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ATTEMPT TO APPLY LIQUID-CRYSTAL THERMOGRAPHY IN PRICK TEST ALLERGY DIAGNOSIS

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Abstract Prick tests are commonly used in allergy diagnosis but in some cases obtained results are difficult for objective interpretation. Application of liquid-crystal contact thermography improves this kind of diagnosis especially in case of coloured or sick skin.

1. INTRODUCTION

The so called prick tests are the most common method of the practical allergy diagnosis. In this method the small amount of an allergen is introduced by a special needle into a patient's skin. After 15 - 20 minutes the weal and flare reaction are observed in the skin. The quantitative analysis consists in visual comparison of the diameters of weal and flare reaction in the skin. This method, however, is not objective, especially for changed (freckled or sick) or coloured, especially black, skin. This was the reason for trying if contact liquid-crystal thermography (LCT) would be means to improve an objectivity of the traditional method.[1-5]

2. EXPERIMENTAL

For initial studies cholesteric liquid crystal mixtures have been used in form of melt because the linear resolution and temperature sensitivity are larger in this case in comparison with liquid-crystal thermographic foils. As liquid crystals the conventional mixtures of cholesterol oleyl carbonate, cholesterol nonanoate and, in some cases, cholesterol chloride have been used. The coloured response for these mixtures has been observed in the range from 2 to 4 Celsius degree, between 32 and 37 Celsius degrees. As a black paint the carbon black dispersed in ethanol solution of poly(vinyl acetate) has been used. In the first step, the coloured maps of upper part of human back and forearm have been done (see Fig. 1.). These maps have played the reference role for the later studies and, on the other hand, showed that forearm is not a proper place for prick tests visualized by LCT because veins pass so close to skin that thermographic picture of test may be disturbed.

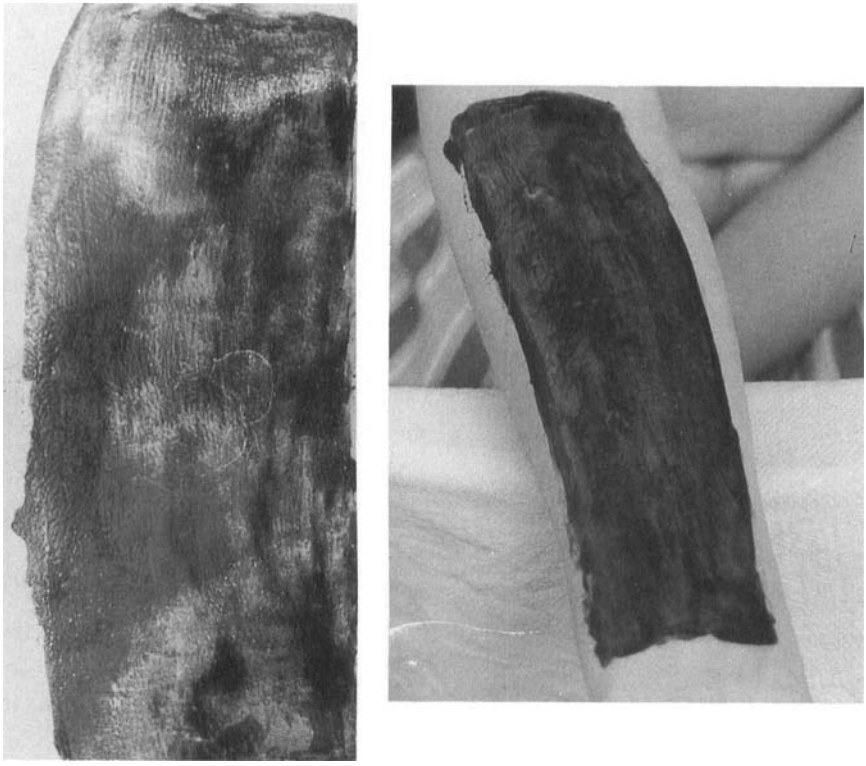

FIGURE 1. Thermographic maps of upper part of human back and forearm without stimulation. See Color Plate II.

The following standard procedure of measurement has been adopted. The prick tests have been applied on the upper part of patient's back in two parallel rows. Then one of them has been painted black and, after drying, coated by liquid crystalline mixture. This mixture has been selected experimentally depending on the external temperature (from 18 to 35 Celsius degrees) and the structure of patient's body (the level of fat and muscle tissues). During these operations an allergen reaction reaches its maximum (an interval about 10 to 20 minutes from the prick test).

As a result of allergy reaction the temperature of skin around the prick point has been increased over normal level. In this way the blue spots have occurred on the red or green background of the rest of the liquid crystal layer. The temperature distribution has been registered by colour photography and then would be analyzed.Some measurements have been done during the process of allergen reaction to observe the dynamics of this process.

3. RESULTS AND CONCLUSIONS

As one can see in Fig. 2 -- 4 this method gives the possibility of objective measurements easy to register, storage and analyse, e.g., means of CCD camera-computer set. The increase of skin temperature as the effect of allergy reaction would be as large as 4 Celsius degrees (see Fig. 3), but in case of normal skin reaction it would be about some tens of Celsius degrees only (see Fig. 4). In the latter case we adopted a well-known convention that the temperature differences between analyzed and surrounding skin lower than 0.5 Celsius degree would be neglected.

The presented method displayed temperature differences between the normal skin and the skin provoked by allergen introduced by prick test method, in equal degree or even better than the visual method. The result is independent on the skin state. Further studies on the application of this method will be continued, especially for evaluation of changed skin reactivity, (for instance black or freckled) which is difficult to visual evaluation. It is well-known that mechanisms leading to develop skin reaction for allergens are represented as local inflammation changes which causes change of skin temperature between reaction area and the surrounding skin.

Our studies show that correlation between an allergy level and thermal changes of skin is complex and may strongly change from one patient to another. This problem requires further studies. For routine applications typical thermograhic foils containing cholesteric liquid crystals would be used. In cases of small reactivity we suggest to use

thin thermographic foils (possibly single-use).

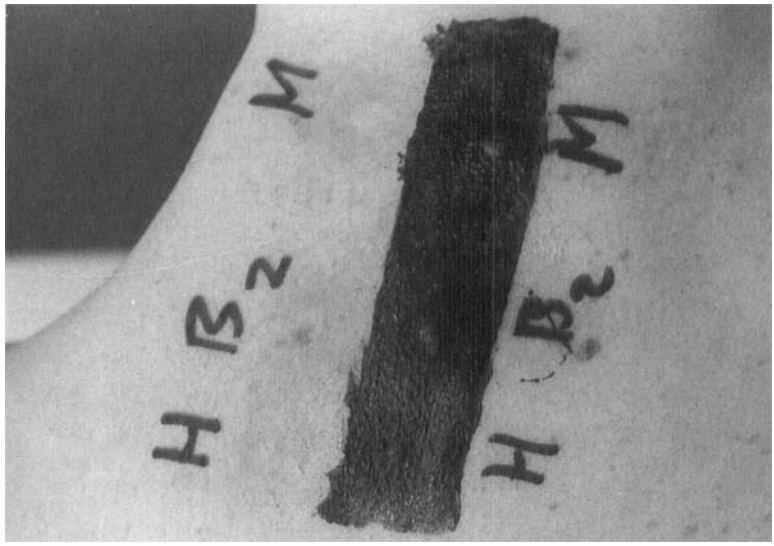

FIGURE 2. LCT termogram of allergen sensitive patient; blue spots mean increase of skin temperature in the vicinity of prick points. See Color Plate III.

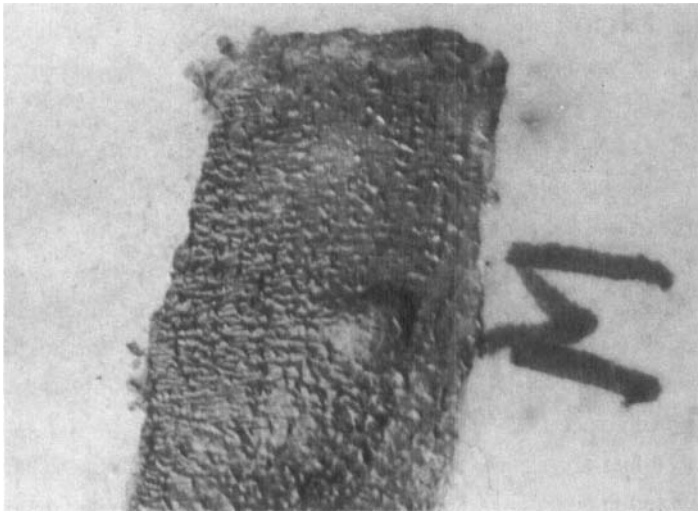

FIGURE 3. High level of allergen skin reaction in case of mushroom allergen. See Color Plate IV.

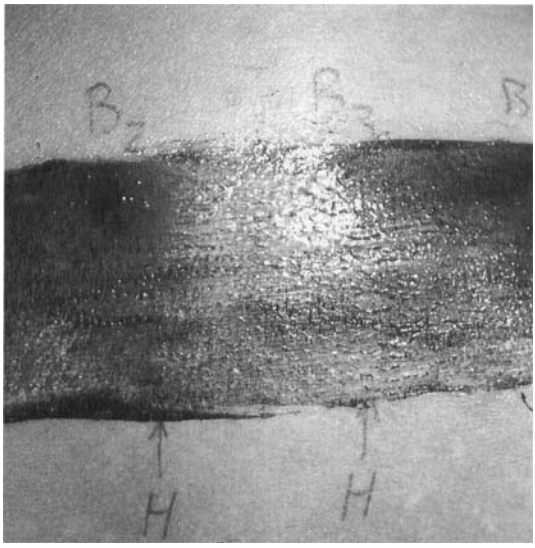

FIGURE 4. Low level of allergen skin reaction. See Color Plate V.

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