SHORT REPORTS

Cytomembrane-Sandwiching in Human Epidermal Langerhans Cells: A Novel Reaction to an Irritant

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Relatively mild exposure of human epidermis to sodium lauryl sulphate caused a general activation of the Langerhans cell system within 5 hours. An unexpected reactive phenomenon was that this irritant caused some cytomembrane parts to fold upon each other, thereby forming numerous Birbeck granules, several of which had an irregular shape. Spotty cytomembrane damage to the Langerhans cells was also observed. *Key words: contact dermatitis; Birbeck granules; Sodium lauryl sulphate.* (Received November 2, 1987.)

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We have investigated the early subcellular reactive changes that followed the topical application of sodium lauryl sulphate. One of several events involved specific cytomembrane activity which leads to the formation of Birbeck granules (BGs) that often had an atypical shape. The finding of this 'cytomembrane sandwiching effect' is of great importance both for the interpretation of BG function and as regards the controversial question of whether true cytomembrane disruptions can or cannot occur in Langerhans cells (LCs).

MATERIAL AND METHOD

Finn chambers containing 50 µl 1% sodium lauryl sulphate (SLS) were applied on the volar forearm of 3 adult volunteers for 5 h. Punch biopsies (3 mm), including contralateral controls, were taken upon removal of the test patches and were processed for electron microscopy (1). Ten series (interseries distance about 20 µm) comprising 30–60 consecutive sections were taken from each biopsy. Five series comprising 50 to 200 consecutive sections were obtained from one patch test biopsy. Parts of a total of 127 LCs could be scanned thoroughly by transmission electron microscopy of exposed epidermis.

RESULTS

Several LCs showed signs of increased activation as early as after 5 h of exposure to SLS. They displayed several of the following signs: dilated rough endoplasmatic reticulation, slightly enlarged perinuclear space, prominent Golgi fields, increased number of coated and non-coated vesicles, lysosomes, and cytomembrane folds. The keratinocytes and melanocytes remained unaffected.

The most striking observation, however, concerned the cytomembrane and BG formation. Several LCs contained a considerable number of BGs in the formative stage, i.e. rod-shaped profiles attached to the cytomembrane. Such profiles were rarely seen in the controls. The sandwiching effect of SLS had gone beyond this stage in a few LCs. Thus, these cells showed a discrete cytomembrane area that was involved in an unusual type of

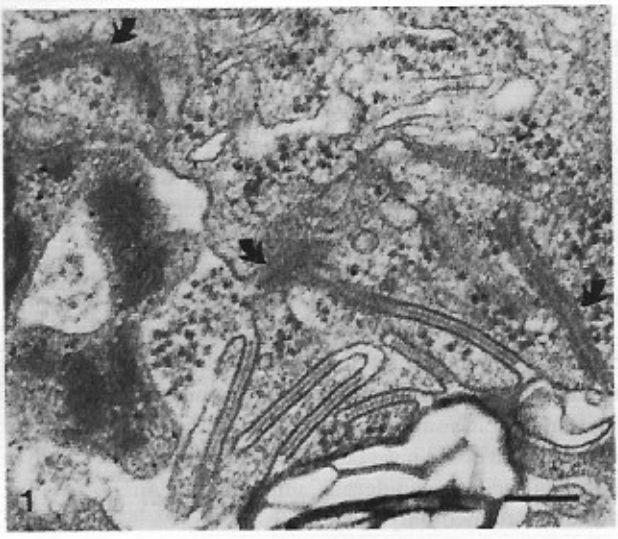

Fig. 1. Increased BG formation; eight BGs are seen still attached to the cell membrane. Three of them are blurred (*arrows*) because the plane of their discs have an unfavourable angle towards the electron beam. Bar, 0.2 μm.

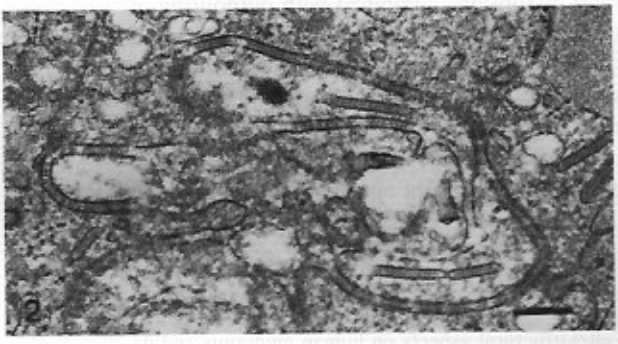

Fig. 2. Internalized BGs having an atypical shape. Bar, 0.1 μm.

BG formation, as manifested by several, sometimes even stacked, cytomembrane infoldings often forming unusually long, curved and, occasionally, branched BGs (Fig. 1). Formation of granules could also occur between complicated cytomembrane folds, giving rise to cytoplasmic BGs with an atypical shape, i.e. ring or U profiles (Fig. 2).

Pronounced membrane ruffling sometimes made it necessary to tilt and rotate the sections for visualization of parts of the cytomembrane. Seeming membrane ruptures could thus be ruled out. However, it seemed that, in spite of extensive goniometry, true small disruptures were present in a few instances. These were only found on dendrites and were combined with cytoplasmic material in the intercellular space in one case only.

DISCUSSION

The BGs derive from the cell membrane and consist of superimposed or sandwiched cytomembrane parts, probably enclosing glycocalix material (1). Little is known about the trigger for BG formation: the process is continuous (2) and is enhanced in certain inflammatory states (1). Further, in vitro exposure to digitonin transforms the cytomembrane of human LCs into BGs of enormous length (3). This fact and our recent finding (unpublished) that certain proteases also have a membrane-sandwiching effect support the view that some external influence on the cytomembrane can trigger a cytomembrane-sandwiching process.

The mechanism of the membrane-sandwiching effect of SLS is still unknown. SLS has both detergent and denaturing properties which could perturb the cytomembrane. Such a mode of action implies, however, that the LCs are more susceptible targets than are the keratinocytes and melanocytes. It is also possible that this special membrane activity reflects the ability of the LCs to capture exogenous substances (1).

SLS-induced cytomembrane-sandwiching was found in only a few LCs, compared with the total number of cells observed. Other than the possibility that some LCs remain unaffected, at least two factors seem to limit the likelihood that cells exhibiting this event will be found. First, only scattered formative profiles were seen and the exaggerated sandwiching process was restricted to a limited part of the cytomembrane. Thus, the examination of 10 series comprising 30–60 consecutive sections, i.e. roughly 1.5–3 μm, could only demonstrate the occurrence of the phenomenon but did not allow its quantitation. The second factor is the obvious and usual individual variation which is unavoidable when patch-testing is used. It is curious that cytomembrane-sandwiching was restricted to discrete parts of the cell membrane. Hypothetically, this could have been due to an uneven distribution of SLS within the intercellular spaces of the living epidermis, implying that an effective membrane-sandwiching concentration was attained only locally.

The question long disputed has been whether disruptions combined with outpouring of cytoplasm can occur in the LCs. It has been suggested that such spotty damage appears in contact allergic reactions, since the LCs are targets for lymphocytes (4). Other authors (5, 6) were unable to find damaged cells in this situation. The present results demonstrate that SLS can cause discontinuities of the cytomembrane, which are real in the sense that small areas of them could not be visualized with the electron microscope in spite of extensive goniometry. This finding prompts a revaluation of the nature of agents which can induce spotty damage to LCs.

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