INVESTIGATIVE REPORT

**In vivo Study of Skin Mechanical Properties in Psoriasis Vulgaris**

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The aim of this study was to investigate the mechanical properties of the skin in psoriatic plaques before and after treatment with dithranol and in clinically uninvolved psoriatic skin in comparison with the skin of healthy controls. In total, 82 psoriatic plaques in 19 in-patients and 51 age-matched control subjects were studied with a non-invasive suction device (Cutometer). The plaques were characterized by statistically significant lower skin distensibility and elasticity, and a higher viscoelastic to elastic ratio compared with adjacent apparently normal skin. Delayed distension and hysteresis measured using a 2-mm diameter probe were decreased, but were increased when measured by a 8-mm diameter probe. These differences can be explained by the increased skin thickness in psoriasis and by the different aspects of skin mechanics determined by the 2 measuring probes. After treatment, the mechanical parameters of psoriatic plaques approached the values of adjacent control skin. The uninvolved volar forearm skin in psoriatic patients (2-mm diameter probe) showed statistically significant lower values of skin distensibility and higher values of viscoelasticity parameters compared with the skin of healthy control subjects. This suggests that the normal-appearing psoriatic skin is not entirely normal. The non-invasive method applied can be used for objective and quantitative evaluation of the effect of therapy in patients with psoriasis. Key words: psoriasis; skin elasticity; cutometer.

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Recently developed non-invasive bioengineering techniques allow an objective and quantitative assessment of the skin functions in psoriasis vulgaris. The most determined parameters are skin thickness, trans-epidermal water-loss (TEWL), blood flow and epidermal hydration (1–10). There have only been a few studies on the mechanical properties of the psoriatic skin (11–13).

The alteration in skin mechanics of the psoriatic plaques is due to increased skin thickness as a result of epidermal hyperproliferation, vasodilatation and oedema in the papillary dermis. Previous studies of patients with systemic sclerosis, scleredema and erysipelas have demonstrated that the measurements of skin elasticity and viscoelasticity with the Cutometer correlate with the skin induration and the presence of dermal oedema (14–16). They are reliable and more sensitive than clinical skin scoring systems.

The aim of the present study was to investigate, by means of a new non-invasive suction device, the mechanical properties of the skin in psoriatic plaques and in clinically uninvolved psoriatic skin in comparison with the skin of healthy controls, and to determine the value of measuring skin elasticity in monitoring the effect of therapy with dithranol.

**MATERIAL AND METHODS**

**Patients**

Nineteen in-patients (15 men and 4 women, age range 27–82 years, mean age 50, median age 44 years) were studied after giving informed consent. The duration of the disease varied from 1 to 35 years (mean 13 years). The mean psoriasis area and severity index (PASI) was 17 (range 4–58). A total of 82 psoriatic plaques was measured, of which 52 were localized on the extremities (arm 6, elbow and dorsal forearm 15, volar forearm 17, thigh 16, cruris 5) and 23 on the trunk (upper back 9, lower back 6, chest 8).

**Controls**

Fifty-one comparable healthy subjects (33 men and 18 women, age range 26–82 years, mean age 48, median 44 years) were studied.

**Skin elasticity measurements**

Mechanical properties of the skin were determined with a non-invasive, in vivo suction skin elasticity meter (Cutometer SEM 474; Courage and Khazaka, Köln, Germany). The device was equipped with 2 measuring probes with apertures of 2 mm and 8 mm in diameter. The time/strain mode was used with a 5-s application of a vacuum of 450 mbar, followed by a 3-s relaxation period and 5 repeated suctions. The skin deformation curve obtained is illustrated in Fig. 1. The following groups of mechanical parameters were analysed.

1. Absolute parameters: $Ue$, immediate distension; $Ur$, delayed distension; $Uf$, final distension (skin distensibility); $Ur$, immediate retraction; $Ua$, final retraction; $R$, residual deformation after the release of the first suction (resilient distension); and $H$, hysteresis, i.e. the difference in final distension between the fifth and the first suction.

2. Relative parameters: $Ua/Uf$, the ratio of total retraction to total distension, called gross elasticity; $Ur/Uf$, the ratio of immediate retraction to total distension, called biological elasticity; and $Ua/Ue$, the ratio of viscoelastic to elastic distension.

**Skin score**

The severity of the cutaneous induration of psoriatic plaques was rated according to a 4-point scale (from 0=normal to 3=severe).

**Study design**

All patients were investigated before and 10 patients (45 psoriatic plaques) were investigated after the treatment. Initially, salicylic acid 10% ointment was applied for 2–3 days to remove the squames. Thereafter, measurements of skin elasticity and clinical scoring of the induration were made. The therapy was continued with dithranol for
on the psoriatic plaques. Uv were significantly lower and Ue increased when measured by the 8-mm probe (Fig. 2). The changes in skin mechanical parameters of the adjacent control skin were not significant except for the decrease in Ur, UaUr and UfUr (2-mm probe; p < 0.05).

Correlation between induration and mechanical parameters of psoriatic plaques. The values of Spearman correlation coefficient are presented in Table I. The induration of the psoriatic plaques significantly inversely correlated with the parameters Ue, Uf, Ur, R, H (2-mm probe) and Uv (2-mm probe), and directly correlated with the parameters UaUr (2-mm probe), UfUr (2-mm probe) and UeUv (8-mm probe).

Comparison between uninvolved psoriatic skin and skin of healthy controls. Using the 2-mm diameter probe, the uninvolved volar forearm skin in psoriatic patients showed sta-

Table I. Correlation between clinical score of induration and mechanical parameters of psoriatic plaques

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2-mm probe</th>
<th>8-mm probe</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Spearman r</td>
<td>p-Value</td>
</tr>
<tr>
<td>Ue</td>
<td>-0.4114</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Uv</td>
<td>-0.4960</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Ur</td>
<td>-0.4423</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>R</td>
<td>-0.3962</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>UaUr</td>
<td>-0.5465</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>UfUr</td>
<td>0.4872</td>
<td>0.0001</td>
</tr>
<tr>
<td>UrUf</td>
<td>0.2925</td>
<td>0.0052</td>
</tr>
<tr>
<td>UeUv</td>
<td>-0.0132</td>
<td>NS</td>
</tr>
<tr>
<td>H</td>
<td>-0.5667</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

NS: not significant. For other abbreviations see Fig. 1.
The present results showed that psoriatic plaques were different from those of the normal skin of healthy controls. This suggests that (i) the Cutometer is more sensitive with the small-diameter probe as a result of the increased epidermal thickness of the psoriatic plaques. Only the values of \( U_v \) and \( H \) measured by the large 8-mm diameter probe reflect the presence of dermal oedema in the psoriatic skin.

These results are in accordance with data reported by Zlatkov et al. (11). Using their own developed suction device the authors observed a decrease in skin extensibility on the psoriatic plaques after 4 weeks of heliotherapy and thalassotherapy. However, the measurements were made using a probe with an aperture of 30 mm in diameter and thus the results of the two studies are not comparable.

The present results differ from data reported by Zlatkov et al. (12). Using a suction device (Dermaflex A; Cortex Technology, Hadsund, Denmark) equipped with a 10-mm diameter measuring probe they established a lower skin extensibility and a higher hysteresis and resilient distension of the psoriatic plaques compared with a regional control. According to Serup & Northeved, the decrease in skin distensibility is a sign of epidermal stiffness due to the elongated rete ridges, while the increase in \( H \) and \( R \) is a sign of softness explained by the oedema of the outer dermis. No significant changes in \( R \) were observed in the present study.

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Another question of interest to investigators is whether the uninvolved volar forearm skin in psoriatic patients differs significantly from these of the normal skin of healthy controls. This
suggests that some changes exist in normal-appearing psoriatic skin, mainly in the epidermis. Marks et al. (22) found ultrastructural differences in corneocytes from the paralesional areas compared with normal corneocytes. Using a Cohesograph they detected a statistically significant increased cohesion of the superficial stratum corneum in uninvolved psoriatic skin. The perilesional skin had a tougher stratum corneum than normal, in that the force required to distract a portion of corneocytes was 80% greater than for similar sites in normal controls.

In conclusion, the non-invasive and quantitative measurements of skin elasticity in patients with psoriasis vulgaris may be considered to be useful in monitoring the effect of therapy and for comparison of the efficacy of different treatment regimens.

REFERENCES