Ultrastructural Changes in the Stratum Corneum after Profuse Swabbing of the Skin with Dimethyl Sulfoxide

Electron microscopic studies[1] have shown that a single topical application of the controversial penetrating solvent, dimethyl sulfoxide[2] (DMSO) on guinea-pig skin, produces definite morphological changes in the stratum corneum. These changes were particularly apparent at its basal level[3], right above the granular layer.

In some further experiments, we have sought to determine which changes take place in the basal stratum corneum following profuse swabbing of guinea-pig skin with larger quantities of DMSO.

6 different male guinea-pigs, 350–450 g were swabbed profusely 4 consecutive times using a total of 6 cm³ of the 90% aqueous solution of DMSO per animal. The solution was swabbed evenly with a cotton applicator over a rectangular area, 3 · 10 cm, lying parallel and right to the midline on the dorsal skin. Punch biopsies were performed simultaneously (30 min, 45 min, 1, 2, 3 and 4 h after treatment) from treated areas, from symmetrical untreated sites over the left side and from 6 untreated control animals. Other details of the experiment and the electron microscopic techniques were described before[1].

The profuse swabbing of guinea-pig skin produced striking changes in the basal layers of the stratum corneum. Specimens obtained half an hour after treatment, showed enlargement of the basal cornified cells and a disappearance of the normal keratin patten. As time went on, large electron transparent areas began to predominate, and 4 h after treatment there were mainly numerous large light cytoplasmic spaces. Many small islands of dense material resembling the keratin matrix were the only remaining visible cellular content. There was also frequent detachment of the basal horny cells from the underlying granular layer with formation of a subcorneal cleft. In the granular layer the intercellular spaces became dilated with separation of the adjoining plaques of the desmosomes (Figures 1 and 2).

The plasma membranes of the stratum corneum remained quite intact, thus confirming KLIGMAN's[4] experience with DMSO, and the data of MATOLSTY[5] that the plasma membranes are more resistant than their keratin content.

These findings seem to support our earlier finding[1] that the increased cutaneous permeability induced by DMSO[4] results from modification, perhaps a dissolution, of the keratin content of the cells rather than changes in their membranes. Also they would suggest an important role of the deeper stratum corneum in the performance of the barrier function of the epidermis[6] which is so uniquely modified by DMSO[7–9].

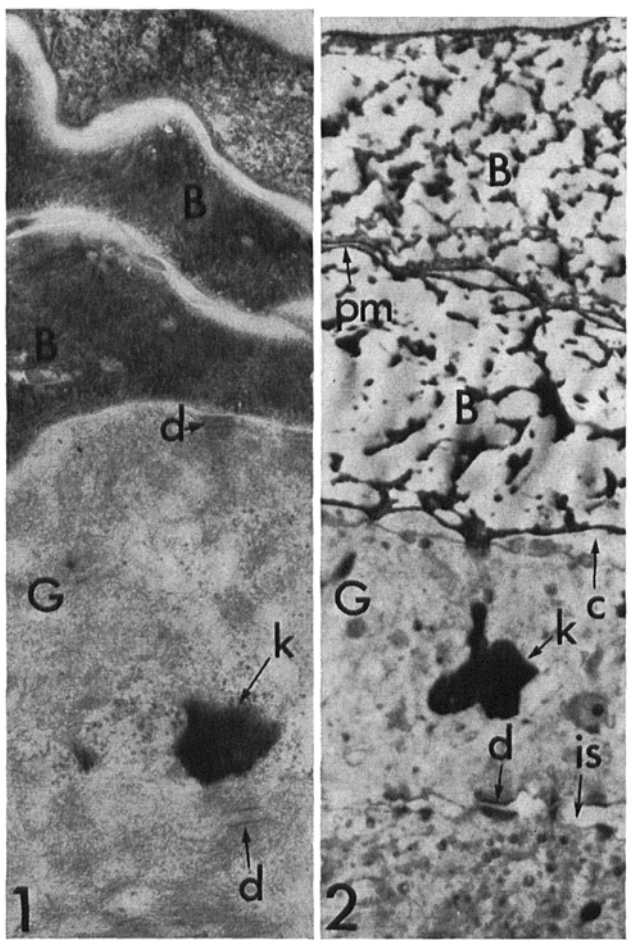

Fig. 1. Basal stratum corneum (B) in the untreated left side of a guinea-pig: both cytoplasmic components, fibrils and the dense matrix are shown. Large keratohyalin granules (k) and desmosomes (d) are seen in the granular layer (G). × 50,000.

Fig. 2. Basal horny layer (B) and granular layer (G) 4 h after treatment of the same animal, over the opposite symmetrical side than in Figure 1, as described in the text. Both lower cells of the basal stratum corneum are enlarged and show wide electron-transparent areas with numerous islands of dense material. A subcorneal cleft (c) has developed. The plasma membranes (pm) of the stratum corneum have become more apparent and seem fairly intact. In the granular layer the intercellular spaces (is) are dilated with separation of the adjoining plaques of the desmosomes (d). × 50,000.

Résumé. Une abondante aspersion de la peau du cobaye avec du dimetil sulfoxide produit de notables changements dans les cellules basales de la couche cornée. Elles s'agrandissent, l'aspect fibrillaire de la kératine disparaît et la couche cornée (barrière cutanée) se décolle de la couche granuleuse.

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1 L. F. MONTES, J. L. DAY, C. J. WAND and L. KENNEDY, J. invest. Derm. *48*, 184 (1967).
2 C. D. LEAKE, Science *152*, 1646 (1966).
3 I. BRODY, J. Ultrastruct. Res. *2*, 482, 1959.
4 A. M. KLIGMAN, J. Am. med. Ass. *192*, 482 (1959).
5 G. MATOLSTY and P. PARAKKAL, J. Cell Biol. *24*, 297 (1965).
6 F. D. MALKINSON, in *The Epidermis* (Ed. W. MONTAGNA and W. C. LOBITZ JR.; Academic Press, New York and London 1964), Chap. XXI.
7 R. B. STOUGHTON and W. FRITSCH, Archs Derm. *90*, 512 (1966).
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