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Electron Microscopy of Glycogen in Meningothelial Meningioma

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Previous histochemical investigations of glycogen in various types of meningiomas (FRIEDE, 1956; TAJIMA, 1960) indicate that most of the fibroplastic (Syn: fibroblastic, CUSHING and EISENHARDT, 1962) meningiomas contain much glycogen in the cytoplasm and fibers of the tumor cells, whereas the cytoplasmic or meningothelial meningiomas do not contain so much glycogen.

On the other hand, in the numerous electron microscopic studies on the various types of meningiomas (LUSE, 1960; KEPES, 1961; RAIMONDI, MULLAN and EVANS, 1962; GONATAS and BESEN, 1963; KOIZUMI, 1963; ISHIDA et al., 1964), the ultrastructural features of the tumor cells and tissues have been demonstrated in detail but nothing has been noted about glycogen as yet. This paper deals with the electron microscopic demonstration of glycogen granules in the tumor cell cytoplasm and the processes of three human meningothelial meningiomas.

Materials and Methods

The materials presented in this study were three human meningothelial meningiomas. After surgical removal, a portion of each biopsy material was fixed for 20 min in cold 4% formaldehyde (PEASE, 1962) buffered with phosphate at pH 7.4 and was postfixed for 2 hrs in a cold 1% phosphate-buffered osmium tetroxide solution (MILLONIG, 1961 a). After complete dehydration in ascending concentrations of ethanol, tissue blocks were embedded in Epon 812 (LUFT, 1961). After polymerization, ultrathin sections were made with a diamond knife on a Porter-Blum MT-1 microtome. The sections were mounted on collodion-coated copper grids and were stained with lead tartrate (MILLONIG, 1961b). These sections were examined with a Hitachi HS-8 electron microscope.

Sections from the paraffin-embedded materials for light microscopy were stained with hematoxylin and eosin. Semi-thin sections (about 1μ) were cut from the epoxy-embedded materials, and PAS reaction was examined.

Observations

Light microscopy

Histologically all three tumors examined were meningothelial meningiomas (Type I or II by the classification of CUSHING and EISENHARDT, 1962) showing no malignant features (Fig. 1). In these tumors a large amount of PAS-positive material is noted remarkably in the cytoplasm of the tumor cells, to various degree, in various regions of the section (Fig. 2).

Electron microscopy

The meningothelial tumor cells vary in shape from round to elongated forms. The nuclei are round or ellipsoidal in shape, but, in some instances, irregular indentations of the nuclear membrane are noted. The chromatin in most nuclei are finely granular and evenly distributed and the nucleoli are prominent. Comparatively large numbers of mitochondria in various shapes—round, ellipsoidal,

Fig. 1. Light micrograph of the meningothelial meningioma. The cells are polygonal and arranged in sheets. Vascularized trabeculae intersect the tumor tissue. Hematoxylin and eosin stain. $\times 200$

Fig. 2. Light micrograph of a semi-thin section from an epoxy-embedded block of the meningothelial meningioma. PAS-positive materials are accumulated in the tumor cell cytoplasm. PAS reaction. $\times 1,000$

irregular and bizarre—are seen in the cytoplasm and the processes of the tumor cells (Fig. 4, 5). Intracytoplasmic fine fibrils are noted in some tumor cells.

Fig. 3. Electron micrograph of the meningotheelial meningioma. Glycogen granules (*GL*) are massively accumulated in the perikaryal region of the tumor cell. *N* nucleus. $\times 18,000$

Extracellular fine fibrils which are considered to be reticulin and collagen fibers are seen in some regions.

Fig. 4. Electron micrograph of the meningotheelial meningioma. Numerous glycogen granules (GL) are scattered in the cytoplasmic matrix. Note the variety in the shape of mitochondria (M).
N nucleus. $\times 18,000$

The most impressive finding in the tumor cells is the accumulation of abundant cytoplasmic granules which, by their size and grouping pattern, are believed

Fig. 5. Cytoplasmic process of the tumor cell of the meningotheelial meningioma containing abundant glycogen granules (GL). Various shapes of mitochondria (M) are seen. Reticulin and collagen fibers are seen in the extracellular region. $\times 18,000$

to be glycogen granules. The characteristic affinity of the granules to lead staining supports this identification (REVEL et al., 1960). In prominent cases abundant glycogen granules occupy almost all the cytoplasmic matrix (Fig. 3, 5). Some tumor cells contain diffusely scattered glycogen granules throughout the cytoplasm and the processes (Fig. 4). Some others seem to be devoid of glycogen granules. Thus, the occurrence and distribution of glycogen granules may differ considerably from cell to cell.

The glycogen in the present tumor cells forms both single (β -type) and compound (α -type) particles, the individual particles measuring 200–400 Å in diameter (DROCHMANS, 1962; REVEL, 1964). These glycogen granule accumulations in the tumor cell cytoplasm in electron micrographs probably correspond to the remarkable PAS-positive material in the tumor cell cytoplasm in light micrographs. The glycogen granules do not show any morphological relation to the Golgi complex, endoplasmic reticulum, mitochondria and other cytoplasmic organelles.

Discussion

The histochemical investigations of the meningioma at the light microscopic level (FRIEDE, 1956; TAJIMA, 1960) have shown that glycogen is rich in most cases of fibroplastic meningioma but not so much in the cases of meningothelial meningioma. As to the electron microscopic observations (LUSE, 1960; KEPES, 1961; RAIMONDI, MURRAN and EVANS, 1962; GONATAS and BESEN, 1963; KOIZUMI, 1963; ISHIDA et al., 1964), the occurrence of glycogen granules has not been noticed in meningothelial, fibroblastic and psammomatous meningiomas. The present histochemical and electron microscopic studies in three cases indicate, in contrast to the previous reports, that even the meningothelial variety of meningioma contains much glycogen in the tumor cell cytoplasm and its processes. This new finding of the present study may be due to the better preservation of glycogen and of the cellular components surrounding it attained by the improvement of techniques for tissue fixation and embedding.

According to FRIEDE (1956), malignant brain tumors contain much more glycogen than benign ones. He regards the occurrence of glycogen as indicating the tendency of regressive changes. The present study demonstrates that, on one hand, the meningothelial meningiomas of benign features do contain a large amount of glycogen; and on the other hand, the glycogen granules remarkably differ in amount from cell to cell even in the same section. It is assumed that each tumor cell's carbohydrate metabolism is variably affected and may not be simply explained from the generalized viewpoint of malignancy or of regressive changes in the tumor.

Summary

Three human meningothelial meningiomas were examined by light and electron microscopy.

The tumor cell contains much glycogen in various amounts in various regions of the tumor tissue. In the most conspicuous cases, abundant glycogen granules fill the cytoplasmic matrix. Some cells contain diffusely scattered glycogen granules throughout the cytoplasm and the processes, but some others seem to be free of

glycogen granules. This variable distribution of glycogen granules within the same tumor seems to reflect that abnormal carbohydrate metabolism probably caused by the neoplastic metabolic process occurs to different degrees among individual tumor cells.

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髄膜細胞性髄膜腫の腫瘍細胞内グリコゲンの電顕像

(内容自抄)

3例の髄膜細胞性髄膜腫生検材料を光線顕微鏡と電子顕微鏡で検索して次の結果を得た。

腫瘍細胞に多量のグリコゲンがみとめられる。最も著しい場合は、グリコゲン顆粒が腫瘍細胞の細胞質基質を充たしているし、また細胞によっては、その細胞質と突起に散在性にグリコゲン顆粒が存在している。グリコゲン顆粒を含まない腫瘍細胞もある。このように腫瘍細胞が量や分布において各種各様のグリコゲン顆粒をたくわえている状態は、腫瘍性の糖代謝異常が個々の細胞にさまざまな程度に起こっていることに基くものと推定される。

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