ACID PHOSPHATASE ASSOCIATED WITH THE GOLGI APPARATUS IN HUMAN LIVER CELLS

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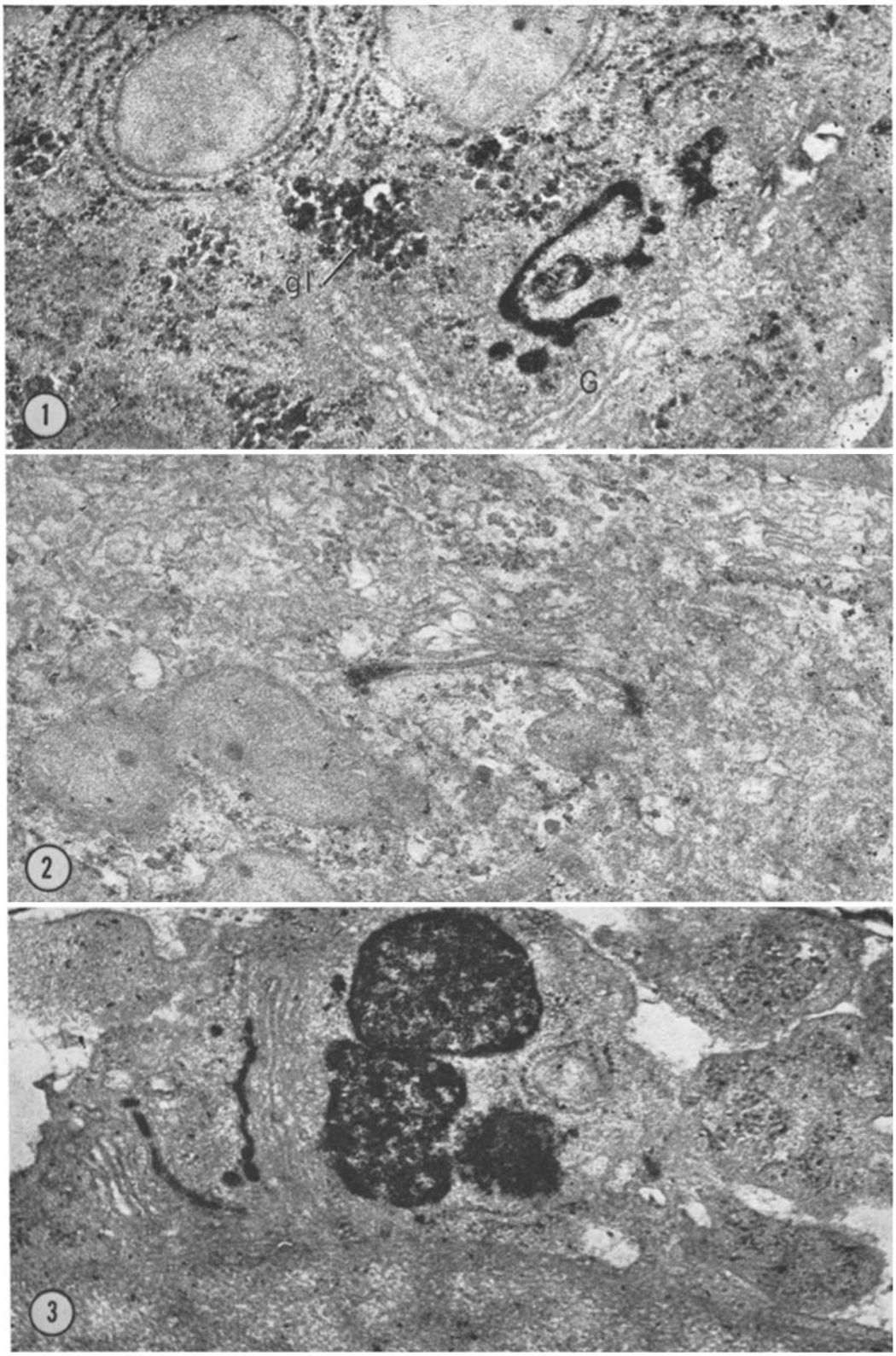
Acid phosphatase is one of the many hydrolytic enzymes, which have been recognized in lysosomes (9), and is considered a reliable marker for histochemical identification of these organelles in the electron microscope (10, 13, 8). Generally speaking, this enzyme is not found in any other cell

FIGURE 1 Liver parenchymal cell. Acid phosphatase activity is present in one cisterna of the Golgi apparatus (*G*), and in some adjoining vesicles. Glycogen (*gl*) is stained by the lead hydroxide used to contrast the sections. × 60,000.

FIGURE 2 Liver parenchymal cell. The enlarged ends of the last cisterna in the Golgi complex show an acid phosphatase activity. The reaction product seems to be localized in the interior of the dilated parts. × 56,000.

FIGURE 3 Kupffer cell. Two cisternae facing each other at the extremities of two stacks of Golgi membranes, are reactive for acid phosphatase, and so are some small vesicles, seemingly detaching from their margin. Acid phosphatase activity is also localized as usual in the big inclusion bodies, that is, in the lysosomes, typical of this type of cell. × 60,000.



organelle, one of the chief exceptions being, in some instances, the Golgi apparatus.

Acid phosphatase has been detected histochemically in the Golgi apparatus of various, quite different cell types: alveolar epithelial cells of the lung (2), epithelial lining of the intestine (24, 3, 18), cells of the convoluted and cortical collecting tubules of the kidney (19), sebaceous glands (6), pancreatic acinar cells (27), neurons (25, 21, 4), hypothalamic neurosecretory cells (26), adenohypophysis cells (28), meristematic cells of wheat (27), and a protist (*Euglena*) (7, 6, 30).

These histochemical observations support the hypothesis of several authors (23, 11, 20) that primary lysosomes originate from the Golgi apparatus. We ought to remember, however, that this hypothesis should not be generalized (3) and that the origin of these particles might be a different one (1, 6, 14, 22).

During a morphological and histochemical study on the behavior of lysosomes in liver cells, under both experimental and pathological conditions (12), we have observed a histochemically detectable acid phosphatase activity in the Golgi apparatus in a single case of viral hepatitis. This finding is exceptional in the case of liver cells (19), and therefore we have judged it worthy of some discussion

MATERIAL AND METHODS

Needle biopsies from the livers of 15 patients suffering from viral hepatitis and from five apparently normal livers were studied histochemically in the light microscope. Parts of four biopsies, from the hepatopatic patients, were studied also in the electron microscope (5, 12). These last liver biopsies were fixed in a 6.5% glutaraldehyde solution in cacodylate buffer for 2 hr (17); a part of each one was postfixed in osmium tetroxide and embedded in Vestopal W (Martin Jaeger Vésenaz/Genève, Switzerland) and a part was frozen-sectioned at 50 μ. These thick sections were incubated in the Gomori medium (pH 5.0) containing β-glycerophosphate, postfixed in osmium tetroxide, and embedded in Vestopal W. Sections incubated in the same medium which also contained 0.01 M NaF were used as controls. Thin sections, unstained or stained with lead (15) for 10 min, were observed in an Hitachi HU-11 electron microscope.

OBSERVATIONS

The modifications of liver parenchymal and Kupffer cells and the alterations in size and distribution of lysosomes have been already described elsewhere (5, 12). In one of the viral hepatitis–affected livers, in which cholestasis was also present from the disease, acid phosphatase activity was noted in the Golgi apparatus of both parenchymal and Kupffer cells (Figs. 1, 2, 3). Golgi-reactive cells were rather rare, and apparently randomly intermingled with cells in which acid phosphatase showed only the conventional lysosomal localization.

In each array of cisternae forming the Golgi apparatus, usually only one of them at the very end of the stack is reactive; some small vesicles, apparently detached from the margin of the Golgi apparatus, are also reactive. Beyond the Golgi apparatus, only the lysosomes are reactive for acid phosphatase (Fig. 3).

DISCUSSION

The presence of histochemically detectable acid phosphatase activity in the Golgi apparatus of either parenchymal liver cells or Kupffer cells, has never been observed until now; rarely some traces of activity, at the limit of detectability, are revealable in some of the Golgi vesicles (19). Since we have observed this enzymatic localization in one case of viral hepatitis, we can postulate that the alterations produced by the viral infection may be responsible for the histochemical localization observed.

Our observations might be explained if we assume that the Golgi apparatus may represent one stage in the transfer of the enzyme from the site of its synthesis to the lysosomes (23, 11, 20). The alterations induced by the viral infection could lead to the concentration of acid phosphatase, which probably is normally present in the Golgi apparatus of liver cells, beyond the point where it becomes histochemically detectable. This hypothesis is consistent with the observations of Lane and Novikoff (16) on cultured KB cells, in which acid phosphatase appears in abnormal localizations, only after the cells have been injured by arginine deprivation or by UV or X-ray irradiation. This could alter the regular transfer of the enzyme from the site of synthesis to the lysosomes.

The localization of the acid phosphatase activity only in the cisterna at the end of the Golgi complex suggests that (*a*) sufficient enzyme concentration for histochemical detection is reached through a sequence of steps in the different cisternae, or (*b*) the last cisterna is the only one

functionally ready for enzyme concentration. This restricted localization of the enzyme has been observed in most of the works mentioned above, and has been discussed by Smith (28) and by Sobel and Avrin (29).

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