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Long-Term Results of Ultrapulsed Carbon Dioxide Laser Resurfacing of the Mediterranean Face

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Abstract.
Backgroud: In Mediterranean countries, increased exposure to sunlight accelerates aging of the skin and the formation of wrinkles. The long-term follow-up results for the patients who underwent resurfacing with ultrapulsed carbon dioxide (CO_2) laser are presented.
Methods: All 47 patients who underwent ultrapulsed CO_2 laser between 1994 and 1996 were included in the study. The patients were photographed with their permission before the laser treatment, at postoperative month 6, and at year 5, with comparison of the results.
Results: In this study, with its 5-year follow-up period, it was found that the ultrapulsed CO_2 laser achieved long-lasting and acceptable facial resurfacing.
Conclusions: The ultrapulsed CO_2 laser enables damage to the abnormal dermal region with high-energy transfer in a very short period. The recent development of high-energy pulsed CO_2 laser has generated much renewed enthusiasm for cutaneous resurfacing, especially over the long term.

Key words: Aging face—Late results—Ultrapulsed carbon dioxide laser

The process of cutaneous aging cannot yet be retarded despite the advances in medicine and technology. The conventional treatments for the aging face include face-lifting procedures and blepharoplasties, in addition to the resurfacing procedures of dermabrasion and chemical peeling. Laser utilization in the medical field has extended since the laser's introduction by Dr. Theodore Maimon in 1960 [16]. Different types of laser technology have been used in the treatment of cutaneous vascular lesions, tattoos, pigmented lesions, and facial rhytidoses [19]. In 1967, Yules et al. [20] and Laub et al. [15] reported the effect of Q-switched ruby laser radiation on dermal tattoo pigmentation in man. Slutzski et al. [18] used used carbondioxide (CO_2) laser for large excisions with minimal blood loss. In 1981, Anderson et al. [2] presented the destruction of microvasculature selectively with dye laser.

The wrinkle lines of the skin lie perpendicular to the long axis of the facial musculature. The repetitive muscle movements and cumulative photodamage, with a resulting loss of dermal elasticity, contribute to increased facial rhytidoses. The original continuous-wave CO_2 lasers produced significant thermal injury to normal structures, leading to an unacceptable risk of scarring [3, 18]. Subsequently, "superpulsed" CO_2 lasers had the property of decreased heat conduction, but they still produced unacceptable thermal injury to the tissue [8, 17]. Ultrapulsed CO_2 lasers enable damage to the abnormal dermal region with high-energy transfer in a very short period. Therefore, the areas possessing a high risk of scar can be included in the ultrapulsed CO_2 laser safely. In this study, we present our long-term results of ultrapulsed CO_2 laser utilization for Mediterranean people exposed to sunlight continuously throughout the year.

Patients and Methods

All the patients treat with ultrapulsed CO_2 laser between January 1994 and January 1996 were included

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Table 1. A summary describing the number of patients and their characteristics

	Patients (n)
Sex	
Female	43 included; 30 excluded
Male	4 included; 9 excluded
Fitzpatrick's classification	
Group 1	3
Group 2	5
Group 3	8
Group 4	18
Group 5	13
Complications	
Hyperpigmentation	8—resolved during the follow-up period of 3 to 4 weeks
Herpes labialis	2—healed with local care
Exclusion criteria	
Face lift	4—all of them older than 60 years
Blepheroplasty	10—all previously or after the surgery applied laser resurfacing to periorbital or other region of the face
Dermofat graft application	9
Botilinium toxin	12
Collagen or hyalurinic acid injection	4
Could not be followed	7

in the study. Patients who underwent any other procedures, such as face-lift, collagen or hyaluniric acid injection, or botulinium toxin, were excluded. All patients with a mean age of 48 years range, (35–59 years) were photographed with their permission before the laser treatment and at postoperative month 6. All the subjects were invited at postoperative year 5 to compare the results. The 47 patients who could be followed up for 5 years were included in the study, whereas those who could not were excluded from the study.

The patients were categorized according to the Fitzpatrick's classification of skin phototype [9]. They were classified mostly in to groups 4 and 5. There were 3 patients in group 1, 5 patients in group 2, 8 patients in group 3, 18 patients in group 4, and 13 patients in group 5. No patients were classified as group 6 (Table 1).

The same experienced plastic surgeon performed all the procedures. All the patients received the procedures under general anesthesia. The laser (Ultrapulse 5000C Laser, Coherent, Palo Alto, CA, USA) was calibrated in the ultrapulsed setting at 300 mJ of energy and 5 W of power using a 3-mm spot through a collimated handpiece. For every part of the face and for the wrinkles, laser pulses were performed in a cosmetic, nonoverlapping style. Meanwhile, saline-soaked gauze was used to clean the laser-pulsed regions. After the total resurfacing of the face, additional pulses were applied to the wrinkles until they disappeared.

The patients were treated using gauze processed with topical antibiotic ointment. Metamizole sodium as prescribed for the relief of pain, and ice pack application was recommended. On the postoperative day 1, paraffin jelly (Vaseline) was applied over the gauze to moisten the face. The patients were told to have a bath on postoperative day 5, and the gauze was removed easily.

To evaluate the clinical response to the ultrapulsed CO_2 laser, a clinical scoring system of wrinkling devised by Griffiths et al. [11] was used [17] (Table 2). All the patients were scored before and after surgery separately by an experienced plastic surgeon in a blinded format. The surgeon was unaware of the whether the photographs were preoperative or postoperative.

Results

The evaluation of pretreatment photodamage, the posttreatment results, and the photographs of the patients taken preoperatively (Figs. 1a, c; 2a, c; 3a, c) and at postoperative month 6 and year 5 were used. For the whole face of the patients, the perioral, periorbital, glabellar, and frontal wrinkles were scored by a plastic surgeon in a blind format (Figs. 1b, d; (2b, d; and (3b, d).

The wrinkles indicated a mean score of 5.98 $\hat{A} \pm$ 1.86 preoperatively. There was a mean score of 3.02 $\hat{A} \pm$ 1.20 at postoperative month 6, and a mean score of 4.33 $\hat{A} \pm$ 1.54 at postoperative year 5. The difference between the preoperative and the postoperative month 6 values was statistically significant ($p < 0.01$). There also was a significant difference between the preoperative and the postoperative year 5 values ($p < 0.05$). Between the postoperative values of month 6 and year 5, a statistical significance was seen ($p < 0.05$). In two patients, herpes labialis was encountered and healed with local care.

Hiperpigmentation manifested in eight patients during the early postoperative period, which resolved during in 3 to 4 weeks with topical application of hyqroquinone 4% (Expigment) nightly. There were no other complications.

The statistical analysis was performed using Student's paired t test.

Discussion

The wrinkle lines of the skin result from facial musculature and repetitive muscle movements in addition to cumulative photodamage, with a resulting loss of dermal elasticity, which contributes to increased facial rhytidoses. Intrinsic aging deleteriously changes the structure and function of human skin. Acute and

Table 2. The clinical scoring system of wrinkling

Class	Wrinkling	Score	Degree of elastosis
1	Fine wrinkles	1–3	Mild (fine-textured change with subtly accentuated skin lines)
2	Fine to moderate depth wrinkles; moderate number of lines	4–6	Moderate (distinct papular elastosis)
3	Fine to deep wrinkles; numerous lines; with or without redundant skin folds	7–9	Severe (multipapular and cifluent elastosis approaching or consistent with cutis rhomboidalis)

Fig. 1. (a) Anterior view of the patient before treatment. **(b)** Anterior view of the patient at year 5 after treatment. The difference between the pretreatment and posttreatment wrinkles, especially in the periorbital and perioral regions, is evident. **(c)** Lateral view of the patient before treatment. **(d)** Lateral view of the patient at year 5 after treatment.

chronic sun exposure may accelerate the aging processes in skin [10, 14]. Habitual exposure to sunlight and white skin are prerequisites for the development of changes in skin structure, including the epidermis (actinic keratosis), dermis (solar elastosis), blood vessels (telangiectasia), sebaceous glands (solar comedones), and melanocytes (diffuse or mottled brown patches), that cause aging of the skin [12]. The culture of most white individuals promotes deeply tanned skin as a symbol of beauty, health, and even happiness. Consequently, physicians face an uphill battle in promoting the healthy aspects of a pale complexion. Not only can excessive solar exposure accelerate and intensify aging in skin; it also can lead to serious health risks [5]. In Mediterranean countries, increased daily exposure to sunlight accelerates the aging of the

Fig. 2. **(a)** Anterior view of the patient before treatment. **(b)** Anterior view of the patient at year 5 after treatment. The efficiency of the pretreatment still is clear in the nasolabial region. **(c)** Lateral view of the patient before treatment. **(d)** Lateral view of the patient at year 5 after treatment.

skin and the formation of wrinkles. According to our experience, the patients from different regions of the country with different exposure rates indicate various degrees of wrinkling. Exposure to sun was not the only factor, but it was one of the most important factors in wrinkle etiology.

The current availability of multiple methods for treating the aging face makes it difficult for surgeons to decide on the most appropriate method for resurfacing facial wrinkles [4]. The treatment methods depend on the depth of the pathology and the depth of the treatment level. The conventional treatments for the aging face include face-lifting procedures and blepharoplasties, in addition the resurfacing procedures of dermabrasion and chemical peeling. Laser utilization in medical field has extended since the introduction of the laser by Dr. Theodore Maimon in 1960 [16]. The ultrapulsed CO_2 laser enables the abnormal dermal region to be damaged with high energy transfer in a very short period. The recent development of high-energy pulsed CO_2 laser has generated much renewed enthusiasm for cutaneous resurfacing. These laser systems have eliminated the risk of scarring that continued to be apparent with the older continuous laser systems [1]. Long-term follow-up evaluation of laser technology has indicated to us especially that the laser can be used safely and easily with the expectation of effective long-term resufts to treat patients 35 to 45 years of age with moderate or low aging for whom surgical intervention is a dilemma.

Dermabrasion and chemical peeling are two methods for the treatment of facial rhytidosis. The outcome of dermabrasion is very technique dependent. The variables that affect the planned *ok?*depth of the treatment include the pressure with which the device is held against the skin, the speed of the rotation, the coarseness of the tip, and the patient's skin type and texture. An increase in the planned depth could culminate in postoperative scarring,and a

Fig. 3. **(a)** Anterior view of the patient before treatment. **(b)** Anterior view of the patient at year 5 after treatment. **(c)** Lateral view of the patient before treatment. **(d)** Lateral view of the patient at year 5 after treatment.

superficial depth could fail to achieve effective improvement in the wrinkles. Kitzmiller et al. [13] compared dermabrasion with CO_2 laser resurfacing and found that CO_2 laser had better results with low morbidity and fewer complications during a follow-up period of 6 months [13]. In our clinical practice, dermabrasion used to be one of the most important tools that we could use for resurfacing. Especially in the treatment of scars, we still prefer dermabrasion combined with chemical peeling, but in delicate cases and for certain regions of the face, ultrapulsed CO_2 laser yields better aesthetic resurfacing results. The technologhy of laser enabled us to control the depth of treatment. Besides, dermabrasion and chemical peeling still are effective for deep-scarred regions.

Collawn et al. [6] studied the skin ultrastructure of patients who underwent facial resurfacing with ultrapulse CO_2 laser and found that in one pass the epidermis was totally removed and there was a little compaction of collagen in the dermis. After two or three passes, however, there were sequential graded increases in collagen compaction with loss of the intervening extracellular matrix. It was reported that elastin was very much affected by laser such that with only one pass, the elastin was abnormal. It presented with a mottled heterogeneous structure, with fibroblast necrosis in the papillary dermis and the reticular dermis. We did not have the opportunity to take biopsies for any of the patients, but the macroscopical view of the laser-applied region showed the tightness of the dermal region, probably because of the affected elastin, as reported.

Alster and Garg [1] applied ultrapulse CO_2 laser to facial rhytidoses, and over a follow-up period of 6 months the treatment culminated in acceptable aesthetic results. Fitzpatrick et al. [7] reported the treatment of photoaged skin with CO_2 laser resurfacing in the periorbital and perioral region. Low complication rates and minimal risks were found during the 6-month follow-up period. It was con-

cluded that heat-induced collagen shrinkage apparently contributes to excellent results by tightening loose skin and folds. Weinstein and Roberts [19] reviewed the long-lasting improvements resulting from CO_2 laser resurfacing, describing the principles and guidelines for this procedure. Our study, with a follow-up period of 5 years, found that ultrapulsed CO_2 laser achieved long-lasting and acceptable facial resurfacing. Furthermore, the effect of the sun that increases the *correct term?*mimic movements and the wrinkles was eliminated, and a decrease in the smiles of the Mediterranean was prevented.

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