, there were improvements in all hyperpigmented and erythematous scars and over all flattening in scars. Hypertrophic scars and atrophic scars responded to treatment with fractional laser photothermolysis. The question elaborated, how the same technology can benefit atrophic and hypertrophic scars is intriguing and deserves further investigation. Perhaps dermal heating normalizes collagen or vascular neogenesis or breaks and realigns abnormal collagen fibers (16,17).

Our results showed that combining nonablative fractional laser and pinpoint technique of standard CO_2 laser improve the clinical appearance of atrophic and hypertrophic scars without significant adverse effects, which corresponds with previous reports on treatment of hypertrophic scars using CO_2 fractional technology (18). The improvement was marked in terms of scar pigmentation and pliability, while less significant in terms of vascularity.

In pinpointed irradiation, no complications could be seen and also the down-time is shortened to 3–6 days. All irradiated points were small dry macules of ablated epithelium which could be gently removed with a topical antibiotic cream after a day. The color of the treated scar area was back to pink or normal within 2 or 4 days. Also, postoperative hyper pigmentation did not occur; this could be because there was no overlapped irradiation, no massive damage, and the time interval between each shot was relatively long.

Our study had limitations including the variability in initial morphology, etiology, age, and anatomic sites of scars. Controlled side-to-side comparative studies with larger sample size and longer follow-up period are required. Standard treatment parameters remain to be established and further clinical studies are also needed to determine the optimal treatment parameters to obtain the best outcome.

Conclusion

This study concludes the safe and effective use of pinpoint irradiation technique by standard CO_2 laser. Additional controlled studies with large number of patients and long-term follow-up are needed to further assess the efficacy and safety of the combination using the pin point fractional technique for the treatment of hypertrophic scars, and to define optimal treatment parameters.

Conflict of interests

Authors report no conflict of interest.

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