Treating Dark Under-Eye Circles with Topical Vitamins A and K

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Abstract

The authors report studies indicating that topical vitamins A and K may reduce the darkness of the under-eye region that often appears as people age.

Suborbital hyperpigmentation (dark circles under the eyes) is a widespread cosmetic problem, ranking second only to wrinkles in surveys regarding patients' cosmetic concerns about the aging face. Until very recently, no treatment could improve this problem. The products on the market were either a type of high-coverage makeup or merely moisturizers with marketing claims. Until 1999,[1] not a single study had been published on the treatment of this disorder. Certainly one of the reasons for this is the lack of understanding as to the etiology of the disorder.

As with many dermatologic disorders related to aging, a combination of factors lead to the final appearance: unsightly dark areas under the eyes. Inheritance certainly plays a role, since the darkness is present in some individuals at a very young age. Ethnicity certainly has an influence here also, as it is well known that subjects of certain national origins show a tendency to have increased deposition of melanin in the suborbital area, independent of other factors. Some individuals have thinner skin than others, which allows the melanin as well as the orbicularis muscle to show through the thin skin in this area.

Two factors interplay to increase the darkness over time: photoaging and gravity. As the skin moves down from the eyelid area due to gravity, it gets thinner; blood vessels increase in response to this thinning. The skin's thinness also allows these vessels and any pigment in the under-eye area to become more visible. Any damage to these can result in deposits of hemosiderin, a rust-colored, iron-containing pigment resulting from the breakdown of red bloods cells. Additionally, exposure to ultraviolet A over time increases the melanin in the area contributing to the darkness. The actinic damage of the area is also manifested in telangiectasia, or broken and dead-end vessels. All these factors combine over time to produce what is perceived, by patients and those who observe them, as dark circles.

Evidence that vitamin K penetrates the skin comes from an initial clinical study of topical vitamin K in which a patient with a bruise covering the inner aspect of the upper arm allowed half the bruise to be treated with 1% topical vitamin K. The untreated portion of the bruise persisted twice as long as the treated half.[2] Vitamin A has long been shown to have topical bioactivity. (See, for example, Ref. 3.) Therefore, we developed a formula containing retinol (vitamin A) and phytonadione (vitamin K_1) to treat under-eye dark circles. In this formula, the two ingredients are delivered via entrapment in a porous microspherical polymeric system.[4] The delivery system both enhances the stability and insures a gradual delivery of the actives to the skin over time, thus maximizing efficacy and skin tolerance. A previously published report[1] has described a clinical study that used photographs and evaluators who did not know which subjects were receiving treatment.

The present study compares results using the novel formulation and a control group, measuring efficacy both visually and instrumentally using a Pantone Color Chart and Minolta Color Computer.

Clinical Study

Population: Of the 16 subjects enrolled in the study, 15 were white and 1 was Hispanic. All subjects were female, ages ranged from 37 to 55 years old. Our selection criteria are listed in the accompanying box.

All patients signed informed consent and the study was performed under IRB control.

Methodology: To evaluate the dark-circle areas under our subjects' eyes, we examined the region and assigned a

[4] *The Microsponge System, Advanced Polymer Systems, Redwood City, CA. Microsponge is a registered trademark of APS.*

color according to the chips from the Pantone Color Formulation Guide 747XR 6th edition that matched shade and tone most closely. This color designation was then analyzed using a colorimeter.[b] The measuring system employed by colorimeters is designed to provide accurate and uniform readings. The one we chose uses a pulsed xenon arc (PXA) lamp inside a chamber to provide even, diffuse lighting over the sample. A double-beam feedback system is also incorporated to ensure that lighting remains consistent for each measurement.

The light from the PXA lamp is divided three ways and passed through special filters. Upon striking the silicon photocells, light energy is converted to electrical signals and sent to the microprocessor, where the signals are converted into coordinates for the chosen "color space" data display. Readings are displayed in the LCD panel and processed.

The colorimeter was interfaced with a DP-100 Color Computer System, which is capable of detecting subtle changes in color by a three-dimensional profile of hue, intensity and chroma. These are then translated into color coordinates whose spacing correlates with the color changes perceived by the human eye. Evaluation related the color values for the untreated baseline readings (Time 0) to those from treated sites at different times.

Any increase in the a* (red/green) coordinates indicates a reddening; a diminution of the L* (brightness) coordinates indicates a darkening of color. Decrease in the b* (blue/yellow) coordinate signifies a shift into the blue region.

[b] *Minolta CR-200 Chromameter (Minolta, Osaka, Japan)*

Study Design

The 16 subjects were divided into a control group of 5 and an active group of 11. The active group used the test product each night as part of a regular skin-care routine, applying a small amount of the cream under the eye where the dark circles appear. The subjects also received a sunscreen to apply each morning throughout the study.

The control group used only sunscreen, in the morning.

The subjects were examined by a board-certified ophthalmologist at baseline and throughout the study to determine if any adverse effect on the eyes occurred.

At baseline, the subjects were examined for dark circles under both eyes, assigned a color according to the Pantone chart and evaluated instrumentally. The improvement in the dark circles was evaluated at 2, 4, 8 and 12 weeks of treatment.

The investigator conducting these evaluations did not know the subjects' treatment.

In addition to the instrumental measurements, a subjective self-evaluation was also conducted. The panelists responded to a questionnaire evaluating the perceived improvement of the dark circles under the eyes at day 0, and 2, 4, 8 and 12 weeks using a 10 point analog scale (1 = no dark circle; 10 = very dark circle).

Inclusion Criteria

- Age: 18-55
- Fitzpatrick Skin Type I, II, III or IV
- Moderate to advanced dark circles
- Good health
- On no medication during the study and one month prior
- Willing to follow the protocol, sign informed consent and remove make-up 30 minutes prior to each visit
- Avoid sun exposure and tanning beds throughout the course of the study

Exclusion Criteria

- Currently using eye product which would interfere with results
- Sunburn or outside occupation
- Uncontrolled metabolic disease
- Pregnant, nursing or planning to become pregnant within 6 months
- Facial peel within the last 8 months
- Atopic disease or seasonal allergies
- Using OTC or Rx skin products

Table 1. The colorimeter reading for L* values in the treatment and control groups, indicating reduction of under eye dark circles

	Day 0	Week 2	Week 4	Week 8	Week 12
Mean, treatment group	51.42	53.40	63.63	66.62	68.72
% reduction, treatment		3.85	23.75*	29.56*	33.64*
Mean, control	53.67	54.73	55.87	55.87	55.87
% reduction, control		1.98	4.10	4.10	4.10

(*statistically significant from day 0 at 95% confidence level)

Table 2. Subjective evaluation by the panelists in the treatment group for dark circles under the eyes (10 point scale)

	Day 0	Week 2	Week 4	Week 8	Week 12
Mean, treatment group	6.8	6.1	5.0	4.9	4.4
% improved, treatment		10.29*	26.4*	27.94*	35.29*
Mean, control	7.0	7.0	6.8	6.8	7.1
% improved, control		0.0	2.86	2.86	-1.43

(*statistically significant from day 0 at 95% confidence level)

All measurements were performed at AMA Laboratories in New City, New York.

Results

L* values for both the treated and the untreated (control) group appear in Table 1 and the results from the subjective evaluation by the panelists are reported in Table 2.

We saw a statistically significant increase in the L* coordinate value, indicating a consistent lightening of color in the active group when compared to baseline. There was no difference in the untreated control group. No adverse effects or unexpected reactions of any kind were observed during the study in either group.

Clinical confirmation of the colorimetric measurements was obtained by the grades given by the participants evaluating the improvement over time utilizing a linear analog scale. There was good agreement in the data from the chromametric measurements when compared with that of the self-evaluation clinically.

Discussion

This study demonstrates the efficacy of a topical preparation containing 0.15% retinol (vitamin A) and 1% phytonadione (vitamin K_1) entrapped in a polymeric delivery system at lightening dark circles under the eyes, both clinically (as evaluated by the subjects) and objectively (as measured instrumentally). All 16 subjects completed the study; none developed irritation or hypersensitivity from the topical agent during the course of the study.

Many eye moisturizers exist on the market and have for many years. None of them have been shown to be efficacious in any way with regard to dark circles under the eyes. Additionally, the control group, which consisted only of a moisturizing base without vitamin A or K, did not experience any diminution of their circles, either in subjective evaluation or in the computer model.

At the present, the mechanism of action of these two ingredients is unknown. However, it has been previously reported that topical vitamin K_1 is of benefit in treating purpura,[2] and that retinol and other retinoids can enhance cell division at the basal epidermal layer.[3] Therefore, we can hypothesize that vitamin K_1 may reduce the visibility of the capillary bed under the eye, while vitamin A may accelerate the removal of melanin granules by increasing cell turnover and, consequently, desquamation.

These two combined effects may explain the observed benefits of the current formulation.

References

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