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SHORT COMMUNICATION

Comparison of 5-aminolevulinic acid photodynamic therapy and red light for treatment of photoaging

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KEYWORDS

Photoaging;
5-Aminolevulinic acid;
Red light;
Photodynamic therapy

Summary

Objective: The aim of this pilot study was to compare the efficacy of ALA-PDT and red light alone in the treatment of photoaging.

Methods: A total of 14 adults with photoaging skin were recruited. ALA-PDT or red light alone was applied to the forearm extensor. Before and after treatment, the treated sites were examined by dermoscopy, the changes in stratum corneum (SC) hydration, transepidermal water loss (TEWL), and the $L^*a^*b^*$ values were measured, and microscopic examination of collagens and elastins was performed.

Results: After ALA-PDT or red light illumination, the appearance of photoaging lesions improved, SC hydration increased and TEWL decreased. These changes in the ALA-PDT group were more obvious than those in the red light group. No significant change was noticed in the $L^*a^*b^*$ values in both groups. The signs of typical solar elastosis damage were improved in both groups.

Conclusions: ALA-PDT showed better skin rejuvenation effect than red light alone.

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Background and objectives

Numerous studies suggest that topical photodynamic therapy (PDT) can improve fine wrinkles, mottled hyperpigmentation, tactile roughness and sallowness [1–4]. PDT-mediated repairing is possible through the upregulation of collagen production and promotion of epidermal

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<http://dx.doi.org/10.1016/j.pdpdt.2014.02.007>

1572-1000/© 2014 Published by Elsevier B.V.

Please cite this article in press as: Ji J, et al. Comparison of 5-aminolevulinic acid photodynamic therapy and red light for treatment of photoaging. Photodiagnosis and Photodynamic Therapy (2014), <http://dx.doi.org/10.1016/j.pdpdt.2014.02.007>

proliferation [4,5]. Various light sources have been used for the activation of photosensitizer in topical PDT. Light might also promote rejuvenation process via non-thermal light modulation. The aim of this prospective pilot study was to investigate the effectiveness of combining 5-aminolevulinic acid (ALA) and red light in the treatment of photoaging skin in Chinese women and men.

Methods

Subjects (7 females, 43–50 years old; 7 males, 42–48 years old; Fitzpatrick skin type III or IV) were outdoor workers and both forearm extensors had the characteristic appearance of photodamage according to the Glogau scale [6]. To determine the optimal incubation time, 10% ALA cream (Fudan-Zhangjiang Bio-Pharmaceutical Co. Ltd., Shanghai, China) was applied to four regions on the left forearm extensor. The production of PpIX was examined spectroscopically at 1, 2, 3 and 4 h, respectively [7,8]. To determine the optimal ALA concentration, ALA cream of 5%, 10% and 20% was applied to three regions on the right forearm extensor and incubated for 2 h before fluorescence examination.

For the PDT group, 10% ALA cream was applied to a circular region of 4 cm diameter on the extensor skin. After 2 h of incubation the ALA-applied area was irradiated by a red LED light (630 nm; Philips, Netherlands) at 50 mW/cm² for 30 min. An identical ALA-PDT treatment was given after 2 weeks. For the light group, the contralateral forearms were exposed to the same dose of red light 3 times a week. The illumination was repeated for 4 weeks. Subjects were advised to avoid bright light for 36 h.

A hand-held dermoscopy was used for acquiring dermoscopic images under 10-fold magnification. The stratum corneum (SC) hydration was determined by a Corneometer (CM 825; Courage+Khazaka, Germany) and results were expressed as the means of five measurements. The transepidermal water loss (TEWL) value was measured using a TEWLmeter (TM300; Courage+Khazaka) and results were expressed as a mean value of 1 min measurement. For assessing skin color, a portable spectrophotometer (CM2600d; Minolta, Japan) was employed to determine the CIE L*a*b* color coordinates. Measurements were carried out under controlled humidity (50 ± 10% RH) and temperature (23 ± 1 °C) after an adaptation period of 30 min for washing the skin and waiting. All measurements were taken before each treatment, 2 weeks and 4 weeks after the final treatment of PDT, and 2 weeks after the final light treatment. Punch biopsies were taken from 5 patients before treatment, 4 weeks after the completion of PDT and 2 weeks after the completion of light treatment. Specimens were subjected to collagen and/or elastin staining.

Results

Effect of incubation time and ALA concentration on PpIX production

There was an obvious increase in PpIX production in the epidermis after 2 h of incubation with 10% ALA (paired *t* test, *P* < 0.05). Although the PpIX production after 2 h incubation

Table 1 Changes in SC hydration after ALA-PDT and light treatment (mean ± s.d., a.u.).

Time (week)	ALA-PDT	Light only
0	34.7 ± 7.2	33.1 ± 6.1
2	36.3 ± 6.6	33.0 ± 8.0
4	37.0 ± 8.1	35.2 ± 7.0
6	43.4 ± 10.0 ^{*,**}	37.8 ± 7.8 [*]

N.B.: (I) ^{*}*P* < 0.05 versus baseline (0 week); ^{**}*P* < 0.05, versus the red light group. (II) 0 = the baseline, 2 = 2 weeks after 1st PDT or 2 weeks of light treatment; 4 = 2 weeks after 2nd PDT or 4 weeks of light treatment; 6 = 4 weeks after 2nd PDT, or 2 weeks after the completion of light treatment (same for Table 2 and Fig. 1).

with 10% or 20% ALA was higher than 5% ALA (*P* < 0.05), there was no significant difference between 10% and 20% groups (*P* > 0.05).

Improvement in skin appearance

Subjects reported noticeable improvement after ALA-PDT (2 times) or red light treatment (12 times), including changes in tactile roughness and hyperpigmentation. Dermoscopy examination showed marked improvement in skin appearance and elimination of photodamage signs in both groups, but more prominent changes were seen in the ALA-PDT group (Fig. 1).

Improvement in SC hydration and TEWL

There was a slight improvement in SC hydration at 2 weeks after one- or two-session PDT (*P* = 0.372 versus *P* = 0.124), but a significant improvement at 4 weeks after two-session PDT (*P* = 0.002) (Table 1). There was also a slight improvement after 4 weeks of multiple light illumination (*P* = 0.164). This improvement became significant 2 weeks later (*P* = 0.049), but was less prominent than that of the PDT group (*P* = 0.046). A decrease in the TEWL value was observed at 2 weeks after one session of PDT (*P* = 0.048). The TEWL value continued to decline at 2 and 4 weeks after two sessions of PDT (*P* < 0.001 for both time points) (Table 2). There was also a decrease after 4 weeks of multiple light illumination, but it was less prominent than the PDT group (*P* < 0.05).

Table 2 Changes in TEWL after ALA-PDT and light treatment (mean ± s.d., g/m² h).

Time (week)	ALA-PDT	Light only
0	14.2 ± 4.3	14.0 ± 1.8
2	11.3 ± 2.7 [*]	13.5 ± 4.0
4	8.5 ± 2.3 ^{*,**}	10.4 ± 2.0 [*]
6	7.9 ± 2.0 ^{*,**}	9.8 ± 2.5 [*]

N.B.: ^{*}*P* < 0.05 versus baseline (0 week); ^{**}*P* < 0.05 versus light only group.

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