Ultrastructural Changes in Water-Clear Cells of the Golden Hamster Parathyroid Gland after Streptozotocin Treatment

By

Shoichi EMURA*, Daisuke HAYAKAWA**, Akira TAMADA*, Tomo YAMAHIRA**,
Kishiko TERASAWA**, Hideo ISONO*** and Shizuko SHOUMURA**

* College of Medical Sciences, Gifu University, 70-1, Kitano-machi, Gifu 500, Japan

** Department of Anatomy, Gifu University School of Medicine, 40, Tsukasa-machi, Gifu 500, Japan

*** Heisei College of Medical Technology, 182, Kurono, Gifu 501-11, Japan

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Summary: The effects of streptozotocin treatment on parathyroid water-clear cells in golden hamsters were investigated. In the cytoplasm of the water-clear cells, lipid droplets were increased as compared to that of the control animals. This finding suggests that treatment of streptozotocin affects functional activity in the parathyroid water-clear cells of the golden hamsters.

Albright *et al.* (1934) first reported the water-clear cell hyperplasia of the parathyroid glands in patients with primary hyperparathyroidism, and several authors have described the ultrastructure of the water-clear cell (Holzmann and Lange, 1963; Sheldon, 1964; Faccini, 1970; Roth, 1970; Thiele and Pichlmayr, 1974; Altenähr, 1981). It has been demonstrated that the water-clear cell was absent in normal human (Altenähr, 1981; Isono *et al.*, 1990) or other vertebrate parathyroid glands (Isono *et al.*, 1990). However, Emura *et al.* (1990, 1991, 1992a, b) indicated that water-clear cells were observed in the parathyroid glands of golden hamster and rabbit.

A streptozotocin, which destroys selectively pancreatic B cells, is widely used to induce diabetes mellitus in experimental animals. Physiological studies have shown that streptozotocin treatment had an effect on calcium metabolism (Schneider *et al.*, 1974; Weber *et al.*, 1976; Shires *et al.*, 1981). Recent morphological study has reported that insulin does not modulate the release of parathyroid hormone (Bertoni *et al.*, 1988).

Our study have shown that lipid droplets were very numerous in water-clear cells as well as in chief cells in the golden hamsters after starvation (Emura *et al.*, 1992b).

This investigation was undertaken to study the effects of streptozotocin treatment on the water-clear cells in golden hamster parathyroid glands.

Materials and Methods

Ten 13-month-old (senile) male golden hamsters were divided into two groups. Senile hamsters were used because water-clear cells were more frequently observed in parathyroid glands of senile hamster than in adult and young ones. The animals were kept under standard conditions. Five experimental animals were injected intraperitoneally in a single dose (65 mg/kg body weight) of streptozotocin (Sigma) dissolved in saline adjusted to pH 4.5 with citrate buffer. Five control animals received an equal volume of the same buffer (pH 4.5) intraperitoneally. The five experimental animals were killed 7 days after streptozotocin administration. The parathyroid glands of the control and experimental groups were removed under sodium pentobarbital anesthesia. The glands were immersed in a mixture of 2.5% glutaraldehyde and 2% osmium tetroxide in Millonig's buffer at pH 7.4 for 1 hr, dehydrated through increasing concentrations of acetone and embedded in Epon 812. Thin sections were cut on a Porter-Blum MT-1 ultramicrotome, stained with uranyl acetate (Watson, 1958) and lead mixture (Sato, 1968), and examined with an Hitachi H-700 H electron microscope.

Results

In water-clear cells, the vacuoles were occasionally observed in the parathyroid glands of the control

senile golden hamsters the cytoplasm was filled, for the most part, with spherical membrane-limited vacuoles containing a finely particulate substance and thread-like material (Fig. 1, inset). These vacuoles in the water-clear cells resembled dilated cisternae of the granular endoplasmic reticulum in the chief cells (Fig. 1).

The cell was situated close to the basal lamina of the capillary vessel (Fig. 1). Mitochondria, free ribosomes, lysosomes and glycogen granules were scattered among the vacuoles (Fig. 1). Some secretory granules were observed in the peripheral cytoplasm (Fig. 1), and Golgi complexes and cisternae of the granular endoplasmic reticulum were sometimes seen.

In the parathyroid glands of the control animals lipid droplets were sometimes observed. However, numerous lipid droplets were observed in the cytoplasm of the chief cells of the experimental animals and glycogen granules were situated close to the lipid droplets (Fig. 2).

Furthermore, the lipid droplets were numerous in the water-clear cells as well as in the chief cells of the parathyroid glands in the experimental animals (Fig. 2, 3). A few secretory granules were present in the cytoplasm (Fig. 4).

Discussion

Bertoni *et al.* (1988) have suggested that synthesis of parathyroid hormone is not suppressed in diabetes but that fat metabolism is disturbed leading to accumulation of lipid vacuoles. Reinila and Akerblom (1984) have reported that diabetes in the rat causes mitochondrial swelling, dilatation of sarcoplasmic reticulum and accumulation of lipid in cardiac myocytes, and that these changes are preventable with insulin treatment. Bestetti *et al.* (1987) have reported that epithelial cells in the thyroid of diabetic rats were characterized by flattened and almost empty rough endoplasmic reticulum cisternae, scanty exocytotic apical and endocytotic vesicles as well as degenerated mitochondria and rough endoplasmic reticulum.

Some authors have reported that the hypoactive chief cells of the parathyroid glands of adult mice show an increase in lipid droplets (Isono *et al.*, 1980; Isono *et al.*, 1981; Isono *et al.*, 1983 Reinila and Akerblom, 1984; Bestetti *et al.*, 1987). It has been described that in the parathyroid glands of hamsters after starvation or treatment of isoproterenol the chief cells are characterized by many lipid droplets (Hayashi *et al.*, 1981; Isono *et al.*, 1985; Emura *et al.*, 1988; Shoumura *et al.*, 1988; Emura *et al.*, 1989). Accordingly, it is suggested that treatment of streptozotocin affects functional activity in the chief cells of

the parathyroid glands.

We have recently reported that numerous lipid droplets are observed in the water-clear cells as well as in the chief cells of the parathyroid glands of the senile golden hamsters after starvation (Emura *et al.*, 1992). In the present study, lipid droplets were numerous in the water-clear cells of the parathyroid glands in the golden hamsters after administration of streptozotocin. Therefore, result of our study suggests that treatment of streptozotocin also affects functional activity in the water-clear cells of the parathyroid glands in the senile golden hamsters.

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Explanation of Figures

Plate I

Fig. 1. Parathyroid water-clear cell (WC) from a control senile golden hamster. The cell is situated close a capillary. The cytoplasm is filled with membrane-limited vacuoles containing a finely particulate substance and thread-like material. Arrows: secretory granules. CC: chief cells. $\times 9,000$. Inset: Parathyroid water-clear cell from a control senile golden hamster. Vacuoles contain a finely particulate substance (double arrow) and thread-like material (arrow). $\times 26,000$

Plate II

Fig. 2. Parathyroid chief cells (CC) from a senile golden hamster after streptozotocin administration. Note numerous lipid droplets (L) and glycogen particles (arrows) situated close to the lipid droplets. LY: lipofuscin-like bodies. $\times 6,600$

Plate III

Fig. 3. Parathyroid water-clear cells (WC) from a senile golden hamster after streptozotocin administration. Lipid droplets (L) are numerous in the water-clear cells and chief cells (CC). $\times 7,700$

Plate IV

Fig. 4. Parathyroid water-clear cell (WC) from a senile golden hamster after streptozotocin administration. The Golgi complex (G) containing prosecretory granule (arrowhead) and a few secretory granules (arrows) is observed. L: lipid droplets. LY: lipofuscin-like body. CC: chief cell. $\times 33,000$