

KERATINOSOMES IN PSORIATIC SKIN

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Abstract. Keratinosomes in psoriatic skin can be slightly larger than those in normal skin. Some seem to develop an unusual internal morphology, and some reach their full development while they are still within the immediate Golgi area. Observational evidence indicates that there may be more keratinosomes in psoriatic skin than are generally found in normal skin. Keratinosomes appear extracellularly from the spinous layer through the horny layer. Some keratinosomes do not move to the outside of the cell and can be seen within cells of the horny layer. There appears to be an increased number of keratinosomes in and between the outer cells of sweat ducts. Keratinosomes are also present within the dark cells of the duct and the extracellular space between the dark cells contains material from keratinosomes.

Key words: Psoriasis; Skin; Granules; Keratinosomes; Epidermis

Small granules in cells of the upper epidermis were first reported in 1957 by Selby (11) who thought these granules were possibly degenerated or transformed mitochondria. Odland (10) reported seeing small granules in the higher epidermal cells and he also associated them with mitochondria. Odland was the first to describe the laminar ultrastructure of these granules. Frei & Sheldon (3) showed that the earlier stages of these granules are found near the nucleus and the Golgi region and that they migrate to the cell surface where their contents are exuded into the extracellular space. The ultrastructure of the granules was detailed by Farbman (2) as measuring 0.2 to 0.3 μm in length and 0.1 μm in width. Internally, the granule was composed of alternate dense and less dense layers, the dense measuring 20 \AA in thickness and the less dense layer 30 \AA thick. These layers were enclosed completely by a unit membrane and there was agreement with previous reports (3) that suggested that the contents of the granules were exuded into the extracellular space.

Matoltsy & Parakkal (8) also found that these granules migrate from the Golgi region and fuse with the cytoplasmic membrane where they open to

the extracellular space and their contents are spread over the cell surface. The keratinosomes are found by Martinez & Peters (7) to be made up of several 70 \AA thick discs appearing as dense and less dense areas in the intact granule. When the granule fuses with the plasma membrane of the keratinocyte it opens to the extracellular space where these discs move out onto the surface of the cell. By exuding their contents into the extracellular space in the form of amorphous material (8) and 70 \AA thick discs the keratinosomes are said to contribute to the barrier function of the stratum corneum and to

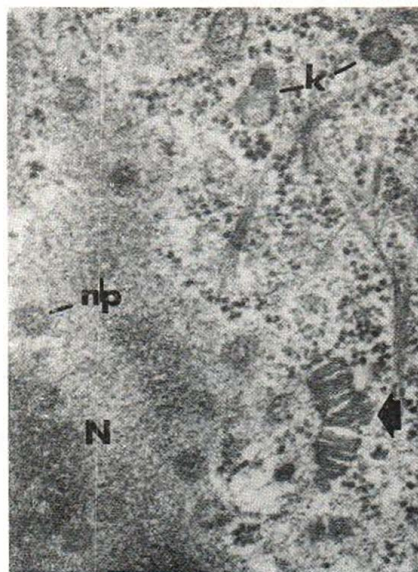


Fig. 1. This section was cut obliquely through the nuclear membrane of a keratinocyte in the spinous layer of psoriatic skin. The nucleus (N) in the lower left hand corner shows nuclear pores (np). Normal-sized keratinosomes can be seen in the upper portion of the picture (k). A fully developed keratinosome (\rightarrow) lying close to the nucleus measures 1.2 μm in length or slightly more than two times larger than normal. $\times 26\ 400$.



Fig. 2. This micrograph of a portion of the granular layer shows areas between cells (--->) that could be said to contain an abnormal number of keratinosomes. $\times 14\ 400$.

increase the thickness of the outer leaflet of the plasma membrane to $40\ \text{\AA}$. Some (14) feel that the thickening of the cell membrane at the horny layer takes place only on the inner leaflet of the plasma membrane.

Acid phosphatase reaction products have been found within the keratinosomes of normal skin (13, 15) as well as within the space between keratinocytes, demonstrating a means of transferring an

enzyme from within the cell to the extracellular space. Similar results were obtained with acid phosphatase studies on psoriatic skin (12).

There exist in today's literature two divergent views as to the relative number and the ultrastructure of keratinosomes in the epidermis of psoriatic skin. Bonneville et al. (1) conclude that the keratinosomes in psoriatic skin are normal in size, appearance, number and location. Hashimoto & Lever (4), on the other hand, find an increase in the number of keratinosomes in the stratum spinosum and in the stratum granulosum, but they found no evidence of the keratinosomes emptying their contents into the extracellular space. In our laboratory, work on psoriatic skin (9) made available to us many speci-



Fig. 3a. Disc-like (*d*) and amorphous (*a*) material seen at lower levels of the skin in keratinosomes within the cells is here seen, at the upper limits of the granular layer, outside the cells, indicating the disposition of the contents of the keratinosomes to the outside of the cells. $\times 28\ 800$.

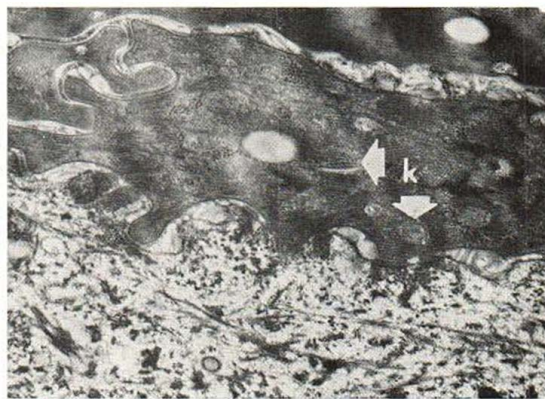


Fig. 3b. Whole keratinosomes (*k*) and remnants of keratinosomes are found in cells of the stratum corneum. $\times 11\ 800$.

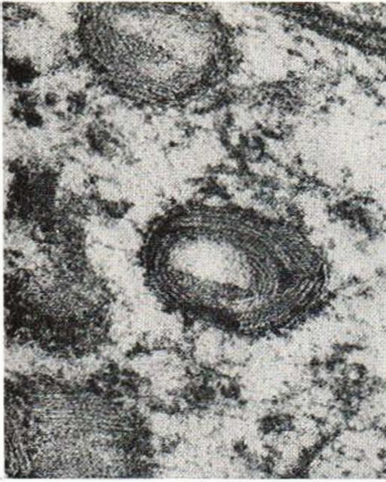


Fig. 4. Keratinosomes were found to have a circular arrangement of the discs. $\times 112\ 000$.

mens that could be used in an electron microscope study and which could possibly shed some additional light on this subject.

MATERIALS AND METHODS

Tissue was taken from both treated and untreated diseased areas and from normal-appearing areas. Half of each specimen was processed for light microscopy and half was processed for electron microscopy.

Fixation

For electron microscopy, the tissue was first fixed overnight in cacodylate buffered glutaraldehyde at 4°C. The tissue is then placed in a 1% solution of cold osmium for 2 hours, followed by uranyl acetate block stain, dehydration in ethanol, and embedding in Spurr. After sectioning, the grids are stained with uranyl acetate and lead citrate.

RESULTS

Keratinosomes were first observed in the mid-spinous layer in the psoriatic epidermis, which finding is consistent with other reports on this disease and is much the same as would be expected in normal skin. Cells in the spinous layer are seen to contain some fully developed keratinosomes lying adjacent to the nucleus, although the vast majority of them are found close to the leading edge of the cytoplasmic membrane. Many of those lying close to the nucleus are much larger than granules seen in normal skin (Fig. 1). Keratinosomes were occasionally observed opened to the extracellular space at this level in the epidermis, although for the most part this function was reserved to the granular layer. When the cells had reached the granular layer, most of the keratinosomes had deposited their contents into the extracellular space. Some spaces between granular cells contained what could possibly be referred to as an abnormal number of keratinosomes (Fig. 2). Also deposited between cells of the



Fig. 5. Some keratinosomes (*k*) in psoriatic skin, both within and between cells of the horny layer, were similar to those

found in ichthyosis vulgaris. These granules do not have the lamellar structure of normal keratinosomes. $\times 48\ 000$.

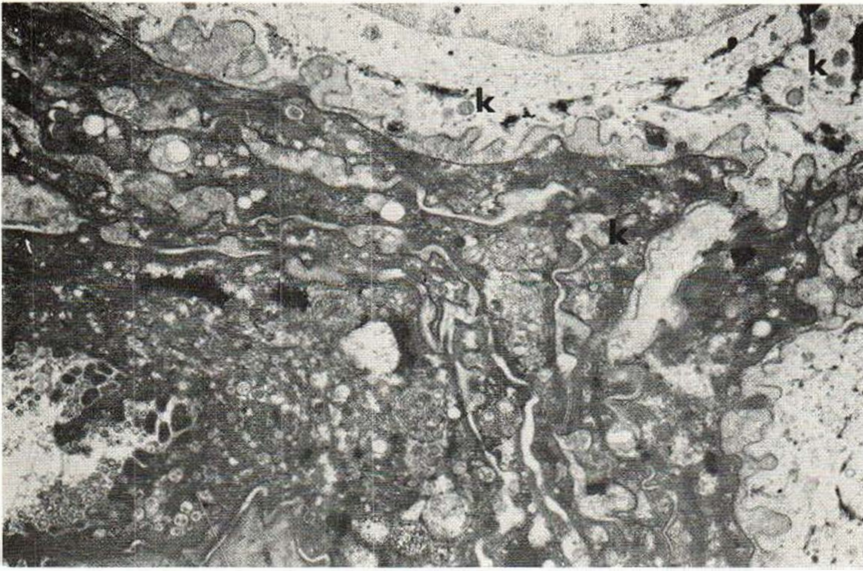


Fig. 6. Keratinosomes (*k*) are evident within light cells of sweat ducts. The extracellular space between dark cells contains the amorphous component of keratinosomes. $\times 12\,200$.

spinous layer, granular, and horny layer, was an amorphous material intermixed with the lamellar portion of the keratinosomes (Fig. 3). The strictly parallel array of the discs within the granule as reported by others is not present in all granules found in our study. Occasionally, granules appear having discs with a circular arrangement (Fig. 4). Remnants of keratinosomes could be seen within cells of the stratum corneum at all levels (Fig. 3*b*). Deposits somewhat similar to keratinosomes in ichthyosis vulgaris as described by Takaki (12) were observed between cells in the stratum corneum in some sections (Fig. 5). Keratinosomes were also found both intracellularly and extracellularly in sweat ducts (Fig. 6).

DISCUSSION

It is impossible to determine with certainty, by using electron microscopy alone, whether or not keratinosomes have their origin within the Golgi apparatus. The static condition that one must work with in electron microscopy precludes the possibility of making a determination on this matter by inspection alone, though the presence of acid phosphatase in the keratinosomes, as demonstrated by Wolff et al., and Takaki, certainly indicates that the Golgi apparatus must be involved in the construc-

tion of these granules. Additionally, Wilgram et al. (14) have added support to the Golgi origin theory in studies in which tissue was stained with osmium zinc iodide. They found both the Golgi apparatus and the keratinosomes impregnated with the stain.

We find in psoriatic skin that there appears to be an increased number of keratinosomes within the spinous and granular cells and that some of these granules are larger than those of normal skin. Although the possibility is present that these large granules might be two granules close together, this does not seem to be a likely explanation because of the arrangement of the discs and by the absence of two opposing limiting membranes. Probably a better explanation, other than that of enlarged granules, would be a complete fusion of two or more granules. We also find that the contents of most of the granules are exuded to the extracellular space. Not all of the keratinosomes empty their contents outside the cell, as some granules are seen in the keratinized cells of the stratum corneum. This could be due to the rapid outward movement of the keratinocytes in psoriatic skin or possibly to an overproduction of keratinosomes. Wolff (16) reported an increased production of keratinosomes where an increased proliferation of epidermal cells is evident.

The material found between cells of the stratum corneum (Fig. 5) and which has the general appear-

ance of the keratinosome material as described in ichthyosis vulgaris cannot be explained within the limits of the work done in this study.

Epidermal cells that form the wall of the sweat duct in psoriatic skin undergo keratinization at an earlier stage than do other epidermal cells at corresponding levels in psoriatic skin, much the same as occurs in normal skin (6). There appears to be a greater-than-normal number of keratinosomes both within and between the light cells that form the duct wall.

Normal sweat ducts have been reported as being without keratinosomes in the inner or dark cells (5). In sweat ducts of psoriatic skin we find granules within the dark cells and a considerable amount of the amorphous component of keratinosomes between the dark inner cells.

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