

Reproducibility of a non-invasive skin irritancy test in a cohort of metalworker trainees

D. ILIEV, U. HINNEN AND P. ELSNER

Department of Dermatology, University Hospital Zurich, Zurich, Switzerland

The identification of subjects with increased susceptibility to irritants may play an important rôle in the prevention of irritant contact dermatitis. A short and quick method of non-invasive testing for assessing irritant sensitivity was developed by Wilhelm and coworkers in 1990, based on the alkali resistance test of Burckhardt. In order to determine the reproducibility of this screening method, 204 healthy metalworker trainees were tested 2× according to Wilhelm within an interval of 6 months. No statistically-significant correlation could be shown, indicating that the reproducibility of this screening method is low. Therefore, we propose applying not just a single test for the assessment of skin irritability, but a series of tests, in order to improve the reliability of this kind of testing.

Key words: alkali resistance; reproducibility; skin irritancy test; bioengineering methods; TEWL; patch test; prevention; metalworkers; occupational. © Munksgaard, 1997.

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Since irritant contact dermatitis is a common disease that is preventable by protective measures, the development of screening methods to identify subjects with increased susceptibility to irritants may be essential to reduce the incidence of this disorder at the workplace. Subjects with increased reactivity could thus be identified and the development of irritant contact dermatitis could be suppressed by preventive counselling and more intensive protective measures.

One of the screening methods used to quantify an individual's susceptibility to irritants was proposed by Wilhelm et al. in 1990 (1). He and his colleagues modified Burckhardt's alkali resistance test (2-4) in order to have a short, simple, non-invasive test for assessing sensitivity to irritant contact dermatitis. This test uses the measuring of the transepidermal water loss (TEWL), after an alkali insult, to determine skin vulnerability. The aim of the present study was to examine the reproducibility of the results of the modified alkali resistance test under field conditions, in order to evaluate its practicability and reliability for the use by occupational health practitioners.

Patients and Methods

Patients

204 unselected metalworker trainees without any current skin disease participated in the study,

which is part of PROMETES (Zurich Prospective Metal Workers Eczema Study) after informed consent (202 males, 2 females, between 15 and 25 years of age, median 16). This field study was performed in 24 metal processing factories in Switzerland. The study had passed review by the ethical commission of the University Hospital Zurich.

Methods

The quick irritancy test with 0.1 ml of sodium hydroxide (NaOH) at a concentration of 0.2 mol/l aqueous solution was performed on the flexural side of the right forearm (5), as described by Wilhelm et al. (1). Transepidermal water loss (TEWL), which depends upon the integrity of the stratum corneum and thus reflects skin barrier function (6-7), was measured with an evaporimeter (Tewameter, Corage & Khazaka, Cologne, Germany) following the guidelines of ESCD (8), before application of NaOH and 5 min after the "quick irritant" NaOH had carefully been wiped off, respectively. TEWL was then converted to a standard temperature of 30°C (TEWLtemp) to make results comparable (9). The effect of the challenge test on TEWL was expressed by calculating Delta-TEWL-values (TEWL after irritation - TEWL before irritation).

The measurements were performed in the autumn of 1994 (average temperature 21°C, median

21°C; average humidity 59%, median 61%), using a mobile caravan equipped with skin bioengineering devices and facilities for applying irritation tests and performing clinical examination. Each volunteer had first to rest for at least 10 min. Heavy work had to be avoided for at least 30 min prior to measuring TEWL. The volunteers were relaxed in a sitting position, and no handwashing was allowed for at least 1 h prior to our measurements. We did not use any wind-shields but all volunteers had to turn their heads sideways while measuring TEWL. All the measurements were repeated in the spring of 1995 (average temperature 23°C, median 24°C; average humidity 59%, median 64%).

Calculations and statistics

Means, standard deviations (SD) and standard errors of the mean were calculated. All participants with basal TEWL values over 30 g/m²/h before irritation were excluded. The association between the results of the 1st and the 2nd tests was assessed by simple linear regression. The software packages SPSS 4.0 and Statview were used for statistical analyses.

Results

Results of the NaOH irritation test at time 0 and after 6 months are shown in Table 1, Fig. 1. A weak, but statistically significant, correlation between the repeated TEWL values before irritation was found. However, there was no correlation between the 2 Δ TEWL values demonstrating the effect of the irritation.

Table 1. Results of repeated NaOH skin irritancy test

	Test at time 0	Test after 6 months	Correlation coefficient (Pearson)
<i>TEWL before irritation</i>			
mean	9.76	6.18	0.14 (<i>p</i> =0.051)
median	9.95	5.66	
standard deviation	3.56	2.32	
25% quantile	7.33	4.63	
75% quantile	11.69	7.25	
<i>TEWL after irritation</i>			
mean	18.85	14.99	−0.12 (<i>p</i> =0.126)
median	9.13	12.29	
standard deviation	5.34	16.47	
25% quantile	15.20	9.47	
75% quantile	21.93	15.77	
<i>ΔTEWL</i>			
mean	9.27	8.86	0.029 (<i>p</i> =0.714)
median	8.05	6.29	
standard deviation	5.21	15.92	
25% quantile	5.82	3.30	
75% quantile	12.42	9.82	

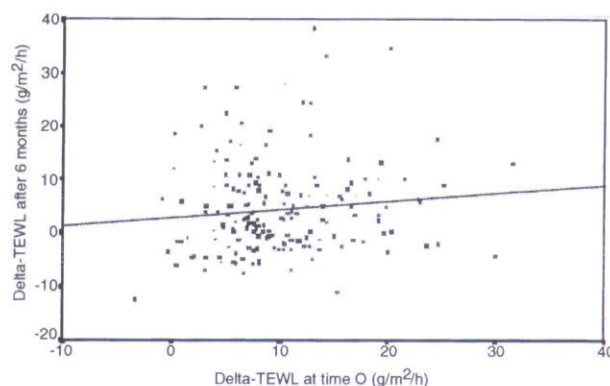


Fig. 1. Scatterplot of repeated NaOH skin irritancy test.

Discussion

With the modified alkali resistance test, Wilhelm et al. described a procedure for quantifying inter-individual differences in stratum corneum barrier function, without inducing visible changes or causing discomfort to volunteers. In their study on 10 volunteers, they reported a highly significant correlation between this short NaOH test and 24-h SLS patch testing. However, these findings could neither be corroborated by Hinnen (10) nor by Bangha et al. (11). Reproducibility was not controlled in the study by Wilhelm et al., nor in those by Hinnen (10) et al. (11).

Reproducibility of SLS irritancy testing has been studied in 20 volunteers by Kawai et al. (12), by visual scoring of the skin and a microscopic scoring method of skin replicas. They found that the values of microscopic scoring were reproducible, while the values of visual scoring were not, in the closed patch test. Unfortunately they did not measure TEWL.

A satisfactory result for the classical Burckhardt test in terms of reproducibility could be demonstrated by Schieferstein et al. (13), using an interval between both measurements of 3 months. He studied a group of 77 volunteers, divided into 2 groups (group I: normal; group II: low/very low), and found a reproducibility of 66.2 %.

The aim of the present study was to evaluate the reproducibility of the NaOH irritation test according to Wilhelm et al. (11) in the context of our ongoing prospective field study being performed in a series of trainee workshops in the metalworking industry. All examinations were done within a caravan equipped for bioengineering tests and air conditioned. Although average room temperature was higher during the 2nd measurements (6 months later), basic TEWL values on the right forearm (measured before application of NaOH) were lower compared to the 1st examination.

The fact that we were unable to reproduce the results of the 1st irritation test indicates that the test method evaluated does not provide information on a subject-specific characteristic (susceptibility to an alkaline irritant) that is constant over time. It is therefore doubtful whether this test on its own is useful for the prediction of irritant contact dermatitis. However, this does not exclude the possibility that it might provide important information in combination with other tests.

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Address:

Dimiter Iliev
University Hospital Zürich
Department of Dermatology
Gloriastr. 31
CH – 8091 Zürich
Switzerland

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