Myelin Figures in the Basal-Granulated Cells of Human Brunner’s Glands

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Summary. Peculiar myelin figures were abundantly found in some basal-granulated cells including S, D₁, and I cells in human Brunner’s glands. Intense acid phosphatase activity was found in the periphery of the myelin figures, indicating that they were secondary lysosomes or residual bodies. The acid phosphatase activity was also found in some secretory granules. There were some secretory granules which were partly membranous in content, suggesting the initial stage of their degradation into myelin figures. There were also features indicating the fusion of secretory granules with the myelin figures. All these findings suggest that the myelin figures are the products of lysosomal degradation of secretory granules.

The rate of occurrence of basal-granulated cells containing myelin figures in Brunner’s glands tended to be higher in subjects with duodenal ulcer than in cases of gastric cancer or ulcer.

During the study on basal-granulated cells in human Brunner’s glands (Kamiya, 1983), it was noted that a large number of peculiar myelin figures were contained in such small granule-containing basal-granulated cells as S, D₁, and I cells.

Similar structures have been reported in pituitary endocrine cells and in B cells of Langerhans islets (Bommer et al., 1976), and have been considered to be secretory granules in the process of degradation (Smith and Farquhar, 1966; Hopkins, 1969; Rufener, 1973; Kodama and Fujita, 1975).

In the present study, acid phosphatase activity is demonstrated in myelin figures, indicating that they are secondary lysosomes. The probable processes of secretory granule degradation into the myelin figures are presented, and the clinical significance of myelin figures is discussed.

MATERIALS AND METHODS

Duodenal tissues were obtained at the time of surgical operation on five patients with duodenal ulcer (2 cases: a 36- and a 40-year-old male), gastric ulcer (1 case: a 44-year-old male) and gastric cancer (2 cases: a 49- and a 79-year-old male). The tissues were fixed for 2 hrs in a fixative containing 1.25% glutaraldehyde and 4% paraformaldehyde.
in 1/15 M phosphate buffer adjusted to pH 7.4. After brief washing, the tissues were postfixed for 1 hr in osmium tetroxide solution adjusted to pH 7.4 with the same buffer, then dehydrated through a graded ethanol series and embedded in Epon 812. Thin sections were cut with a diamond knife on an LKB Ultrotome, and were double-stained with uranyl acetate and lead citrate solutions and observed with a JEM 100B electron microscope. Semi-thin Epon sections (about 1 μm thick) were stained with toluidine blue for light microscopic observation.

For cytochemical examination, small pieces of tissue were obtained from each case at the time of operation. They were fixed for 30 min in an ice-cold fixative containing 2% glutaraldehyde in 0.1 M cacodylate buffer (pH 7.4) supplemented with 8% sucrose. After washing, 40 μm-thick frozen sections were cut from these tissues on a freezing microtome, and incubated for 10 min at 37°C in Gomori’s medium (Gomori, 1941). For light microscopic observation, the reaction products were made visible with ammonium sulfide. For electron microscopic observation, the incubated sections were postfixed for 1 hr at 4°C in 1% osmium tetroxide solution buffered by 0.1 M sodium cacodylate (pH 7.4). The subsequent procedures were the same as those described above. To explore the rate of occurrence of basal-granulated cells containing myelin figures, 100

![Fig. 1.](image-url)
basal-granulated cells were observed from each case; thus a total of 500 cells was observed by electron microscopy.

RESULTS

Cells containing dark granules were identified in the secretory portions of human Brunner's glands stained with toluidine blue (Fig. 1a). These cells were different from exocrine cells in having a relatively electron-lucent cytoplasm and containing no mucous granules. Electron microscope observation revealed that the dark granules stained with toluidine blue were myelin figures containing randomly arranged myelin-like membranous structures (Fig. 1b, 2). These myelin figures tended to be aggregated into large clusters (Fig. 1b, 3b, 4). It should be noted that the cells containing such myelin figures also possessed small secretory granules (Fig. 1b, 3b). Judging from the morphology of these secretory granules, the cells were identified as those basal-granulated cells as S, D₁, and I cells. D cells, the most common basal-granulated cells in human Brunner's glands (Kamiya, 1983), possessed no myelin figures.

Electron microscopic cytochemistry showed a positive acid phosphatase activity in the myelin figures. The reaction products were confined mainly to their periphery (Fig. 3b, 4). A few primary lysosomes contained intense reaction products. The acid phosphatase activity was also noted in some secretory granules (Fig. 5a). Such acid phosphatase-positive secretory granules sometimes contained partly membranous areas, suggesting the beginning of degradation of secretory granules (Fig. 5b). There were also some secretory granules which were presumed to be in the process of fusing with myelin figures (Fig. 5c). The density of secretory granules in basal-granulated cells

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Fig. 2. Electron micrograph showing myelin figures at a high magnification. They consist of randomly arranged myelin-like membranous structures. Sg secretory granules. × 50,000
which contained the myelin figures was much lower than in those without the myelin figures.

In the patients with gastric ulcer or gastric cancer, the rate of occurrence of the basal-granulated cells containing myelin figures, was 11%, 12% and 10% of the total S, D1 and I cells, respectively. In contrast, the figures were 22%, 23% and 70% of the total S, D1 and I cells, respectively, in the patients with duodenal ulcer.

**DISCUSSION**

The present observation that the myelin figures in basal-granulated cells are positive in acid phosphatase activity indicates that they are secondary lysosomes or residual bodies (DE DUVE and WATTIAUX, 1964; HOLTZMAN et al., 1966). The membranous structures of the myelin figures are considered to be undigested residual materials.

The occurrence of acid phosphatase activity in secretory granules should be considered in terms of secretory granule degradation (SMITH and FARQUHAR, 1966; HOPKINS, 1969). The acid phosphatase, which is presumed to be brought to the secretory granules by primary lysosomes, is believed to digest and degrade the granules into myelin

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Fig. 3. a. Light micrograph showing acid phosphatase-positive cells (arrows) in the secretory portion of the Brunner’s gland. 40 μm thick frozen section. ×500. b. Electron micrograph obtained from one of the acid phosphatase positive cells not identical with but similar to those shown in Figure 3a. The acid phosphatase-positive cells contain small secretory granules (short arrows) indicating that the acid phosphatase-positive cells are basal-granulated cells. The reaction products (long arrows) are located mainly in the periphery of myelin figures (mf). Some myelin figures are aggregated into large clusters. The area of the rectangle is shown at a higher magnification in Figure 4. This section was not stained for enhancement of electron density. N nucleus. ×12,500
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figures. The partly membranous changes of the granule contents, as seen in Figure 5b, are considered to be the beginning of granule degradation. The myelin figures were found to be fused with acid phosphatase-positive or sometimes acid phosphatase-negative secretory granules. Each myelin figure is aggregated into large clusters. This presumable process of degradation of secretory granules in basal-granulated cells is similar in principle to that described by Smith and Farquhar (1966) in anterior pituitary endocrine cells. Similar myelin figures of secondary lysosomes are found in other endocrine cells (Rufener, 1973; Kodama and Fujita, 1975; Bommer et al., 1976), suggesting that lysosomal degradation of secretory granules might be a general phenomenon in endocrine cells. However, intestinal basal-granulated cells containing myelin figures were only seldom seen. This might be due to the short life span of intestinal basal-granulated cells (Niki, 1980; Inokuchi et al., 1983).

It is noteworthy that the rate of occurrence of basal-granulated cells containing myelin figures was considerably higher in the patients with duodenal ulcer. S, D₁ and I cells have been considered to be related to the protection of duodenal mucosa by their enhancing the mucus secretion from the exocrine cells of Brunner's glands (Kamiya, 1983). Considering that myelin figures are indications of secretory granule degradation, it seems reasonable to propose that some relationship might exist between the increased number of myelin figure containing basal-granulated cells and the occurrence of the duodenal ulcer.

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Fig. 5. a-c. These three micrographs show the presumable process of secretory granule-degradation. The sections were stained with uranyl acetate. a. One secretory granule is positive in acid phosphatase activity (arrow), whereas the other is negative. mf Myelin figure × 60,000. b. Two large granules which contain reaction products. One granule (arrow) has a membranous part, suggesting the beginning of secretory-granule degradation. Sg secretory granules. × 60,000. c. A secretory granule (arrow) is presumably fused with myelin figures (mf). This granule has the reaction products of acid phosphatase activity. × 60,000
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