Dissertation

Biophysical Aspects of Contact Dermatitis and its Prevention

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Natalia Kuzmina (middle right) defended her thesis on 26 March 2004 at the Department of Dermatology, Karolinska University Hospital Huddinge. The External Examiner was Tove Agner (middle left), Department of Dermatology, Gentofte Hospital and the Chairman of the reviewing board was Lennart Emtestam (left) and Peter Lidbrink (right), Head of the Department.

The skin is a unique organ covering the whole body and it takes part in important processes, including metabolism, immunology, inflammation and nutrition. Diseases may express themselves by changing the skin's function without being recognized by their visual characteristics. In fact, healthy-looking skin may function very abnormally due to underlying pathology and, in such cases, additional diagnostic methods may be helpful. The advantage of using non-invasive ones permits the collection of repeated, correct and comparable objective data, without causing inconvenience to the persons investigated. Numerous methods of measuring various cutaneous parameters: skin hydration (corneometry); the amount of superficial lipids (sebumetry); pH in the superficial layers of the skin; skin thickness (echographic evaluation); skin colour (colorimetry); skin blood flow (laser Doppler flowmetry (LDF)); skin barrier function (transepidermal water loss), skin impedance and confocal imaging have become available.

In our studies, we used visual scoring together with several established non-invasive methods (trans-epidermal water loss, Corneometer, laser Doppler) and a new one (electrical impedance) to assess the irritant and allergic contact reactions, the effects of the treatment on skin sensitivity and skin dryness. The more specific aim of this thesis was to distinguish between irritant and allergic contact skin reactions (I), evaluate effects of pre-treatment with a urea-containing emollient on nickel-allergic skin reactions (II), assess interlaboratory variability in non-invasive measurements of the skin (III), monitor effects of a moisturiser on the skin of the elderly (IV), compare baseline biophysical properties of the skin and those after challenge with sodium lauryl sulphate in patients with eczema and healthy subjects (V).

In Paper I, we studied clinically similar allergic and irritant skin reactions in 33 nickel-allergic patients. The assessment was made by visual scoring, measurements of electrical impedance and transepidermal water loss. The changes in impedance indices had distinctive patterns. The data suggest that the method used to measure electrical impedance is of value in distinguishing between contact reactions of allergic and irritant nature.

In Paper II, we evaluated the effects of pretreatment with a urea containing moisturiser on contact allergy in

20 nickel-sensitised patients and five controls. The skin reactions were blindly evaluated by clinical scoring and by measuring the transepidermal water loss and electrical impedance. Both the visual assessments and measurements with non-invasive instruments showed about the same patch-test reactions. We therefore concluded that skin nickel reactivity in nickel-sensitised patients is not significantly affected by the use of this urea-containing moisturiser.

In Paper III, two independent groups studied the patch test reactions to irritants visually and by measuring impedance, transepidermal water loss and laser Doppler. The aim was to assess interlaboratory variability in the measurement of skin electrical impedance. We found that the baseline impedance values and those after barrier disruption differed in the two groups. The group with more marked changes in impedance showed significantly more transepidermal water loss after application of SLS. Differences in reactivity between subjects, operator and instrumental variability were thought to be possible causes.

In Paper IV, we compared the effect of urea alone and in combination of urea with sodium chloride as regards their moisturising properties on skin of the elderly people. Our findings suggest that the moisturisers seem equally effective, at least concerning their ability to reverse impedance indices towards normal, an effect ascribed to changes in hydration of the stratum corneum. Moreover, these results obtained by a new instrument for impedance measurements agreed with those obtained by another well-established electrical instrument measuring skin capacitance. It is therefore suggested that the electrical impedance technique is suitable for assessing the effects of moisturisers on elderly human skin.

In paper V, we examined the effects of basic physiological characteristics, such as impedance and transepidermal water loss and the effects of the use of sodium lauryl sulphate in 29 patients with eczema and 19 healthy controls. We found clear differences in the baseline values of impedance between the patients and the controls. Moreover, patients with eczema showed larger changes in both transepidermal water loss and certain impedance indices after irritant exposure, which may indicate differences in reactivity to sodium lauryl sulphate. Therefore, our findings indicate that the impedance technique may help to "detect" chemically vulnerable skin.

The main conclusion of this thesis is that bioengineering techniques give descriptive, detailed information about pathophysiological changes in the skin of patients. Our data suggest that, in addition to well-established biophysical methods, this new impedance technique is of value for experimental studies of contact dermatitis. However, more investigations are needed before it can be used in routine diagnostic work, e.g. technical refinement and the development of guidelines for impedance measurements.

This thesis is based upon the following original papers

I. Nyrén M, Kuzmina N, Emtestam L. Electrical impedance as a potential tool to distinguish between allergic and irritant contact dermatitis. J Am Acad Dermatol 2003; 48: 394-400.

II. Kuzmina N, Nyrén M, Lodén M, Edlund F, Emtestam L. Effects of pretreatment with a urea-containing emollient on nickel allergic skin reactions. Manuscript submitted.

III. Kuzmina N, Duval C, Johnsson S, Boman A, Lindberg M, Emtestam L. Assessment of irritant skin reactions using electrical impedance – a comparison between 2 laboratories. Contact Dermatitis 2003; 49: 26-31.

IV. Kuzmina N, Hagströmer L, Emtestam L. Urea and sodium chloride in moisturisers for skin of elderly: a comparative, double-blind, randomised study. Skin Pharmacol Appl Skin Physiol 2002; 15: 166-174.

V. Kuzmina N, Hagströmer L, Nyrén M, Emtestam L. Basal electrical impedance in relation to sodium lauryl sulphate-induced skin reactions - a comparison of patients with eczema and healthy controls. Skin Res Technol 2003; 9: 357-362.