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Combined visible light and infrared light-emitting diode (LED) therapy enhances wound healing after laser ablative resurfacing of photodamaged facial skin

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Abstract

LED therapy accelerates healing post-resurfacing. Laser ablative resurfacing is still the most effective method for the rejuvenation of severely photoaged and photodamaged facial skin, but the long-healing time coupled with other troublesome sequelae mean a long patient downtime. Phototherapy with light-emitting diodes (LEDs) has recently been attracting attention in accelerating wound healing. The current study was designed to assess the beneficial effects of LED phototherapy on wound healing and postoperative sequelae following laser ablative resurfacing. The study had both a prospective and retrospective arm. The prospective study population consisted of 28 female patients who underwent ablative Er:YAG/CO_2 laser resurfacing (four full face, eight periocular, 16 perioral), followed by hemifacial LED therapy with 830 nm followed by 633 nm LED panels, 20 min/session (55 and 98 J/cm^2, respectively. The contralateral side of the face was covered with an opaque material to prevent exposure to the LED energy. A similar number of age- and treatment-matched patients previously treated in the same way, but without LED therapy, formed the retrospective arm. Tissue healing time and postoperative sequelae were compared for the treated and untreated sides in the prospective group and for the untreated retrospective group. The healing time in the LED-treated side was around 50% faster and sequelae significantly less compared with the untreated side, but interestingly these factors were slightly better in the untreated side compared with the retrospective untreated controls. At a 6-month follow-up in the prospective group, no significant difference in wrinkle improvement was seen between the treated and untreated side, but the skin appeared younger-looking on the LED-treated compared with the untreated side. Combined LED therapy significantly improved healing time and treatment sequelae in laser ablative resurfaced photoaged facial skin. It appears that this combined LED therapy approach may also help to sustain the good results through a maintenance therapy program.

Keywords: Light-emitting diode; Photoaged skin; Photobiomodulation; Phototherapy; Skin rejuvenation; Wound healing

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Introduction

The rejuvenation of photoaged skin using laser- and non-laser-based systems remains a very hot topic both for patients and for clinicians, particularly nonablative skin rejuvenation under an intact and unharmed epidermis. However, in patients with severely photoaged skin exhibiting many deep wrinkles, lines, coarse open-pored skin and severe dyschromia, nonablative resurfacing is definitely not an appropriate option. On the other hand, laser ablative resurfacing in the hands of experienced clinicians has produced excellent results, but the related extended healing time, severe exudation, crusting, oedema and prolonged erythema are very problematic for patients, resulting in long periods of downtime from both their work and social environments. Long-term adverse side effects, including herpes simplex infections, are also a major consideration. The author's previously published technique using a combined Er:YAG/CO_2 laser [1] helped to reduce somewhat the wound healing time and associated complications compared with CO_2 resurfacing on its own [2]. Some adjunctive method to reduce wound healing time and control side effects better would make laser ablative resurfacing a more attractive option for the severely photoaged patient in whom nonablative skin rejuvenation produces very disappointing results.

Low incident doses of laser energy, so-called laser therapy, have been well-associated with accelerated wound healing [3–5]. Recently, a new generation of light-emitting diodes (LEDs) was developed as a spin-off from the US NASA space medicine program [6], and these LEDs, which are many times more powerful that their predecessors, have shown promising results in experimental wound healing applications [7]. Several commercially available systems have now appeared based on arrays of LEDs, and the present study was designed to assess the potential efficacy of one such system with two interchangeable heads emitting at near infrared (830 nm) and visible red (633 nm) in accelerating wound healing and controlling side effects such as pain, exudation, crusting, oedema and erythema following laser ablative resurfacing of photoaged facial skin.

Materials and methods

Patients

Two groups of patients were planned, one prospective and one retrospective group, all of whom required laser ablative resurfacing for severely photoaged facial skin. Twenty-eight patients in each group were matched as far as possible for age, skin type and resurfacing location. In both groups four patients underwent full face laser ablative resurfacing, eight periocular and 16 perioral. Table 1 shows the demographics of both groups with no significant differences seen between them (Retrospective vs. Prospective, mean age: 50.14 ± 9.37 vs. 50.07 ± 9.29; and skin type: 7 Type II, 15 type II and 6 type IV vs. 8 type 2, 15 type III and 5 type IV). The patients making up the retrospective group were drawn from the author's patient data in the combined Er:YAG/CO_2 laser resurfacing paper previously cited [1]. In the prospective group, patients were randomly assigned to receive left-or right side phototherapy, while the contralateral side of the face was covered with an opaque sheet to prevent light reaching the skin on that side, thus serving as an unirradiated control. Each patient in the prospective arm thus served as her own control, and the patients in the retrospective arm served as the totally unirradiated controls.

The trial was explained to, and written informed consent as to participation and use of clinical photography obtained from, all participants in the prospective group. Patients in the retrospective group were already covered by the written informed consent obtained for that trial. The current trial was approved by the Ethics Committee of the Antoni de Gimbernat Foundation, and was performed according to the World Medical Association Declaration of Helsinki.

Phototherapy unit

The system used in the study for the prospective group was the Omnilux LED-based phototherapy system (Photo Therapeutics, Limited, Fazely, Tamworth, UK) which consists of a base unit fitted with interchangeable LED array-based heads of different wavelengths. The panels on the head are articulated to allow the head to follow the contours of the face. Following laser ablative resurfacing, light at 830 ± 5 nm (near infrared) and at 633 ± 3 nm (visible red) was sequentially delivered from interchangeable heads (Omnilux plus™ and Omnilux revive™, respectively).

Treatment regimen

Laser ablative surfacing was performed with the parameters as previously reported by the author and colleagues [1]. In brief, the combined Er:YAG/CO_2 system was employed in a single pass technique with a 50% overlap, giving 2-pass equivalence. The laser energy was delivered through the same collimated 3 mm ∅ handpiece, an ablative shot with the Er:YAG laser (29 J/cm^2) being followed almost instantaneously with a subablative shot with the CO_2 laser (2.8, 3.5, 4.2 J/cm^2, depending on wrinkle depth and skin site) (full set of parameters summarized in Table 2).

Table 1. Patient demographics in retrospective and prospective groups

Retrospective				Prospective			
Patient no.	Age (years)	Skin phototype	Area for resurfacing	Patient no.	Age (years)	Skin phototype	Area for resurfacing
1	60	III	TF	1	62	III	TF
2	50	II	POr	2	48	II	POr
3	40	III	POc	3	39	III	POc
4	58	III	POr	4	56	III	POr
5	56	III	POr	5	56	III	POr
6	34	IV	POc	6	35	IV	POc
7	39	II	POr	7	59	III	POr
8	59	III	POr	8	58	III	POr
9	61	III	POr	9	60	II	POr
10	72	III	TF	10	76	III	TF
11	44	II	POr	11	46	II	POr
12	42	III	POc	12	40	III	POc
13	39	III	POr	13	41	II	POr
14	57	II	POr	14	56	II	POr
15	65	IV	TF	15	64	IV	TF
16	36	III	POr	16	35	III	POr
17	46	IV	POr	17	44	III	POr
18	62	II	TF	18	63	II	TF
19	49	III	POr	19	51	IV	POr
20	53	III	POr	20	53	III	POr
21	51	IV	POc	21	51	IV	POc
22	47	II	POr	22	48	II	POr
23	43	III	POr	23	44	III	POr
24	45	II	POc	24	44	II	POc
25	51	III	POr	25	52	III	POr
26	54	IV	POr	26	53	III	POr
27	44	IV	POr	27	46	IV	POr
28	47	III	POc	28	47	III	POc

TF = full face; POr = perioral; POc = periocular.

Table 2. Summary of laser parameters for the combined Er:YAG/CO_2 resurfacing system (delivered via 3 mm ∅ collimated handpiece with 50% overlap, equivalent of 2 passes per 1 pass)

Parameter	Er:YAG	CO_2
Wavelength	2,940 nm	10,600 nm
Irradiation mode and time	pulsed: 350 μs	C/W: 50 ms
Irradiated area	≈0.07 cm^2	≈0.07 cm^2
Output power	—	4, 5, 6 W
Irradiance (Power density)	82,900 W/cm^2	56.6, 70.7, 84.9 W/cm^2
Fluence (Energy density)	29 J/cm^2	2.8, 3.5, 4.2 J/cm^2

Immediately after resurfacing and at 72 h post-resurfacing patients received 20 min of 830 nm LED therapy (incident irradiance of 55 mW/cm^2, radiant flux approximately 60 J/cm^2). In the following week two sessions of 633 nm LED therapy were given, 3 days apart, and in the third week one final session of 633 nm LED therapy was delivered. Each of these sessions was also 20 min (incident irradiance of 80 mW/cm^2, radiant flux approximately 96 J/cm^2). Postoperative wound care was as previously described by the author and colleagues [8]. Patients returned at 3 and 6 months post-resurfacing for assessment.

Assessment of efficacy

Subjective patient/clinician assessment

At the 3- and 6-month assessments postresurfacing, the clinical improvement on the treated and untreated side was rated by the patient and treating physician as being "very good", "good", "fair", "poor" or "bad", following the criteria developed in earlier studies [9,10]. Briefly, "very good" was when both the patient and physician agreed that the result was as desired by both parties; "good" was when the result, though acceptable, was not quite up to the expectations of the patient, but the physician was pleased with the outcome; "fair" was when the improvement was rated by both patient and physician as being less than expected, but still with some improvement; ''poor'' was where the result in no way measured up to the expectations of either the patient or the physician, and ''bad'' was where the result was worse than before treatment. In addition patients were interviewed regularly during the first three weeks of the study by a trained nurse based on a questionnaire to elicit patients' findings on exudation, crusting, pain and oedema.

Clinical photography

Digital clinical photography was taken in the prospective group subjects before treatment (baseline), immediately after, 24 h, 3 days, 1, 2, 4, 6 weeks then at 3 and 6 months post resurfacing (Sony MAVICA MVC-FD91, 2 MPxl , Tokyo, Japan). Corresponding clinical photography was identified from the patient records of the retrospective group subjects. The 2002 study also used digital photography, but from an earlier version of the camera used in the current study. Using the photography at baseline and at 3 and 6 months postresurfacing a panel of two independent and blinded experienced clinicians assessed the degree of improvement on a five-point scale corresponding to that of the patients' subjective assessment: namely ''very good'' (85–100% improvement, no sequelae), ''good'' (65–84% improvement, no sequelae), ''fair'' (45–64% improvement, some minor sequelae), ''poor'' (<45% improvement, noticeable sequelae) or ''bad'' (little improvement or worse, noticeable to significant sequelae). 'Sequelae' included prolonged erythema, pigmentary changes and scar formation. In the event of any major discrepancy in the assessments a final assessment was reached by consensus. The panellists were only told that the subjects had undergone laser ablative resurfacing, some whole face with the one system, and some with a different hemifacial technique, They were not aware as to which group each patient belonged (retrospective or prospective), nor which side was treated in the prospective group patients.

Objective computer assessment

Also, based on the clinical photography, a computer-based assessment program [11] objectively calculated the time course and severity and intensity of the erythema up to the 3-month assessment, comparing the treated and the untreated sides in the Prospective group subjects and the treated area in the Retrospective group photography.

Results

All 28 patients in the Prospective group completed the trial including the 3- and 6-month assessments. Table 3 shows the averaged subjective efficacy at the 3- and 6-months assessment points for all three groups, also broken down by procedure. No subject in either group scored 'poor' or 'worse'. Full face resurfacing was most effective, followed by perioral resurfacing with periocular resurfacing being the least effective, By combining the 'very good' and 'good' scores, the overall subjective efficacy rates for the Retrospective, Prospective control and Prospective treated groups at the 3-month assessments were calculated at 86%, 86% and 93%, respectively, and at the 6-month assessment these values were 97%, 97% and 100%, respectively. As seen in Fig. 1, at the 3-month assessment the overall efficacy of the Prospective treated group was significantly better than both the Prospective control and Retrospective groups (paired t-test, $p<0.01$). At the 6-month assessment, although the Prospective treated group was slightly better than the other two, the difference was not significant. The independent clinician panel returned results based on the clinical photography which were more or less exactly the same as the subjective efficacy arrived at by the patient/clinician interviews (data not shown).

Tables 4, 5 and 6 show the resolution of the monitored side effects (exudation, crusting, pain and oedema) for the three groups, all of which had satisfactorily resolved by 3 weeks post-resurfacing. The timing was slightly but insignificantly faster in the Prospective control than in the Retrospective group, but significantly faster in the Prospective treated group, ($p<0.001$ for all, paired t-test), being around one half of the time taken in the other two groups.

As for erythema, the intensity of which was measured with the computer program, erythema in the Prospective treatment group decreased significantly faster at all time points from postoperative day 20 to day 70 (paired t-test, $p<0.0001$ for all), by which time it had totally resolved compared with residual erythema of just over 20% for the Retrospective and Prospective untreated control group (Fig. 2). By postoperative day 20, erythema had decreased by almost 50% in the control group.

Illustrative case

Fig. 3 shows a representative case, a 76-year-old female, taken from the prospective group. Fig. 3A shows the pretreatment findings, with a typical severely photoaged face. The right side of the face was the untreated control and the left side of the face was set to receive LED therapy. At one month after resurfacing (Fig. 3B), the results were excellent, with no significant difference seen in wrinkle improvement between the two sides. Figs. 3C and D compare the pre- and post-treatment findings on the untreated control side of the face, and Figs. 3E and F on the LED-treated side. Comparing Figs. 3D and F, the untreated side still

Table 3. Averaged subjective efficacy at 3 and 6-month assessments broken down by group, showing the average rating and rating by procedure

Retrospective				Prospective (Control)				Prospective (LED-treated)			
Ave. grade	No. of pats	By procedure		Ave. grade	No of pats	By procedure		Ave. grade	No. of pats	By procedure	
3 month assessment											
VG	17	TF	3	VG	18 (64)	TF	4	VG	19 (68)	TF	4
	(61)	POr	12			POr	11			POr	12
		POc	2			POc	3			POc	3
G	7 (25)	TF	1	G	6 (22)	TF	0	G	7 (25)	TF	0
		POr	4			POr	6			POr	5
		POc	2			POc	0			POc	2
F	4 (14)	TF	0	F	4 (14)	TF	0	F	2 (7)	TF	0
		POr	0			POr	1			POr	1
		POc	4			POc	3			POc	1
6 month assessment											
VG	19 (68)	TF	4	VG	20 (72)	TF	4	VG	21 (75)	TF	4
		POr	13			POr	12			POr	12
		POc	2			POc	3			POc	5
G	8 (29)	TF	0	G	7 (25)	TF	0	G	7 (25)	TF	0
		POrl	5			POr	5			POr	6
		POc	3			POc	2			POc	1
F	1 (3)	TF	0	F	1 (3)	TF	0	F	0 (0)	TF	0
		POr	0			POr	1			POr	0
		POc	1			POc	1			POc	0

No subject was rated ‘poor’ or ‘worse’.
TF – full face; POr – perioral; POc – periocular. Values in brackets: (Approx. % of group).
VG – very good; G – good; F – fair. See text for an explanation of the grading.

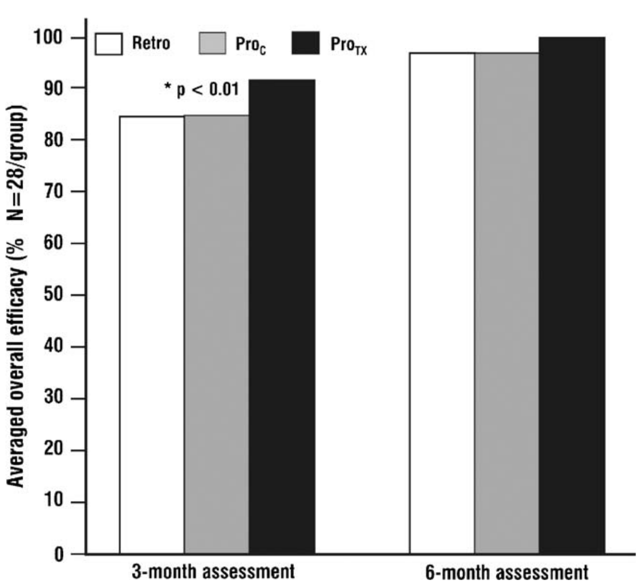

Fig. 1. Averaged overall efficacy (sum of ‘very good’ and ‘good’ scores) compared among the three groups at the 3- and 6-month assessment points. Retro = retrospective group; Pro_{C} = prospective control group; Pro_{TX} = prospective treated group.

maintained a little erythema compared with the untreated control side.

Discussion

Laser ablative resurfacing is still the ‘gold standard’ in the skin rejuvenation of severely damaged photoaged facial skin, and can give excellent results with removal of even deep rhytides, large dyschromic lesions and the provision of a ‘new’ epidermis. The main setback to this approach are the severe and prolonged side effects and possible complications following what is in effect a controlled second degree burn of the treated area, which can involve the entire face. The side effects include pain and discomfort, oedema, exudation, crusting and erythema. The complications include prolonged erythema which may also be severe, secondary hyperpigmentation and scar formation. In any event, the ablative resurfacing patient has to take a comparatively long period away from work and social duties due to the unattractive appearance of his or her face during the early healing stages. Thus, despite the excellent results,

Table 4. Resolution (in post-resurfacing days) of exudation, crusting, pain and oedema in the Retrospective group

Day	Exudation				Crusting				Pain				Oedema			
	VM	M	L	N	VM	M	L	N	VM	M	L	N	VM	M	L	N
1	28	—	—	—					23	5	—	—	28	—	—	—
2	28	—	—	—					21	7	—	—	28	—	—	—
3	27	1	—	—	5				13	8	7	—	23	5	—	—
4	22	6	—	—	9				9	10	11	—	15	10	3	—
5	5	9	14	—	17				3	13	9	3	9	12	6	1
6	1	6	12	9	20				—	9	11	8	1	10	11	7
7	—	—	11	17	24				—	—	13	15	—	8	10	10
8	—	—	—	28	26	2	—	—			3	25	—	—	12	16
9					25	3	—	—	—	—	—	28	—	—	—	28
10					23	5	—	—								
11					15	9	4	—								
12					8	7	9	4								
13					1	6	14	7								
14					—	—	12	14								
15					—	—	3	25								
16					—	—	—	28								

VM = very much, M = much, L = little, N = none.

Table 5. Resolution (in post-resurfacing days) of exudation, crusting, pain and oedema in the Prospective control (LED unirradiated) group

Day	Exudation				Crusting				Pain				Oedema			
	VM	M	L	N	VM	M	L	N	VM	M	L	N	VM	M	L	N
1	28	—	—	—					22	6	—	—	28	—	—	—
2	28	—	—	—					20	8	—	—	27	1	—	—
3	26	2	—	—	6				12	9	7	—	20	6	2	—
4	20	8	—	—	12				8	10	10	—	8	14	5	1
5	5	4	19	—	22				3	12	9	4	1	15	6	6
6	—	—	6	22	27	1	—	—	—	8	9	11	—	10	11	7
7	—	—	—	28	26	2	—	—	—	—	8	20	—	—	10	18
8					25	2	1	—	—	—	—	28	—	—	—	28
9					26	2	—	—								
10					20	4	4	—								
11					10	9	5	4								
12					2	7	8	11								
13					—	5	8	15								
14					—	—	10	18								
15					—	—	2	26								
16					—	—	—	28								

VM = very much; M = much; L = little; N = none.

many patients are now unwilling to undergo this procedure and instead opt for nonablative procedures which, while offering less or even no downtime, give much less satisfactory results and require aggressive maintenance programs. If some adjunctive treatment could dramatically shorten the downtime, attenuate some or all of the side effects and at the same time offer prophylaxis against complications, then laser ablative resurfacing might well become more attractive. It is after all our aim, and that of the patient, to get the best and longest-lasting result, and for severely photoaged facial skin laser ablative resurfacing offers the best results.

The literature in the final two decades of the last Millennium and up to the present has contained many references to the efficacy of low incident levels of laser energy, referred to as low-level laser therapy (LLLT) or simply laser therapy [3], in a number of areas, most important among which were pain attenuation in a variety

Table 6. Resolution (in post-resurfacing days) of exudation, crusting, pain and oedema in the Prospective LED irradiated group

Day	Exudation				Crusting				Pain				Oedema			
	VM	M	L	N	VM	M	L	N	VM	M	L	N	VM	M	L	N
1	28	—	—	—					12	8	8	—	19	9	—	—
2	20	5	3	—					5	9	9	5	9	12	5	3
3	8	7	7	6		8			0	8	7	13	1	7	8	12
4	—	8	10	10		28			—	—	—	28	—	3	8	17
5	—	—	—	28	—	19	6	3					—	—	—	28
6					—	8	10	8								
7					—	1	15	12								
8					—	—	—	28								
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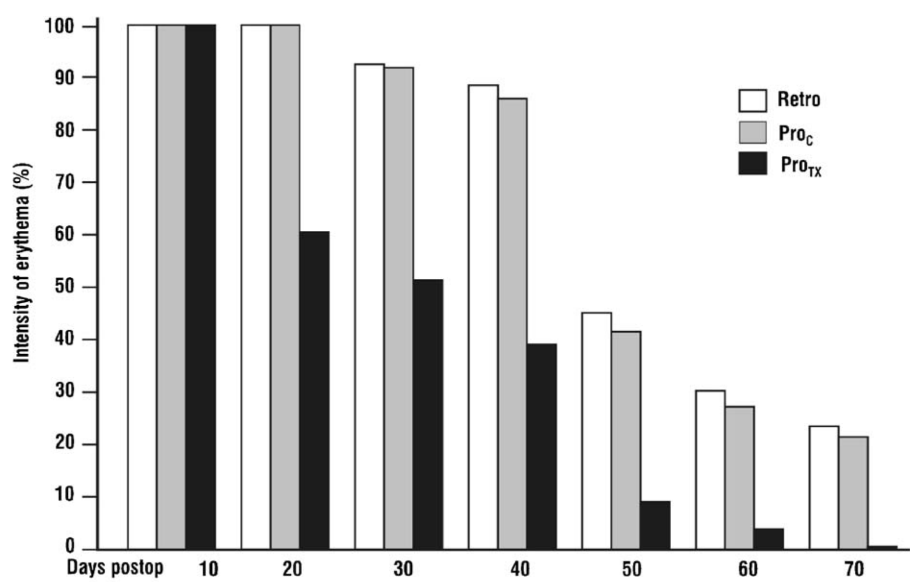
VM = very much; M = much; L = little; N = none.



Days postop	10	20	30	40	50	60	70
Retro	100.0%	100.0%	92.0%	88.5%	45.0%	30.0%	23.5%
Pro_C	100.0%	100.0%	91.5%	86.0%	41.5%	27.0%	21.5%
Pro_{TX}	100.0%	60.5%	51.5%	39.0%	9.0%	3.5%	0%

Fig. 2. Computer-assessed resolution of erythema intensity for the time points shown compared among the three groups. Retro = retrospective group; Pro_C = prospective control group; Pro_{TX} = prospective treated group.

of acute and chronic pain types [12–13], the accelerated healing of slow to heal wounds including recalcitrant ulcers [14], improved lymphatic drainage [15] and local blood flow rate and volume [16], and wavelength-specific photomodulation of the action potentials of the wound healing cells, namely macrophages [17], mast cells [18], neutrophils [19] and fibroblasts [20].

The recent development of comparatively high-powered and quasi-monochromatic LEDs has coupled the wavelength-specific benefits of the laser therapy systems with less expensive LED-based systems, capable of treating large areas in one single irradiation in a hands-free manner when mounted on articulated panels in arrays such as in the system used in the present study.

Fig. 3. A representative 76-year-old female from the Prospective group. The right side of her face was designated as the unirradiated control side, and the left side received combined 830/633 nm LED therapy. **A**. Pretreatment findings, full face. **B**. One month after treatment. Wrinkles and dyschromia have been much improved, and the skin condition is very good. **C**. LED-untreated control side, semi-profile, before resurfacing. **D**. Right side, after resurfacing. Although the overall result is very good, some erythema is still evident. **E**. LED-treated side, semi-profile, before treatment. **F**. Left side of the face, one month postresurfacing. Excellent result with complete resolution of erythema.

As already mentioned, good support has been given to the bio-modulating effects of low incidence levels of laser energy, but all these therapeutic actions were accomplished with laser light which has coherence as one of its particular characteristics. LEDs, as the main component of the device used in this study, produce very narrow band light, which has been reported as producing acceleration of wound healing, but does not have coherence as its main characteristic. It has been suggested that coherence is the most important characteristic accounting for the efficacy of laser therapy [21]. The results of the present study do not agree with this finding, but the LED irradiation was being applied superficially into skin which had undergone a controlled second degree burn for ablative resurfacing. This might suggest that coherence in phototherapy certainly has relevance when dealing with targets deep in the tissue, such as the major joints and their articular components, and the major muscles. For superficial targets, however, coherence loses a lot of its importance and from the authors' own observations in LED therapy of superficial wounds with the system used in the present study, it is the quasi-monochromatic wavelengths, high photon intensities and dose delivered by the LED panels which are of primary importance, rather than coherence.

From the literature quoted, two wavelengths in particular have shown specific effects in different cell types: 633 nm in the visible red and 830 nm in the near infrared, both wavelengths were available with the system used in the present study. It has gradually become obvious in the field of nonablative skin rejuvenation that no single wavelength can hope to accomplish all reactions required in the wound healing process, whereas combinations have proved significantly more effective [22]. The same should hold true with the near IR/visible red combination used in the present study.

The intense light emitted by the LED-based heads during the 20 min treatment sessions is distributed evenly by the articulated panels which comprise the system heads, thus treatment of wounded skin with this combination LED energy is believed to initiate a chain of reactions, well described in the literature and based on the cells already discussed above, to activate blood flow, to enhance collagen formation, and to shorten wound healing time without compromising good wound healing. The results comparing the LED-treated and untreated sides in the Prospective group and the completely LED-untreated Retrospective group would appear to bear this out from all the above aspects.

The order of application is deliberate. The 830 nm wavelength is well-associated with photobiomodulation of the wound healing cells: the mast cells, neutrophils and macrophages. The subsequent doses of 633 nm concentrate on the fibroblasts, but maintain the reaction level in the other cells. Both wavelengths are well-associated with increases in local blood flow rate and volume, and 830 nm also stimulates the transitional remodeling phase, involving fibroblast-myofibroblast transformation. The synergy between these two wavelengths is tremendous as seen in the excellent results and increased patient satisfaction.

In conclusion, non-invasive combination LED therapy will probably become an extremely valuable addition to enhance wound healing after laser ablative resurfacing procedures, and possibly other aesthetic procedures as well. Safety, efficacy and patient tolerance were all very high. Furthermore, LED therapy can be used not only in isolation but also in conjunction with other therapies, to help increase patient compliance and satisfaction, and help reduce costs for both patient and clinician.

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On behalf of his co-authors and himself, the principal author declares no financial or other interest in any of the companies and equipment mentioned in this article.

Zusammenfassung

Therapie mit Kombidiode zur Emission von sichtbarem und infrarotem Licht verbessert Wundheilung nach Resurfacing durch Laserablation von lichtgeschädigter Gesichtshaut

Resurfacing durch Laserablation ist noch immer das wirksamste Verfahren zur Verjüngung stark lichtgealterter und lichgeschädigter Gesichtshaut, doch die lange Wundheilung und andere lästige Folgeerscheinungen bedeuten eine erhebliche Ausfallzeit für den Patienten. Bei der Beschleunigung der Wundheilung ist man kürzlich auf die Phototherapie mit lichtemittierenden (LED-) Dioden aufmerksam geworden. Im Rahmen der vorliegenden Studie sollten die positiven Auswirkungen der LED-Phototherapie auf die Wundheilung und postoperative Folgeerscheinungen nach Laser-Resurfacing evaluiert werden. Die Studie bestand aus einem prospektiven und einem retrospektiven Teil. Die prospektive Gruppe bestand aus 28 weiblichen Patienten, die mit dem Er:YAG/CO_2-Laser (4 × gesamtes Gesicht, 8 × periocular, 16 × perioral) behandelt wurden und sich anschließend einer hemifazialen LED-Therapie bei 830 nm sowie einer Behandlung mit 633 nm-LED-Platten unterzogen. Die Behandlungsdauer pro Sitzung betrug 20 min bei 55 J/cm^2 bzw. 98 J/cm^2. Die kontralaterale Gesichtsseite wurde mit strahlenundurchlässigem Material abgedeckt, um sie vor der LED-Energie zu schützen. Die retrospektive Gruppe bestand aus einer gleichen Anzahl von Patienten passenden Alters, die zuvor die gleiche Behandlung, jedoch ohne LED-Therapie, erfahren hatten. Gewebeheilungsdauer und postoperative Folgeerscheinungen für die behandelten und unbehandelten Seiten in der prospektiven Gruppe s.u. wurden miteinander verglichen. Die Wundheilungszeit der LED-behandelten Seite war um etwa 50% kürzer und die Folgeerscheinungen waren signifikant geringer als bei der unbehandelten Seite, aber diese Faktoren waren interessanterweise bei der unbehandelten Seite etwas besser als im Vergleich zur retrospektiven unbehandelten Kontrollgruppe. Bei einer Nachuntersuchung der prospektiven Gruppe nach 6 Monaten fand sich zwischen behandelter und unbehandelter Seite kein signifikanter Unterschied in der Faltenreduktion, aber im Vergleich zur unbehandelten Seite erschien die Haut der LED-behandelten Seite jünger aussehend. Die kombinierte LED-Behandlung verkürzte die Heilungsdauer und die minderte Folgeerscheinungen des

Laser-Resurfacing von lichtgealterter Gesichtshaut signifikant. Es scheint, dass dieser Kombi-LED-Therapieansatz auch dazu beitragen könnte, die positiven Ergebnisse durch ein Erhaltungstherapieprogramm zu verstärken.

Schlüsselwörter: Lichtemittierende Diode; Lichtgealterte Haut; Photobiomodulation; Phototherapie; Hautverjüngung; Wundheilung

Resumen

La terapia combinada mediante diodos emisores de luz Visible e Infrarroja (LED) contribuye a la curación de las lesiones faciales luego del resurfacing con láser ablativo de la piel foto dañada

La técnica de Resurfacing mediante el uso de láser ablativo continua siendo el método más eficaz para el rejuvenecimiento de la piel facial severamente foto dañada o foto envejecida, a pesar de que el largo período de curación junto a otros efectos problemáticos luego del tratamiento, implican una prolongada inactividad del paciente. Recientemente, el uso de la fototerapia con LEDs (Diodos de Emisión de Luz) ha ganado importancia para la aceleración del proceso curativo.

El presente estudio fue diseñado con el fin de determinar los efectos beneficiosos de la fototerapia LED en la recuperación de las lesiones y las secuelas postoperatorias luego del resurfacing con láser ablativo. Para ello, se incluyeron datos prospectivos y retrospectivos. El estudio prospectivo fue realizado en 28 pacientes mujeres, sometidas a un tratamiento de resurfacing utilizando el láser ablativo Er:YAG/CO_2 (4 cara completa, 8 periocular, 16 perioral), seguido de una terapia LED hemifacial, con pases LED de 830 nm y 633 nm, 20 min/sesion (55 J/cm^2 y 98 J/cm^2), respectivamente. El lado contralateral de la cara fue cubierto con un material opaco para prevenir la exposición a la energía del LED. Para el estudio retrospectivo se incluyó un grupo de pacientes de edad similar sometidas a un tratamiento comparable, pero sin terapia LED. Se comparó el tiempo de recuperación del tejido y las secuelas postoperatorias de las pacientes del grupo prospectivo en los lados de la cara tratado y no tratado, y las pacientes no tratadas del grupo retrospectivo. El tiempo de recuperación en el lado tratado con LED fue aproximadamente un 50% más rápido y la cantidad de secuelas postoperatorias fueron significativamente menores a las determinadas para el lado no tratado. Sorprendentemente, estos factores presentaron incluso una leve mejoría en el lado no tratado comparado con las pacientes sin tratamiento del estudio retrospectivo.

En el seguimiento de seis meses del grupo prospectivo no se encontró diferencia significativa en el mejoramiento de las arrugas en los lados tratado y no tratado, aunque la piel en el lado de la cara tratado con LED presentaba un aspecto más rejuvenecido.

El tratamiento combinado conn LED acortó el tiempo de recuperación y redujo perceptiblemente los resultados del resurfacing con láser ablativo de la piel facial foto envejecida. Aparentemente el uso de esta terapia combinada con LED contribuiría a preservar los buenos resultados mediante un programa de terapia de mantenimiento.

Palabras clave: Diodo emisor de luz; piel fotoenvejecida; fotobiomodulación; fototerapia; rejuvenecimiento de la piel; cicatrización

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