J. Cosmet. Sci., 49, 175–181 (May/June 1998)

The greasiness of moisturizers: A methodological study

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Accepted for publication May 15, 1998.

Synopsis

The aim of this study was to investigate if simple blotting can be used to provide reproducible quantitative data on the amount of excess moisturizer. Simple blotting of excess moisturizer was studied, changing the volume applied, the time allowed for absorption (before blotting), the time allowed for blotting, the area studied, the region studied, the blotting pressure, and the type of blotting paper. The coefficient of variation was calculated for each parameter. A standardized procedure is described: application of 50 µl/25 cm^2 of moisturizer on volar forearm skin. After 20 minutes blotting was performed with a 25 cm^2 (5 by 5 cm) piece of ordinary filter paper with pores of medium size. Blotting was done for 120 seconds with firm pressure applied by a rubber-gloved hand. The method had a coefficient of variation of 23% and was significantly correlated to skin surface lipids as measured by the Sebumeter ($p < 0.0001$). Different commonly used moisturizers, as well as a protective cream and a simple gel, were compared using the new method, and the results were found to be in accordance with the clinical impression of cream greasiness. It appears to be possible to quantify non-absorbed moisturizer on the skin surface with an accuracy similar to that of other biophysiological methods. This simple method offers an improved possibility to classify moisturizers according to cosmetic acceptability and to quantify absorption for a better assessment of relative moisturizer efficacy.

INTRODUCTION

Moisturizers contain varying amounts of water, which evaporate shortly after application, leaving a lipid residue (1). It is speculated that the cumulative effects of moisturizers are due to the absorption of this lipid residue, while short-term effects are mostly due to simple hydration by the water phase of the moisturizer.

The effects of any moisturizer is, however, also determined by the actual pattern of use by the individual, i.e., how is it applied and in what context, e.g., before clothing, after bathing, etc. Little is known about this, but it is speculated that the most common practical use involves application immediately prior to dressing, i.e., that only a short time is available for absorption of the applied moisturizer. A considerable excess residue of moisturizer lipids are thus left to be absorbed by the clothes. This unabsorbed excess represents a measure of the greasiness of the moisturizer that may affect actual use and cosmetic acceptability. We therefore describe a simple method to study this problem.

In addition, a quantification of the unabsorbed excess is necessary to identify the absorbed or active proportion of the moisturizer, which is necessary in any future estimates of the relative efficacy of different moisturizers, i.e., effect per milligram of absorbed cream.

MATERIALS AND METHODS

All testing was conducted on healthy volunteers following informed consent. Preliminary methodological studies were carried out using one type of moisturizer only (Locobase®, Yamanouchi Pharma, Leidendorp, Netherlands), while different commonly used moisturizers, a protective cream, and a simple gel were used in the final study (see Table I).

The basic hypothesis of the study was that a standardized collection of excess or residue following a single application is a reliable method for the study of moisturizer greasiness *in vivo*. The basic design involved application of a known volume of moisturizer to a standardized area of volar forearm skin, allowing time for evaporation of the water phase of the moisturizer, and finally absorption of excess moisturizer into a standard laboratory filter paper. The increased weight of this filter paper then reflects the amount of excess moisturizer (=blotted weight) according to the following simple equation:

$$\text{Blotted mg} = \text{applied mg} - (\text{evaporated water mg} + \text{residue after blotting mg} + \text{absorbed by skin mg})$$

The following preliminary studies were carried out in healthy volunteers to assess the variability of this simple method.

Table I
Moisturizers Used and Their Declared Contents

Brand and producer	Constituents	Residue % (mean; 95% confidence interval)
Vaseline®, Johnson & Johnson, New Jersey	Petrolatum	48.2 (43.4–52.9)
Locobase®, Yamanouchi Europe B.V., Leiderdorp, Netherlands	Cetearyl alcohol, ceteth-20, mineral oil, petrolatum, citric acid, sod. citr. anhydr., ethylparaben, purified water	37.9 (34.6–41.2)
Decubal creme®, Dumex A.S., Denmark	Isopropyl myristate in glycerin, purified lanolin, dimeticomin cetolatum, polysorbate 60, sorbic acid, purified water	19.6 (17.8–21.4)
Clinique Moisture-On-Call®, Clinique Laboratories, New York	N/A	14.7 (13.3–16.0)
Nivea Visage®, Beiersdorf OY, St. Karins, Finland	Liposome complex 10%	14.5 (13.0–16.0)
Kerodex®, ArSiMa, Copenhagen, Denmark	Paraffin products, sodium phosphate, emulgators, iron oxides, methylparaben	9.8 (7.9–11.7)
Gel	Cellulose gum, glycerin, water, benzalconium chloride, disodium EDTA	1.5 (0.6–2.3)

N/A = no data available.
Unabsorbed % is the percentage of the applied cream that could be blotted from the surface of the skin after 20 minutes, and can be seen as an expression of the greasiness of the cream.

VOLUME APPLIED

The applications studied were 25 µl/25 cm^2, 50 µl/25 cm^2, 100 µl/25 cm^2, and 150 µl/25 cm^2. The volume was carefully spread with a rubber-gloved finger. The finger covers were weighed after application to ensure that a no major differences occurred due to the moisturizer adherent to the cover. Blotting was done after 20 minutes with the blotting paper (25 cm^2) pressed against the skin with a rubber-gloved hand for two minutes (n = 15).

TIME ALLOWED FOR ABSORPTION

A previous study has suggested that the water phase evaporates within 15 minutes of a single application of a moisturizer (1). A standard amount of moisturizer (50 µl/25 cm^2) was applied, and blotting was done after 20, 40, 60, 120, and 180 minutes. Blotting was done using standard-sized blotting paper (25 cm^2) and an even, firm pressure from a rubber gloved-hand for two minutes (n = 10).

TIME ALLOWED FOR BLOTTING

A standard amount of moisturizer (50 µl/25 cm^2) was applied, and blotting was done after 20 minutes. Blotting was done using standard-sized blotting paper (25 cm^2) and a rubber-gloved hand for 30, 45, 60, 90, or 120 seconds (n = 15).

AREA STUDIED

The same density of moisturizer was applied in areas of different size (50 µl/25 cm^2 and 200 µl/100 cm^2), and blotting was done after 20 minutes. Blotting was done using standard-sized blotting paper (25 cm^2) and a rubber-gloved hand for 120 seconds (n = 15).

REGION STUDIED

Dry skin (volar forearm) and sebaceous skin (upper back) were compared. Moisturizer was applied in different areas (50 µl/25 cm^2), and blotting was done after 20 minutes. Blotting was done using standard-sized blotting paper (25 cm^2) and a rubber-gloved hand for 120 seconds (n = 15).

BLOTTING PRESSURE

Moisturizer was applied (50 µl/25 cm^2), and blotting was done after 20 minutes. Blotting was done for 120 seconds either with a rubber-gloved hand or with a 1-kg weight (n = 15).

TYPE OF BLOTTING PAPER

The blotting capacity of filter paper with different mean pore sizes from 0.4 to 5.0 µm was compared (standard, small, medium, big; filter type BB, OOH, OOK and OOR, Munktell, Sweden). Moisturizer was applied (50 µl/25 cm^2), and blotting was done after 20 minutes. Blotting was done for 120 seconds with a rubber-gloved hand (n = 15).

Optic methods have previously been used to study skin surface lipids. Using the proposed amount of moisturizer, direct optical measurement of skin surface lipids was impossible, as the results were beyond the range of the apparatus. Skin surface lipids were therefore measured using the Sebumeter® (Khazaka & Courage, Cologne, Germany) after blotting. Blotting is not an absolute process and is modified not only by the method used in the actual blotting, but also by the dynamic absorption of the lipids into the superficial compartment of the skin. Using the Sebumeter for further measurement of skin surface lipids after blotting may therefore add validity to the proposed method by analogy with previously described technology. Weighing was done using a Sartorius Basic scale (0.001–100 g) (Sartorius, Göttingen, Germany).

Using this method, the greasiness of five commonly used creams on the Danish market was studied and compared to that of a protective cream, a gel, and an untreated control area. Each measurement was performed in triplicate and the mean value used in further calculations. Descriptive statistics as well as non-parametric statistics (Spearman rank correlation and Kruskall-Wallis paired comparisons) were used.

RESULTS

Methodological variation was described by the coefficient of variance (=SD*100/mean), which was found to be in the range of 8%–44% (see Table II). A large coefficient of variation was seen when small amounts of cream were present, e.g., if only a little had been applied or if the time given for absorption was long. A standard procedure was chosen by selecting a setup that was practical to manage and in which all elements had a low coefficient of variance. The standard procedure was: application of 50 µl/25 cm^2 moisturizer on volar forearm skin. After 20 minutes blotting was done with a 25 cm^2 (5 by 5 cm) piece of ordinary filter paper with pores of medium size. Blotting was done for 120 seconds with firm pressure applied by a rubber-gloved hand. The final chosen standard procedure had a coefficient of 23%. The amount of excess residual cream following a single application of the different moisturizers, protective cream, and gel is shown in Table I. Vaseline® left the highest proportion of the applied cream as residue, while the gel tested left only little residue, which was in good accordance with the clinical impression of their greasiness. Because absorption into the skin is a relative rather than absolute step, complete reabsorption by blotting is not possible in any process resembling actual use. The overall correlation between blotted moisturizer and unblotted residual skin lipids as measured by the Sebumeter is shown in Figure 1, which shows a significant positive correlation between the two methods ($p < 0.0001$, Spearman rank correlation).

DISCUSSION

Our observations suggest that simple blotting under standardized conditions is a reliable method for quantification of non-absorbed excess moisturizer. The methodological variation as assessed by the coefficient of variance is within the same range as many recognised biophysical measurements of the skin, and this simple method may therefore be of use in future studies of moisturizer greasiness and efficacy.

Table II
Coefficients of Variation for Different Variables

Parameter studied	Changes	Coefficient of variation (%)
Volume of moisturizer	25 µl/25 cm^2	35
	50 µl/25 cm^2	14
	100 µl/25 cm^2	23
	150 µl/25 cm^2	8
Area	25 cm^2	14
	100 cm^2	22
Post-application time	20 min	23
	40 min	18
	60 min	12
	120 min	34
	180 min	44
Blotting time	30 s	31
	45 s	11
	60 s	21
	90 s	12
	120 s	8
Load on blotting	Rubber-gloved hand	17
	1 kg	17
Anatomical region	Volar forearm	13
	Back	11
Blotting paper	OOH (small pores)	20
	OOK (medium pores)	18
	OOR (large pores)	20
	BB (standard, mixed-size pores)	20

Previous studies have used the Sebumeter for the assessment of skin surface lipids (1). Actual use of moisturizers or other creams, however, involves the application of amounts of lipids that are in excess of the range of the optic method, and Sebumeter measurements were therefore performed after blotting. Blotting is modified by many factors, including the film-forming capacity of the lipids and the steady state achieved by the diffusion of lipids in and out of the superficial compartment of the skin. Using the Sebumeter for further measurement of skin surface lipids after blotting therefore adds validity to the proposed method. A significant correlation between the two methods was seen ($r_s = 0.53$), although considerable scatter was noted on single measurements, suggesting the two methods give mutually supportive rather than mutually exclusive results and should perhaps be used together. Using the proposed method to compare the greasiness of commonly used moisturizers, protective creme, and gel also showed that the results appear to be in good accordance with the general clinical impression, although a panel of test persons were not used in this study. Of the moisturizers examined, Vaseline® and Locobase® leave the most residue, while gel and the cosmetic moisturizer from Clinique® leave the least residue.

The dry or lipid content of each moisturizer is, of course, a key factor. Vaseline® has a very high dry content, while moisturizers developed primarily for cosmetic use and gels have a high water content. This would *a priori* suggest that the latter products exert their

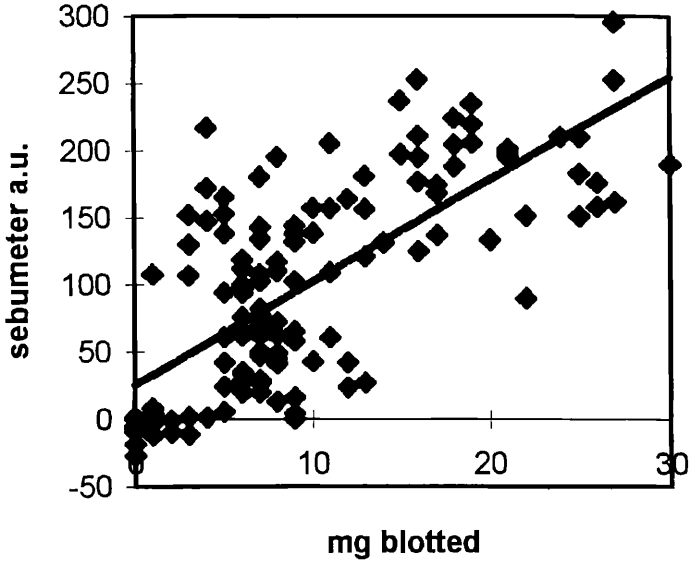

Figure 1. Correlation between the amount of moisturizer blotted and the post-blotting skin surface lipid as measured by the Sebumeter (R^2 = 0.5272).

effect mainly through direct hydration of the skin, while the greasier products act through lipidization. The previous notion of an occlusive effect has not been substantiated (2). The proposed simple method makes practical testing of greasiness possible. Many factors are involved in this practical quality of moisturizers, and it has been proposed that differences in emolliency may partly be predicted by the emollients used. Brand and Brand-Garnys have suggested emolliency to be a function of the inherent spreadability and lubricity of moisturizer constituents (4). These qualities can be predetermined for a reduced development time of actual products, and the final results can potentially be verified by our proposed method. The exact formulation is, however, also of obvious importance, and, for example, the use of liposomes may increase absorption as reflected by the lower amount of unabsorbed residue in the Nivea® moisturizer.

The efficacy of moisturizers is of immediate practical interest, and it is speculated that the effects vary according to the absorption of either the water or lipid phase. A previous study has suggested that the water phase evaporates within the first 15 minutes of application and that longer-term effects, i.e., after ten minutes or more, are therefore more likely to be due to absorption of the lipid phase (1).

The protective cream studied (Kerodex®) showed a picture dissimilar from that of the moisturizers. This cream is designed to leave an adherent and water-protective layer on the skin surface (2). In clinical use there is an impression of occlusive "residue," but our investigation shows that actual greasiness is very low, as would be required for any practical use of a protective cream.

Practical use of moisturizers suggests that a considerable residue of excess unabsorbed moisturizer is left on the surface of the skin to be absorbed by the clothes or worn off at no benefit to the user. This unabsorbed excess is greasy and may affect frequency of use and general cosmetic acceptability of any given moisturizer. Quantification of this unabsorbed moisturizer therefore offers quantitative and clinically relevant data on the

cosmetic acceptability, as well as an impression of the absorbed amount, of a given moisturizer. The simple methodology studied in this paper reveals that it is possible to measure the non-absorbed moisturizer with an accuracy similar to that of other recognized biophysical methods. This approach therefore offers the possibility of studying actual absorption of moisturizers and other creams and subsequently better assessment of moisturizer efficacy per absorbed milligram. In addition, the quantification of non-absorbed residue on the skin surface has implications for the cosmetic acceptability of new preparations.

ACKNOWLEDGMENTS

The authors wish to thank Eva Hofmann, Ingelise Pedersen, Helle Thrane, and Benedicte Wulf for their excellent technical assistance.

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