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Study of lip hydration with application of photoprotective lipstick: Influence of skin phototype, size of lips, age, sex and smoking habits

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Abstract

Objectives: To study lip hydration levels when applying a lipstick sunscreen for 3 months and to evaluate the influence of size of lips, age, sex, smoking and skin phototype.

Study design: The study group was formed by 140 volunteer subjects, one group consisting of 70 patients applying a commercial lipstick sunscreen three times a day and the other group of 70 controls in which no product was applied. The age range was 20-86 years. The influence in lip hydration levels of age, sex, phototype, size of the lips and smoking habits was studied using a Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany). Results: An increase in lip hydration was found between the basal (53.49 ± 15.259) and final (59.34 ± 14.51) Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany) measurements over the three months of treatment, with statistically significant differences with respect to the control (p=0.002). However, no statistically significant differences in lip hydration were observed with regard to age, (p=0.48), gender (p=0.876), skin phototype (p=0.653), lip area (p=0.291) and smoking (p=0.178). Conclusions: Application of a lipstick sunscreen 3 times a day for 3 months increases lip hydration.

Key words: *Corneometer, lips, lipstick sunscreen, hydration, age.*

Introduction

The lips, in close connection with the perioral skin, have important physiological functions. They are one of the most alluring features on the face, and can express one's emotional status during verbal and psychological communication (1,2). The histology of the lips is well described, the vermilion area is covered by a thin stratum corneum, made up of orthokeratotic cells of a shorter turnover than normal stratum corneum (3,4).

Various methods for determining the hydration state of the stratum corneum (SC) have been summarized by Flurr et al. (5). The Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany) is a capacitive device for measuring the hydration of the SC and gives important information on the biophysical properties and function of the skin barrier. With an adequate amount of water in the SC, the skin maintains an intact barrier function (6-10). The lips and the perioral region are poorly protected from the sun and this area is continually exposed to solar radiation, the surface of the lower lip receives the highest exposure to ultraviolet light in the whole facial region (4,11,12). Current society has established the suntan as a fashion symbol of health, beauty and social status. However, investigations carried out over recent years show that excessive exposure to solar radiation constitutes a serious danger to the skin as it causes premature cutaneous ageing and can lead to the appearance of malignant lesions (13). Even so, the importance of photoprotecion with lipsticks as part of a solar protection strategy is sometimes underestimated. The International Agency for Research on Cancer (IARC) does not recommend the use of lip protection, although it does recognize that ultraviolet rays are a factor of higher risk for the development of premalignant and malignant lip lesions (13).

The aim of this study was to investigate lip hydration levels using Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany) when applying a lipstick sunscreen three times a day for 3 months in function of lip size, age, sex, smoking, and skin phototype.

Material and Methods

The study was carried out in the Odontology Clinic, Department of Oral Medicine, at the University of Murcia, after approval from the University Bioethics Committee. The study was carried out between January and May 2008. The study group comprised 140 randomly-selected volunteer subjects. Group A was formed by 70 patients applying lipstick sunscreen 3 times a day, and group B by 70 controls without lipstick sunscreen. The age range was 20-86 years. Volunteer patients without lip pathology, skin lesions, or clinical signs of lip dryness were included. Patients younger than 18 years, pregnant, with lip pathology or active skin lesions, psychological inability to follow the recommended instructions or using another type of lipstick sunscreen during the study period were excluded. Once informed and agreeing to participate in the study, the data were recorded by a single investigator.

Measurement protocol

The patient was required to rest for 10-20 minutes before the analysis and not to use any cosmetic product on the lips for at least 2 hours beforehand. For the measurements we used a Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany) which measures the electrical capacitance of the skin surface in arbitrary units. The measurements were made in a room at a temperature of 20° C and a relative humidity between 40 and 60%, in Murcia, latitude 37° 50' North and 01° 30' West. To evaluate hydration, 3 repeated measurements were made with the Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany) on the same area of the lower lip, allowing 5 seconds between each measurement and calculating the mean. To carry out the measurement, the sensor head is held at right angles to the lower lip, applying only the pressure exerted by the spring in the probe head (Fig. 1). The sensor takes the measurement when in contact with the lip, and uses an audible signal to indicate when completed. To verify the accuracy of the Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany) and the penetration capacity of the electric field, the instrument was recalibrated after prolonged use. The Corneometer measurements were made on the day of inclusion in the study and at 3 months.

Fig. 1. Lip hydration measurement using Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany). To carry out the measurement, the sensor head is held at right angles to the lower lip, applying only the pressure exerted by the spring in the probe head.

We used a commercial lip protector Interapothek SPF 30® (Laboratories Brun, Asturias, Spain), with a firm consistency and protection factor of 30. The protector is composed of the following ingredients (Microcrystalline wax, Paraffin, Cocoa, Zinc Oxide, Castor oil, Octyldodecanol, Lanolin, Methylparaben, Ethylparaben, Butylparaben, Propylparaben, Isobutylparaben, Vitamin C, Tocopheryl Acetate, Lecithin, Edta, Aromas). The participants were instructed to carry the protector with them and to apply it 3 times a day.

Measurement of protected lip area

In order to evaluate the area of the lip skin usually protected by lipstick, the test subject applied a coloured lipstick (Lip red L´Oreal Laboratoire Pharmaceutique, Paris, France) carefully to the lip skin while standing in front of a mirror. Afterwards, the subject kissed a sheet of white photocopy paper, which lay on top of a finely porous sponge. Before each new application the lip surface was carefully cleaned. The subjects were instructed to fold their arms behind their back and to touch the paper with closed and relaxed lips. The 70 participants made 10 measurements each. The kissing imprint was outlined, and the area of the lips calculated by scanning these outlines for each patient and measuring the surface area with the aid of an Imaging program. Analysis was carried out using MIP 4.5® software (CID, Barcelona, Spain) (Fig. 2).

The level of compliance was evaluated by weighing the protectors before giving them to the subject and then at the conclusion of the study, thus ascertaining the quantity used.

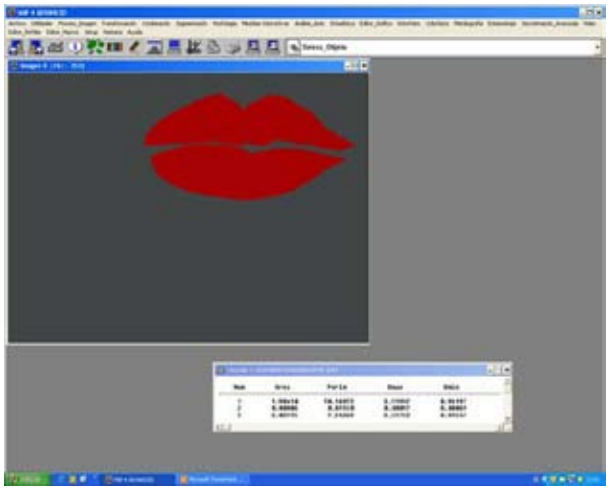

Fig. 2. The kissing imprint (10 by patient) on top of a finely porous sponge were scanned for calculate the total lips area using an imaging programme. Analysis was carried out using MIP 4.5® software (CID, Barcelona, Spain).

Statistical analysis

Data were analyzed using the SPSS 12.0 program (SPSS® Inc, Chicago, IL, USA). A descriptive study was made of each variable. The associations between the different qualitative variables were studied using Pearson's chi squared test and the Student's t-test was used for quantitative variables (for data showing a non-skewed distribution). The Kolmogorov-Smirnov normality test and Levene variance homogeneity test were applied; data with a skewed distribution were analyzed using a non-parametric ranking test. We used the Kruskal-Wallis test (for more than two samples) and the Mann-Whitney U-test for two independent samples. Values of $p \leq 0.05$ were accepted as significant.

Results

Our study was formed by a sample of 140 individuals, 70 study and 70 control. The mean age of the whole sample was 39.64 ± 13.811 with a range of 20 -86 years. The characteristics of the study and control groups were similar with respect to age, sex, level of education, skin phototype, mean hours of annual sun exposure and lip hydration measured with the Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany) in arbitrary units (Table 1). The lipstick sunscreen was well tolerated by the 70 subjects during the three months of the study, and no adverse effects, including allergic or irritative reactions, were observed. None of the subjects abandoned the study.

In the group applying the lip protector, the lip area, perimeter and diameter of both upper and lower lip were evaluated, finding a total lip area in cm2 of 6.55 ± 1.33 (4.04-10.98). When studying the relationship between the total size of the lips and the increase in lip hydration over the 3 months of treatment, we found that although the smallest increase in hydration was produced in larger lips, there were no statistically significant differences (p=0.291) (Table 2).

When studying by age groups, we observed no significant differences for age, sex and increase in lip hydration after 3 months of protector application (Table 2).

With respect to smoking, in the group applying the lipstick sunscreen there were 20 smokers (24.3%) and 50 non-smokers (75.7%) finding no statistically significant relationship between smoking and lip hydration (p=0.178) (Table 2).

When evaluating lip hydration measured with the Corneometer, we observe that the study group increased lip hydration by 6.5 points, however it had reduced in the control group, with statistical significant differences ($p<0.001$).

Table 1. Homogeneity of samples (study and control groups) with respect to characteristics: age, sex, sociocultural level, skin phototype, basal Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany) measurement and stated hours of annual sun exposure. (Student's t and Pearson $\chi 2$ tests).

Sample characteristics	Groups		p-*value*
	Study (n=70)	Control (n=70)	
Age: (X±SD)	38.10 ± 11.54	41.16 ± 15.69	0.191
Gender			0.583
Male: n (%)	20 (28.57)	23 (32.86)	
Female: n (%)	50 (71.43)	47 (67.14)	
Education			0.337
Primary: n (%)	7 (10)	8 (11.43)	
Secondary: n (%)	14 (20)	21 (30)	
University: n (%)	49 (70)	41 (58.57)	
Phototype			0.449
T. II: n (%)	11 (15.73)	9 (12.85)	
T. III: n (%)	13 (18.57)	8 (11.45)	
T. IV: n (%)	16 (22.85)	23 (32.85)	
T. V: n (%)	30 (42.85)	30 (42.85)	
Initial lip hydration: (X±SD) (au)	53.49 ± 15.25	54.73 ± 17.27	0.652
Hours of annual sun exposure: (X±SD)	217.97 ± 331.34	157.71 ± 179.17	0.183

Note: au = arbitrary units. No participant had skin phototype I or VI

Discussion

The vermilion border of the lips (lip for short) constitutes one of the most outstanding parts of the face because of its features that are distinct from the surrounding skin.

Our results show that using lip protection 3 times a day produces an increase in hydration at 3 months with statistically significant differences ($p<0.001$) with respect to those that do not, and finding no significant differences for age, sex, skin phototype, lip size and annual amount of exposure to the sun.

An aging population, with more free time and exposure to ultraviolet (UV) solar radiation, has produced an increasing demand for protecting the skin against the detrimental effects of UV exposure (11,12). The present study was carried out in the region of Murcia. The measurements were always made under the same conditions; in the morning at a temperature of 20ºC and relative humidity of 40-60%.

Cutaneous ageing is a continuous process involving intrinsic ageing (a universal and inevitable alteration attributed to the passage of time) and extrinsic ageing (the superposition over intrinsic ageing of changes attributed to chronic solar exposure and other environmental factors, among which, smoking) (2,4). Smoking also provokes skin changes. Blood flow alteration leading to temperature drop can be observed immediately after smoking. Collagenous and elastic fibre degradation constitute another important modification related to smoking. Our results found no statistically significant differences between smokers and non-smokers for lip hydration ($p=0.178$). Leung and Harvey in 2002 (14) concluded that the magnitude of smoking effects on the ageing process is so great that if a person smokes 20 cigarettes a day, his or her skin age could increase by up to 10 years. Kadunce in 1991 (15), after controlling for age, sex, solar exposure and pigmentation, observed an independent association between smoking and wrinkles that shows a significant tendency with the increase in tobacco load: smokers of more than 50 packs per year had a 4.7 times greater chance of developing wrinkles than non-smokers. Kadunce (15) also observed that solar exposure was associated with the development of wrinkles. The effects of cigarette smoking and exces-

Table 2: Lip hydration measured with the Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany) over 3 months of treatment in the study group, with respect to age, gender, phototype, lip area, hours of sun exposure and protector consumption. (Kruskal-Wallis H and Mann-Whitney U tests).

Variable n (%)	Evolution of lip hydration (n =70) in arbitrary units over three months of treatment: (*Mean and range*)	p-*value*
Age (years)		0.483
<35: 33 (23.6)	2.36 (-19.37 to 42.47)	
35-45: 24 (17.1)	3.61 (-25.46 to 40.07)	
>45: 13 (9.3)	8.66 (-22.00 to 49.33)	
Sex		0.876
Male: 20 (28.57)	3.52 (-25.46 to 28.70)	
Female: 50 (71.43)	3.58 (-22.00 to 49.33)	
Phototype		0.653
T. II: 11 (15.73)	4.57 (-11.94 to 42.47)	
T. III: 13 (18.57)	-1.51 (-13.43 to 28.70)	
T. IV: 16 (22.85)	4.56 (-25.46 to 49.33)	
T. V: 30 (42.85)	0.43 (-16.30 to 40.07)	
Smoking		0.178
Non-smoker	3.81(-11.87 to 40.07)	
Smoker	2.41(-2.54 to 49.33)	
Total lip area		0.291
<6: 26 (18.6)	3.58 (-19.37 to 49.33)	
6-7: 20 (14.3)	4.98 (-15.97 to 42.47)	
>7: 24 (17.1)	-0.82 (-25.46 to 28.70)	
Total hours annual sun exposure		0.771
≤120: 28 (20)	4.76 (-22.00 to 38.53)	
121-240: 32 (22.9)	2.90 (-19.37 to 49.33)	
>240: 10 (7.1)	-1.59 (-25.46 to 42.47)	
Total consumption of lip protector (grams)		0.647
<1.35: 24 (17.1)	4.51 (-15.97 to 49.33)	
1.35-2.35: 23 (16.4)	3.66 (-19.37 to 35.37)	
>2.35: 23 (16.4)	2.47 (-25.46 to 42.47)	

sive sun exposure on wrinkling were multiplicative.

In solar protection it is necessary to consider the differences in skin type. The skin phototype was classified in accordance with Fitzpatrick16. This study included subjects with phototypes II, III, IV and V, the majority being phototype V (42.85%) / In the present study, the skin phototype was classified in accordance with Malvy J (16), and included subjects with phototypes II, III, IV and V, the majority being phototype V (42.85%) finding no statistically significant between differences lip hydration and skin phototype.

We should consider the differences in the nature and thickness between the skin and the lips. In short, lip epithelium thickness would increase from the external part to the most internal mucosal part. Normal skin epidermis would gradually change from ortho-keratinized epithelium of the vermilion border to para-keratinized thick intermediate tissue (pre-mucosal area) and then to non- or para-keratinized mucosa. The incomplete formation of the corneal layer of the surface of the lips may be responsible for the decreased barrier function. The presence of water is an essential condition for the maintenance of normal SC structure and function (3,4,12). Dryness or excessive hydration of the SC may cause dermatitis and other skin diseases. Caisey et al. (17) investigated and compared the hydration level in different areas of the lip by means of capacitance measures using the Skin Chip® (ST Microelectronics, Berkley,

CA, USA), they found the inner part of the lip mucosa is less hydrated than the external. These unexpected findings could be related to the presence of a pre-mucosal area whose structure is clearly different from the vermilion border. Lévêque and Goubanova (1) studied lip hydration by measuring capacitance and also analyzed the lip surface patterns obtained from capacitance map images generated with Skin Chip® (ST Microelectronics, Berkley, CA, USA). They found that both lips are different in terms of dryness, with the lower lip being drier than the upper.

The measurement of skin surface hydration has gained considerable interest in recent years because the water content of the SC influences various physical characteristics of the skin such as barrier function, drug penetration, and mechanical properties. The different noninvasive hydration measurement systems, and the information they provide, are not same; while the measurement result with the MoistureMeter® (Delfin Technologies, Kuopio, Finlandia) is dependent both on the hydration of the SC and the thickness of the dry layer of the SC, the Corneometer 825® (Courage & Khazaka Electronic GmbH, Cologne, Germany) provides a hydration value for a constant depth, (in the first 10-20 μm of the stratum corneum) (5,7,8,10).

We should emphasize the high motivation of the participants since there was no abandonment, in spite of the 3 months duration of the study. Likewise application of the protector produced no adverse effects. Regarding the level of compliance, this was evaluated by weighing the protector before giving it to the subject and later when the study had concluded, thus checking the quantity consumed. According to Gaughan MD (18) a protector with a high area density should preferably be used, although low density products have greater consumer acceptance, stating that this maybe be one of the reasons for which patients are poorly protected (18).

It is important to instruct the general public about the need for protection from the adverse effects of solar radiation, to modify behavior to avoid exposure at times of highest radiation, using appropriate clothing for protection, and if necessary to use correctly applied photoprotection. The European Cosmetic Toiletry and Perfumery Association (COLIPA) (19), suggest a protection area density of 2 ± 0.2 mg/cm-2. The importance of using protection with a high protection factor as well as frequent reapplications is well-known. However photoprotection with lipsticks as part of a solar protection strategy is sometimes underestimated.

Our results show that using lipstick sunscreen three times a day increases hydration after 3 months with statistically significant differences ($p<0.001$).

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