

# The use of light-emitting diode therapy in the treatment of photoaged skin

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## Summary

**Background** Light-emitting diode (LED) therapy is an increasingly popular methodology for the treatment of sun damage. Combination use of light wavelengths reported to stimulate collagen synthesis and accelerate fibroblast–myofibroblast transformation may display a composite rejuvenative effect.

**Objective** To clinically assess reduction in sun damage signs following a 5-week course of LED therapy and to assess subject's perception of the treatment.

**Methods** Thirteen subjects with wrinkles or fine lines in the periorbital and nasolabial region and those presenting Glogau scale photodamage grade II–III received nine 20-min duration light treatments using the Omnilux™ LED system. The treatments combined wavelengths of 633 and 830 nm at fluences of 126 and 66 J/cm<sup>2</sup>, respectively. Sun-damage reduction was assessed at 6, 9, and 12 weeks by clinical photography and patient satisfaction scores.

**Results** The majority of subjects displayed “moderate” (50%) or “slight” (25%) response to treatment at investigator assessment. Treatment of the periorbital region was reported more effective than the nasolabial region. At 12-week follow-up, 91% of subjects reported improved skin tone, and 82% reported enhanced smoothness of skin in the treatment area.

**Conclusion** Good response to LED therapy has been shown in this modest sample. Larger trials are needed to assess optimum frequency of light treatments and overall treatment time.

**Keywords:** LED (light-emitting diode), photoaging, light therapy, rejuvenation

## Introduction

The most significant causative factor of the clinical signs of aged skin is sun exposure. Chronic exposure to ultraviolet A2 light (320–340 nm) and ultraviolet A1 light (340–400 nm) is associated with photoaging and

the subsequent formation of rhytids, fine lines, texture abnormalities, and pigment dyschromias.<sup>1</sup>

Nonablative procedures have been found to be effective in the treatment of photoaging. These methods have grown increasingly popular due to the prolonged recovery period frequently associated with ablative interventions such as laser resurfacing and chemical peels.<sup>2–4</sup>

Light-emitting diode (LED) therapy is a nonablative, athermal intervention used in the rejuvenation of damaged skin. It has been reported to be an effective, nonpainful, safe modality yielding high patient satisfaction.<sup>5</sup> It is proposed that specific LED light wavelengths are absorbed in the skin and used to modulate cell function, proliferation, and repair in sun-damaged tissue, in a process termed photobiomodulation.<sup>6</sup>

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Dr Baez acted as the principal investigator in the trial. All subjects were screened, treated, and reviewed under supervision of Dr Baez.

Dr Reilly collated data from all subjects in the trial and structured write up of the clinical work.

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Previous work has been published on the combination use of 633 and 830 nm LED therapy in the treatment of photoaged skin.<sup>7</sup> Red (633 nm) light has been shown to increase fibroblast growth factor and collagen synthesis in the skin.<sup>8</sup>

Although the authors are aware of published work assessing the effects of rejuvenative treatments by means of optical digital profilometry<sup>7</sup> and histological biopsy evaluations of synthetic and degradative collagen markers,<sup>2</sup> to evaluate combination 830 and 633 nm and 590 nm pulsed light, respectively, the purpose of this small trial was to clinically assess improvements in signs of sun damage and to assess patient perceptions of treatment success.

## Materials and methods

### Subjects

Thirteen subjects (3 men, 10 women; age range, 35–55 years; mean age, 48 years) were recruited from a single cosmetic surgery clinic in Sydney, New South Wales, Australia, for study participation. Inclusion criteria were presentation of wrinkles or crows feet in the periorbital region, wrinkles or fine lines in the nasolabial region, and those presenting photodamage grade II–III (moderate to advanced photoaging) in conformity with the Glogau scale.

Subjects with a history of an inflammatory skin condition, history of photosensitivity reactions, or those who were currently prescribed medications with photosensitivity listed as a potential side effect were excluded. Also excluded were those who had received laser skin treatments within the 6 months preceding study, chemical peels/glycolic acid treatments within 3 months preceding study, had a history of keloid or hypertrophic scarring, or were current or ex-smokers.

All subjects were recruited and initially screened in October 2004, and all gave informed written consent to the course of treatment.

### Light source

Two individual Omnilux™ LED light systems were used to deliver treatments: (1) Omnilux Revive™ delivering noncoherent red light at a wavelength of  $633 \pm 3$  nm and an intensity of  $105 \text{ mW/cm}^2$  (a total dose of  $126 \text{ J/cm}^2$  after 20 min exposure) and (2) Omnilux Plus™ delivering noncoherent light at a wavelength of  $830 \pm 5$  nm and an intensity of  $55 \text{ mW/cm}^2$  (a total dose of  $66 \text{ J/cm}^2$  after 20 min exposure; Omnilux Revive™ and Omnilux Plus™, Phototherapeutics Ltd, Altringham, Manchester, UK).

### Treatment

All subjects received a total of nine light therapy treatments over a 5-week period. Subjects were irradiated with 830-nm light source for 20 min ( $55 \text{ mW/cm}^2$ ,  $66 \text{ J/cm}^2$ ) on days 1, 3, 5, 15, 22, and 29. Subjects were irradiated with 633 nm, also for a 20-min duration ( $105 \text{ mW/cm}^2$ ,  $126 \text{ J/cm}^2$ ), on days 8, 10, and 12.

The hinged, planar array light source was positioned approximately 1 cm from the subject's face (nose tip) for the duration of all treatments. Facial exfoliation using a polyethylene-based exfoliant preceded all light treatments, and protective eyewear was worn by all subjects during all light treatments.

### Assessment

At baseline visit, assessment of Fitzpatrick skin scale type, Glogau photodamage classification, and tactile grading of skin roughness was made in all subjects.

For tactile roughness, 0 indicates smooth skin; 1 indicates smooth skin with occasional rough areas; 2 indicates mild roughness; 3 indicates moderate roughness; and 4 indicates severe roughness.

Baseline digital photography (Nikon Coolpix, Nikon, Tokyo, Japan; 4.5 megapixel) was done for all subjects: two exposures to the bilateral periorbital regions (eyes open and closed), two full face exposures (eyes open and closed), and a frontal close-up image of the nasolabial area. This was repeated at day 8, day 15, and weeks 6, 9, and 12. Lighting and ambient conditions were standardized throughout the trial, and all image analysis and photoaging assessments were conducted by the principal investigator.

At 6, 9, and 12 weeks, the principal investigating physician repeated assessment of Glogau scale in all patients and graded skin roughness using tactile grading score. In addition, response to treatment was graded by the assessor into one of seven categories: "complete response" (complete resolution of photodamage), "almost complete response" (~90% improvement in photodamage), "marked response" (~75% improvement), "moderate response" (~50% improvement), "slight response" (~25% improvement), "no response," and "condition worsened." These assessments were made for both the periorbital and nasolabial region. In addition, adverse reactions in terms of pain, stinging/burning sensation, erythema, blistering, ulceration, pigmentation, and scarring were scored on a scale of 0 (absent) to 10 (severe).

Details of adverse events and concomitant medications were noted at all treatment appointments.

Subject's own assessment of treatment success was assessed at 6, 9, and 12 weeks. Subjects were asked to

**Table 1** Response to treatment at all follow-up points.

Area	Follow-up point	Marked response (75%) to treatment (%)	Moderate response (50%) to treatment (%)	Slight response (25%) to treatment (%)
Periorbital region	Week 6	0	8	92
	Week 9	0	25	75
	Week 12	9	27	64
Nasolabial fold	Week 6	0	8	92
	Week 9	0	25	75
	Week 12	0	9	81

**Table 2** Subject responses in wrinkle softening and overall effect of treatment.

Area	Time point	Softening of wrinkles (%)		Effect of treatment (%)				
		Yes	No	Excellent	Good	Moderate	No effect	Poor
Periorbital region	Week 6	58	42	0	17	33	33	17
	Week 9	58	42	0	17	50	33	0
	Week 12	36	64	0	45	36	18	0
Nasolabial fold	Week 6	50	50	0	17	33	42	8
	Week 9	42	58	0	17	33	50	0
	Week 12	18	82	0	9	55	27	9

respond “yes” or “no” as to whether they perceived the light treatments to have softened wrinkles in the periorbital and nasolabial areas individually. Furthermore, subjects were asked to grade the effect of treatment in these areas as “no effect,” “poor,” “moderate,” “good,” or “excellent.” Finally, all participants were asked to respond “yes” or “no” to their perception of improved “skin tone,” “skin softness,” “skin smoothness,” “skin clarity,” “skin elasticity,” and “skin firmness” as result of the course of treatment.

## Results

Eleven subjects completed the trial to 12-week follow-up. One subject completed all light treatments and follow-up at 9 weeks but failed to return for the 12-week follow-up. A second male subject withdrew after receiving one light treatment due to an adverse event. This subject presented self-limiting contact dermatitis as a result of a reaction to the protective eyewear worn during light exposure. This subject’s data were excluded from analysis. Treatments were otherwise well tolerated. No other significant adverse events were noted during the course of follow-up.

Assessors grading of reduction in photoaging signs at all follow up points for both the periorbital and nasolabial region are displayed in Table 1. None of the subjects in the group were assessed as having “no response” or “negative

response” to the treatment. The majority of subjects displayed moderate (50%) or slight (25%) response to treatment. Treatment of the periorbital region was reported more effective than the nasolabial. Nine percent of the subjects achieved 75%, and 27% of subjects achieved 50% improvement in periorbital photodamage score at the 12-week follow-up. Regarding the nasolabial fold, 9% of subjects displayed 50% response, and the remainder were assessed as having “slight” 25% response at the 12-week follow-up.

Clinical photographs displaying improvement in photoaging signs in the periorbital, nasolabial, and full-face views are shown in Figures 1, 2, and 3, respectively.

Subject responses to the overall effect of treatment are displayed in Table 2. At the 12-week follow-up, 45% of subjects graded treatment effect in the periorbital area to be “good”; this is compared with 9% in the nasolabial fold. Thirty-six percent of subjects noted “moderate” effect in the periorbital region, and no subject noted “poor” effect of treatment. Success of treatment in the nasolabial fold is once again not as pronounced, with 55% subjects noting overall effect to be “moderate,” 27% reporting “no effect,” and 9% reporting “poor effect.” Curiously, a greater proportion of patients noted “good” effect on light treatment in the nasolabial fold at an earlier 9-week follow-up than at the final 12-week appointment.



Day 1  
Patient a Open eye view



Week 12



Day 1  
Patient b Closed eye view



Week 12

**Figure 1** Periorbital photography at initial screening visit and at the 12-week follow-up (patients a and b).



Day 1



Week 12

**Figure 2** Nasolabial photography at initial screening visit and at the 12-week follow-up (patient c).



Day 1



Week 12

**Figure 3** Full-face photography at initial screening visit and at the 12-week follow-up (patient d).

**Table 3** Subjective reports of improvements in skin parameters at all follow-up points.

Follow-up assessment	Tone (%)	Softness (%)	Smoothness (%)	Clarity (%)	Elasticity (%)	Firmness (%)
Week 6	83	75	83	58	50	42
Week 9	83	83	83	67	67	67
Week 12	91	73	82	64	45	55

Table 3 displays subjective reports of improvements in skin parameters at all follow-up points. At the 12-week follow-up, improved skin tone was reported by 91% of subjects, improved smoothness by 82%, improved softness by 73%, improved clarity by 64%, improved firmness by 55%, and improved elasticity by 45% of subjects.

## Discussion

This modest study attempted to assess the effects of LED treatment on patients with photoaged skin in the setting of a cosmetic medicine clinic. Local tolerance of treatment was good throughout the group. In both the periorbital

and nasolabial region, an ~50% reduction in signs of photoaging was most frequently reported over the 12 weeks of follow-up. The majority of subjects included reported a “moderate” effect of the light treatment over this period, although the significant majority reported improvements in skin parameters such as smoothness, softness, and firmness at the final 12-week assessment. These results are similar to previous studies using LED therapy<sup>7,9</sup> and also show some correlation with other more aggressive techniques such as radiofrequency<sup>10</sup> and Nd:YAG laser.<sup>11</sup> However, it is interesting that there was a marked difference in the results between the nasolabial and periorbital regions in this study, which is not reported with more aggressive techniques.<sup>10,11</sup>

Limitations of this study include the small sample size and the subjective, ill-defined nature of the skin parameters, which subjects were asked to note. For example, it is difficult to ascertain whether subjects could distinguish the definition of a term such as “skin tone” from “skin firmness.” Longer follow-up is certainly required because subjective responses of treatment results at 9 weeks were on occasion more positive than at 12 weeks. Efforts were made to standardize head position, lighting, and ambient conditions for clinical photography; yet, this is frequently a potential confounding factor in trial designs of this nature.

In conclusion, subject's expectations from a cosmetic treatment such as LED therapy will naturally vary. However, as reported, a 50% reduction in photoaging signs in the treated area over a 12-week period should make LED therapy an increasingly attractive option for antiaging in cosmetic therapy.

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