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ORIGINAL ARTICLE

Novel approach with fractional ultrapulse CO_2 laser for the treatment of upper eyelid dermatochalasis and periorbital rejuvenation

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Abstract Fractional ultrapulse CO_2 laser resurfacing improves photodamage, wrinkles, and acne scarring by ablation of damaged tissue with subsequent regeneration and remodeling of collagen. In this study, the authors examined the efficacy and safety of fractional CO_2 laser and introduce a novel approach to the treatment of upper eyelid dermatochalasis. We treated 20 patients with low and moderate upper eyelid dermatochalasis. We did photographic analysis of results by measuring distance of upper eyelid fold and lateral eyebrow in vertical axis from a horizontal line joining medial and lateral canthi. All patients underwent UltraPulse CO_2 laser (Microxel MX 7000) resurfacing at upper eyelid, superior to eyebrow, and in periorbital area. Measurements were taken before and at 3 and 6 months after the laser treatment. We evaluated results at 3 and 6 months after laser treatment and found that the UltraPulse CO_2 laser induced elevation of eyelid crease and brow position (1.62±0.69 and 2.110±0.66 mm at 3 months; 1.63±0.68 and 2.300±0.67 mm at 6 months, respectively) as compared to before the treatment. Side effects were mild, patients reported minor crusting and oozing that resolved within 48 to 72 h, edema (1–2 days), and moderate postoperative erythema resolved within 4 days. These data illustrate the safety and efficacy of fractional ultrapulse CO_2 laser in the treatment of low and moderate upper eyelid dermatochalasis with added advantage of nonsurgical brow lift.

Keywords Fractional ultrapulse CO_2 laser · CO_2 laser · Upper eyelid treatment · Dermatochalasis · Periorbital rejuvenation · Aging

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Introduction

Aging of skin is a continuous process and has two distinct types intrinsic (internal) related to gene level and extrinsic (external) caused by various environmental factors such as sun exposure, repetitive facial expression, gravity, and smoking. The cumulative effect of these two factors leads to various morphological and structural changes in skin components which are more evident on facial skin such as wrinkles, thinning of skin, atrophy of subcutaneous fat, prominent nasolabial fold, jowl, etc. The typical aging changes in orbital region are brow ptosis, dermatochalasis, blepharochalasis, periorbital wrinkles, fat pad, etc. [1]. Numerous procedures for correcting periorbital aging are described in the literature. Medical therapy such as tretinoin cream (Retin-A) and chemical peels (glycolic acid) can be satisfying for patients with slight signs of aging and for those not interested in more aggressive therapeutic interventions. Blepharoplasty and brow lift (or endoscopical techniques) are surgical procedures that are considered to be the gold standard for the treatment of periorbital aging but

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require painful and a more prolonged recovery and possible complications [2]. Fractional ultrapulse CO_2 laser induces limited collateral thermal damage through selective skin vaporization and causes effective tissue tightening and collagen shrinkage. This laser technique is low cost, low risk, has short operative and recovery times, and is well accepted by patients [3, 4]. In this study, authors examined the efficacy and safety of fractional CO_2 laser for the treatment of upper eyelid dermatochalasis and describe a technique to improve periorbital aging.

Methods

In this prospective study, we recruited patients after clinical evaluation and records were obtained through the Department of Plastic and Reconstructive Surgery "Tor Vergata" University of Rome. The protocol of the study was approved by the local ethics committee, and all patients read and signed written informed consent forms. The study included 20 female Caucasian patients with mean age of 46 years (range 30–68 years) divided in two groups according to their age, older and younger than 45 years, as described in Table 1. We recruited patients between January 2010 and June 2010, and the study was completed in June 2011. The inclusion criteria for recruitment were skin phototypes of I–III, low to moderate dermatochalasis, and periorbital rhytides [5].

Exclusion criteria for recruitment were active infection, compromised immune function, anticoagulation, tendency to produce hypertrophic scars or keloids, previous treatment with dermabrasion, chemical peel, botulinum toxin, filler injections, laser treatment or intense pulsed light or surgical procedures of study areas, photosensitivity, pregnancy or lactation, oral retinoid drugs within the past 6 months, eyelid malpositions (ectropion, entropion, blepharoptosis, retraction), abnormal eyelid movements (blepharospasm, hemifacial spasm, seventh nerve palsy), brow ptosis, and patients not considered to be able to follow the treatment protocol.

Before undertaking laser treatment, all patients in the study group were evaluated by complete clinical examination, a photographic examination in four projections (frontal, lateral, three-fourths, and axial). Photographs were taken in JPEG format with a Nikon Digital Camera (D300) equipped with a lens-mounted ring flash. Photos were standardized in magnification, lighting, and positioning. Photographs were excluded if they had blinked or slightly closed the lids.

We used photographs, taken before and 6 months after the laser treatment for analysis of results. The common parameters utilized were elevation of upper eyelid skin crease and lateral brow in the photograph taken at 6 months after the laser treatment as compared to before the treatment. We draw a vertical line passing through midline of the face which divides face in two equal parts [6]. Then, a horizontal line was drawn between medial and lateral canthi of the eye. Now, a vertical line was drawn passing through a midpoint of the horizontal line, which was parallel to the line passing through midline of the face. On this vertical line, we measured elevation of upper eyelid crease from horizontal line in the photographs taken before and 6 months after the laser treatment. To measure the brow elevation, we used a vertical line passing through lateral canthus and parallel to midline. On this line, we compared brow elevation in photographs taken before and 3 and 6 months after the laser treatment. We applied *t* test for statistical evaluation of patients to compare the results at 3 and 6 months after the laser treatment. Linear regression test was utilized to evaluate effectiveness of laser in different age groups. All calculations were done using SPSS V 20 for Mac OS X (IBM SPSS Statistics). The overall degree of patient satisfaction was assessed at the 6-month follow-up, using a structured questionnaire grading the treatment results as excellent, good, fair, or poor.

Laser technique

Local cutaneous anesthesia (lidocaine 2.5 % plus prilocaine 2.5 %) as an oil/water was applied 90 min before the procedure. For more sensitive patients, we used trigeminal nerve blocks using 1 % lidocaine without epinephrine. Sand-blasted metal eyeshields were inserted with Lacri-Lube and topical proparacaine for corneal protection. Cleaning and disinfection of eyelids and periorbital area was done using chlorhexidine solution. The patient was placed in supine position and the operator stands behind his head. The supraorbital region was treated with one pass of confluent nonoverlapping pulses using a collimated 3-mm handpiece reclined 45° to the skin, up to 10 W of power, peak up to 290 W, pulse duration 100 μs, repeat time 5 μs, and with a fractional ultrapulse CO_2 laser (MX-7000 MICROXEL, Dae Shin Enterprise, Seoul, Korea). The shots

Table 1 Patient data with results at 6 months and correlation with age

Group	Patient (*n*)	Age (years)	Elevation of eyelid skin	Elevation of brow
			At 6 months	At 6 months
A) <45	9	37±5	1.54±0.48*	1.68±0.36*
B) >45	11	52±7	2.57±0.34**	2.81±0.37**
Total	20	46±10	2.11±0.66***	2.30±0.68***

*$p<0.05$; **$p<0.004$; ***$p<0.001$

were directed at a distance of 1–2 mm from each other, starting just proximal to the superior edge of the eyebrow as shown in Fig. 1. Because of inclination of handpiece, the beam of laser would travel in such a way that the proximal half of contact area of the skin will have more depth penetration as compared to the distal half as shown in the figure. Thus, each spot formed by laser beam on skin will show two different colors depending on the depth of penetration: the proximal half would be brownish whereas the distal half would be whitish erythematous due to deep and superficial penetration of the beam, respectively. One or two more microspot lines can be directed parallel to the previous when you want more eyebrow lift.

The upper eyelid was treated with a handpiece perpendicular to the skin, at a fluence of 12–14 mJ/cm^2 and 1–3 W of power with superpulsed modality. The shots were positioned throughout the eyelid crease with the possibility of distancing or overlaying the spots depending on the severity of the dermatochalasis. Following this, the entire upper eyelid surface was treated with two passes using a rectangular-shaped scanner with fractional ultrapulsed modality and the rest of the periorbital area was then treated with one more fractional ultrapulsed pass. The power used was up to 20 W, pulse duration 200–900 μs, and dot pitch (the spacing between shots) from 0.2 to 1.0 mm. Penetration depth, which ranges from superficial to deep dermal, depends on skin thickness, and treatment parameters are controlled by the operator. Ice water compresses and Aquaphor ointment (Beiersdorf, Inc., Wilton, CT) were applied immediately after treatment and reapplied every 2 h for 72 h. The procedure was performed as office procedure, and we followed the standard protocols for wound care and postoperative management in subsequent office visits.

Results

A total of 20 patients with low and moderate upper eyelid dermatochalasis were treated with a fractional ultrapulse CO_2 laser. Patients were seen for evaluation of final clinical outcomes at 6 months after the treatment series. During treatment, patients reported minimal pain that was alleviated with the use of the topical anesthesia and cold air. Side effects were mild, patients reported minor crusting and oozing that resolved within 48 to 72 h, and edema (1–2 days) and moderate postoperative erythema resolved within 4 days.

We measured the results in terms of elevation of the upper eyelid skin crease position and eyebrow position as mentioned earlier. We found that there was average elevation of eyelid crease and brow position (1.62±0.69 and 2.110±0.66 mm at 3 months; 1.63±0.68 and 2.300±0.67 mm at 6 months, respectively) as compared to before the treatment (Table 2). Clinical examples are shown in Figs. 2 and 3.

Comparison group study showed that there is a correlation between patients age and the end result, (β=0.883 for elevation of eyelid skin crease and β=0.937 for elevation of brow, $p<0.001$). There was a better improvement in group B after laser treatment (Table 1).

When we plotted the results of patients' satisfaction levels, grading a scale as excellent, good, fair, or poor, we found that most of them (60 %) showed good satisfaction with the effect of treatment. The 20 % of patients have deemed respectively excellent and fair satisfactory treatment. No subject rated satisfaction level as "poor."

Discussion

Dermatochalasis is an involution process characterized by excess eyelid skin and affects eyelids in older individuals. However, it still may be confused with blepharochalasis, which is the expansion of the orbital septum and preseptal orbicularis muscle secondary to repeated angioneurotic edema and is seen more commonly in younger patients [7]. According to Putterman [8], recurrent episodes of angioneurotic edema cause loose skin and orbital fat herniation. Involvement of the lower eyelids in blepharochalasis can be quite dramatic, and this protruding tissue is known as malar bags or festoons.

Dermatochalasis must be differentiated from the less common blepharochalasis. In the assessment of the patient's

Fig. 1 Scheme of laser technique

Table 2 Results at 3 and 6 months after laser treatment

	At 3 months	At 6 months	*p* value
Elevation of eyelid skin	1.62±0.69	2.11±0.66	<0.001
Elevation of brow	1.63±0.68	2.30±0.68	<0.001

aging eye appearance, all anatomic components contributing to the region must be evaluated. In the analysis of the upper third of the face, the hairline, depth of central brow rhytids, glabellar frown lines, and brow position should be evaluated. Eyebrow position is the main determinant and should be evaluated in the setting of dermatochalasis because eyebrow ptosis can amplify the appearance of involutional dermatochalasis. In women, the eyebrow should rest at or just above the supraorbital rim with the peak of the brow between lateral limbus and lateral canthus of the eye. In men, the brow usually is flatter and parallel with or slightly below the superior orbital rim. The severity of upper eyelid hooding is mostly determined by the degree of dermatochalasis and brow ptosis, while the presence of upper eyelid ptosis may further aggravate it [9]. Brow ptosis can be mistaken for upper eyelid skin laxity, fat herniation, or true eyelid ptosis, and it is important to evaluate which entities are present.

If the brow position is low, a consideration is to elevate them with traditional coronal, pretrichial, mid-forehead, direct lifts, or with newer endoscopic techniques. Complications with all brow-lifting treatments include possible hair loss at the site of scalp incision, long-term scalp anesthesia or paresthesia, facial or trigeminal nerve damage, visible scar or hypertrophic scar, hematoma, or infection [10, 11].

Our technique uses the principles of traditional surgery for the eyebrow lifting, but we get this effect using a laser

Fig. 2 Pre- (**a**) and postoperative (**b**) laser treatment

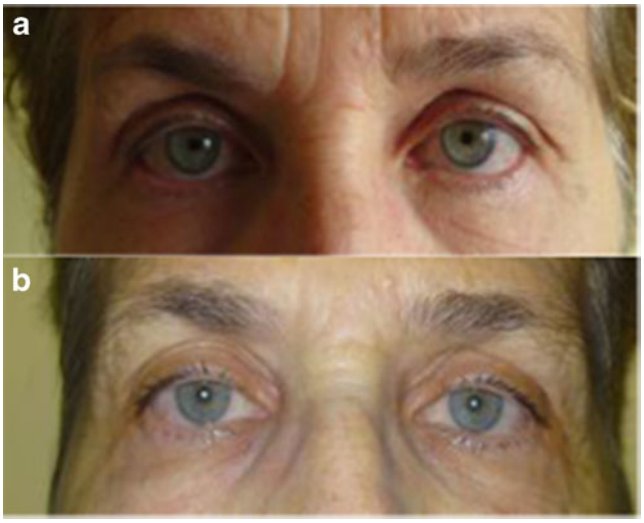

Fig. 3 Pre- (**a**) and postoperative (**b**) laser treatment

technique. Since 1996, Fitzpatrick [12] showed excellent clinical results in a small number of patients treated with CO_2 laser continued emission. In 2004, Alster [13] demonstrated that high-energy pulsed CO_2 laser can safely and effectively improve dermatochalasis and periorbital rhytides. In 2007, Hantash et al. [14] first described the use of ablative fractional photothermolysis that produces an array of microthermal zones of a customizable density and depth, with a confluent pattern of ablation and coagulation extending from the stratum corneum through the dermis. In the initial in vivo studies, demonstrating the histologic and clinical effects of this device, Hantash et al. confirmed with immunohistochemistry that persistent collagen remodeling occurred for at least 3 months posttreatment. Ablative ultrapulsed fractional laser, creating confluent columns of thermal injury in a random array extending from the stratum corneum to the reticular dermis, has demonstrated significant effects on skin tightening and texture [15–17].

In addition, it is possible to increase the skin-tightening effect and the eyebrow lifting using this particular technique. Reclining handpiece by 45° to the skin is formed two areas of different depth of vaporization which potentiates retraction and fixation of the eyebrows at a higher level without the necessity to affix internal or external sutures. Further eyelid retraction was optimized using pulsed mode at eyelid crease and resurfacing over the eyelid and periorbital area. Therefore, by using fractional ultrapulse CO_2 laser, we could achieve satisfactory results in mild to moderate dermatochalasis with relatively simple and safe way. Also, we avoid the complications which are known with traditional surgical treatments and ablative devices in treatment of dermatochalasis using this technique.

One of the interesting findings in our study was that group B patients showed mild better results as compared to the other group. Although type I collagen synthesis

diminishes with age in eyelid skin, older women have demonstrated the best performance after laser treatment [18]. However, the detailed interpretation needs further investigation in future.

Conclusion

Blepharoplasty surgery is considered to be the standard treatment for both redundancy of eyelid skin and eyebrow lifting, although it has significant downtime and potential serious complications. This laser approach has advantages of decreased recovery period, higher safety profile, and rejuvenation with improvement skin texture.

This study evaluated improvement of the upper eyelid skin laxity and periorbital skin using a fractional ultrapulse CO_2 device in patients with low and moderate upper eyelid dermatochalasis. In instances when patients with periorbital rhytides and/or dermatochalasis do not desire surgical treatments, CO_2 laser vaporization of periocular skin may well offer the most effective treatment alternative.

Conflict of interest None of the authors have a financial interest in any of the products, devices, or drugs mentioned in this article.

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