The Effect of pH on Sodium Lauryl Sulfate Irritancy Potential

— Non-invasive multiple parameter measurement —

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Five volunteers received patch tests with 5% sodium lauryl sulfate (SLS) in solutions of differing pH. The irritant effect was monitored by visual scoring as well as by a laser Doppler velocimeter, evaporimeter, cutometer, and colorimeter.

The non-invasive methods used in this study with the exception of the cutometer were effective in the evaluation of skin irritation. No significant differences in the skin responses to SLS in different pH solutions were found either clinically or by the non-invasive methods used for quantification. It was concluded that the pH of SLS is not a major factor in the degree of skin irritation produced by SLS. (Ann Dermatol 2:(1) 13-16, 1990)

Key Words: Colorimeter, Cutometer, Evaporimeter, Laser Doppler velocimeter, pH, Sodium lauryl sulfate

Irritant contact dermatitis is a common clinical problem, far commoner than allergic contact dermatitis. Unlike allergic contact dermatitis, its mechanism is poorly understood and its management can be very difficult. Recently, a considerable amount of experimental work in the field of irritant contact dermatitis has been done. Patch testing on human skin with sodium lauryl sulfate (SLS) has become a major method of testing for irritancy. However, the quality of SLS used has varied markedly causing a great variation in the irritancy potential.

The use of additional assessment parameters and their correlation to one another could provide relevant new information. Also, the study of cutaneous inflammatory reactions could be served by assessment methods which can quickly and relaiably detect changes at an early stage.

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Therefore, this study was undertaken to evaluate the influence of pH on SLS irritancy potential by visual scoring, by estimation of transepidermal water loss with an evaporimeter, by estimation of dermal capillary blood flow with a laser Doppler velocimeter, by measurement of color difference and density difference with a colorimeter and by measurement of elasticity and plasticity of the skin by a cutometer.

MATERIALS AND METHODS

Five healthy volunteers participated in the study; all were males and had a median age 27.4 years (range 25-30 years). Informed consent was obtained from all volunteers. A 48-hour occlusive patch test was prepared with 5% sodium lauryl sulfate (Sigma Co.) in buffered and unbuffered solutions (pH 5 HCl, pH 7 distilled water, pH 9 NaOH). Ten uL of 5% SLS was measured onto two layers of filter paper that were placed inside a large aluminum Finn Chamber® (12mm in internal diameter, 1mm in depth, Epitest, Helsinki, Finland). The Finn Chambers were fixed to the skin by non-

occlusive tape (Scanpor®, Norgesplaster Als, Oslo, Norway).

Patch tests were placed symmetrically on the volar side of the forearms. The SLS patches were placed on the right forearm and the left forearm was used as a control site and their placement was not made known to the observer. Test chambers were removed after 48 hours and the test reactions were evaluated 30 minutes after removal to allow any tape reaction to resolve.

The reactions were evaluated by clinical grading, according to the following scale: 0-no reaction; 1-slight scaling or very weak erythema; 2-weak erythema, possibly slight infiltration; 3-marked erythema, infiltration, possibly vesicles and crusting; 4-pronounced erythema, infiltration, possibly vesicles, bullae, pustules and/or pronounced crusting.

To quantify the skin response further, the following non-invasive bioengineering methods were used.

Transepidermal water loss (TEWL) was measured by an evaporimeter (Servo Med, Stockholm, Sweden). The methodology of evaporimeter has been described in detail by Nilsson.[1] A laser Doppler velocimeter (Perimed, Stockholm, Sweden) was used for measuring the cutaneous blood flow. Operating principles for this instrument are described in Nilsson et al.[2] Skin elasticity and plasticity was measured by a cutometer (Courage+Khazaka, Cologne, W. Germany). Skin color and density difference was measured by a

Table 1. Degree of the skin irritation of SLS

Subject No.	Clinical grading		TEWL (mg/cm²/hr)		Blood flow (mV)		Skin color	
	5% SLS	Control	5% SLS	Control	5% SLS	Control	5% SLS	Control
1	0.8	0	19.3	−1.4	14.3	−1.3	4.2	0.1
2	2.3	0	23.0	−2.6	33.0	−0.7	4.5	0.3
3	3.0	0	31.7	−3.0	67.7	0	7.0	0.3
4	3.0	0.3	47.4	−0.5	97.0	3.3	11.4	1.2
5	1.3	0	21.8	1.7	67.7	−0.7	6.9	0.7
P value	P<0.05		0<0.05		P<0.05		P<0.05	

Each value was calculated as (diff* in pH 5+ diff in pH 7+diff pH 9)/3
*Difference between measurements before and after application of SLS.

Table. 2. Effect of pH on the irritation of SLS

Subject No.	pH	Clinical grading		TEWL (mg/cm²/hr)		Blood flow (mV)		Skin color	
		5% SLS	Control	5% SLS	Control	5% SLS	Control	5% SLS	Control
1	5	1.0	0	20.1	1.0	18	−2	3.89	0.63
	7	1.0	0	28.3	−2.4	21	−1	4.42	0.18
	9	0.5	0	9.5	−2.7	4	−1	4.24	−0.37
2	5	3.0	0	27.6	−2.4	65	0	5.20	0.50
	7	3.0	0	22.1	−2.9	21	−2	4.84	0.82
	9	1.0	0	19.2	−2.6	13	0	3.50	−0.28
3	5	4.0	0	39.0	−2.2	102	0	9.57	0.16
	7	3.0	0	20.5	−4.1	36	0	4.42	0.61
	9	2.0	0	34.6	−2.8	65	0	7.12	0.20
4	5	4.0	0	62.8	1.2	120	2	12.03	2.26
	7	2.0	0.5	32.9	−1.2	72	6	9.43	0.66
	9	3.0	0.5	46.4	−1.4	99	2	12.62	0.82
5	5	1.0	0	13.8	4.1	58	2	5.77	0.73
	7	1.0	0	23.4	1.8	62	0	6.80	0.60
	9	2.0	0	28.1	−0.8	38	−4	8.01	0.88

P value is statistically not significant.

colorimeter (Minolta, Tokyo, Japan)

All visual scoring and instrumental recordings were performed three times by the same investigator. The laboratory temperature was kept in the range 19-22°C, the relative humidity was 35-55%. Disturbances in the laboratory during measurements were kept to a minimum.

Statistics

The Wilcoxon matched-pairs tests were used when comparing the different qualities of SLS. The chosen level of significance was $p<0.05$.

plasticity measured by the cutometer revealed no consistent results (data not shown).

Table 2. shows the recorded values for each parameter in different pH solutions (pH 5, pH 7, pH 9). We did not feel that the pH of the SLS had any influence on the irritancy potential. (Fig. 1.)

DISCUSSION

Sodium lauryl sulfate (SLS), an anionic surface active agent used as an emulsifier in many pharmaceutical vehicles, cosmetics, foaming dentifrices and even food, is well known as a standard skin

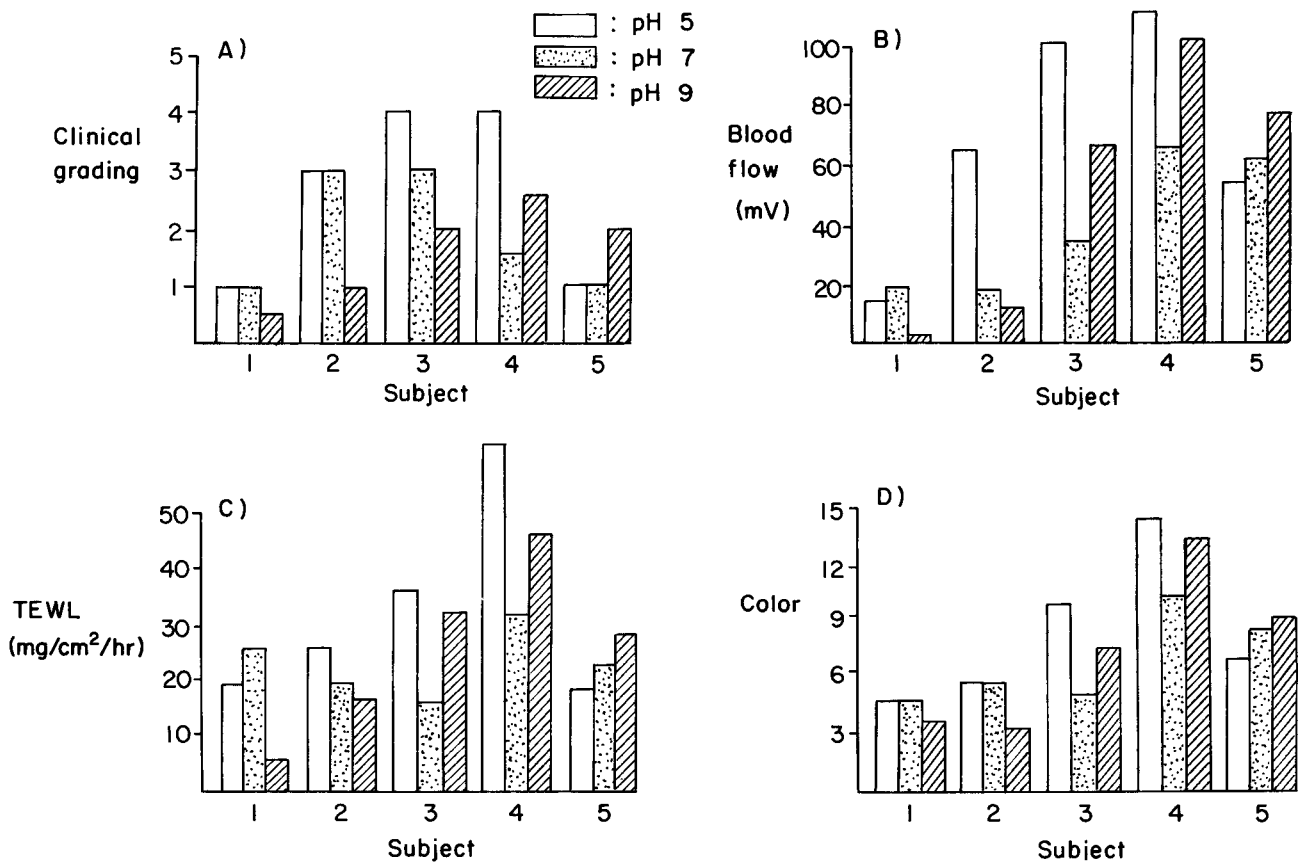

Fig. 1. Histogram of the skin irritation caused by SLS in different pH solutions. Each value indicates the difference between 5% SLS and the control in Table 2. A) Clinical grading B) Laser Doppler velocimeter C) Evaporimeter D) Colorimeter

RESULTS

The results from clinical testing are shown in Table 1. The clinical grading correlated well with the results of the evaporimeter, laser Doppler velocimeter, and colorimeter. Skin elasticity and

irritant. But, the great variation in the SLS solutions used suggested that this variation might result in a difference in the irritancy potential. When studying the literature on the subject, the concentration of SLS used varied markedly from 0.25% to 10%[3-6] and there were individual variations in

skin sensitivity, regional variations,[3] climatic and seasonal variations[3] and the volume applied to the skin.[7]

Previously, we studied the relation between visual scoring and skin blood flow of irritation reactions and the optimum irritant concentration to be used as a positive irritant control in routine patch tests.[8] There was a good correlation between visual scoring and skin blood flow using the laser Doppler velocimeter. We found that a five percent SLS could be used as a positive irritant control in routine patch testing.

In the current study, 5% SLS is used to evaluate the effect of pH on SLS irritancy potential as measured by non-invasive bio-engineering methods. The laser Doppler velocimeter records the increased blood flow which in most instances correlates well with the visible changes of erythema and edema in the irritant reaction.[9,10] This method may, however, not always quantitate the degree of reaction.[11, 12] Good agreement has been reported between the laser Doppler velocimeter and the evaporimeter in irritant reactions to SLS in humans.[13] Non-invasive methods used in this study have shown a relatively good correlation with clinical grading except for the cutometer (data not shown). There was an exception, however, in the discrepancy between the visual grading and non-invasive method findings in subject No. 4. The explanation may be that non-invasive methods are sometimes more sensitive than vision in detecting skin irritation. The above data suggest that skin color and density difference as measured by a colorimeter, as well as transepidermal water loss by evaporimeter and cutaneous blood flow by laser Doppler velocimeter, can be a valuable and sensitive method of detecing damage to the skin by SLS.

The results of clinical testing demonstrate that no difference in skin irritation potential exists in the varying pH levels of SLS solutions. These observations are, however, in contrast to the recent study by Taves et al.[14] which suggested that a rise in pH of anionic detergents caused increased irritation of human skin. In the sample population studied, no statistical significance was revealed. But, Anger et al.[3] reported that the differences in the skin irritation caused could hardly be related to the difference in pH. This agrees with our results. Thus, more populated and conditioned studies are necessary to clarify the effect of pH on the skin irritancy potential of SLS.

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