Ultrastructure of the Water-Clear Cell in the Rabbit Parathyroid Gland

Shoichi EMURA, Shizuko SHOUMURA and Hideo ISONO

Department of Anatomy, Gifu University School of Medicine, Gifu, Japan

Received November 21, 1991

Summary. The ultrastructure of water-clear cells has been described in human hyperplastic parathyroid glands. However, previous studies have failed to demonstrate this type of cell in normal human or other vertebrate parathyroid glands. Upon recognizing water-clear cells in the parathyroid glands of the golden hamster, we intended to examine the occurrence of these cells in other animals. In the present study the parathyroid glands of about one-year-old rabbits were observed by electron microscopy. Water-clear cells containing numerous vacuoles were demonstrated dispersed among the chief cells. The cells were generally situated close to the basal lamina of perivascular space which lay against the capillary vessel and were attached by desmosomes to the chief cells. Irregularly shaped vacuoles in the water-clear cells resembled dilated cisternae of the granular endoplasmic reticulum in the chief cells. Several ribosomes could be seen attached to the membrane of some of the irregularly shaped vacuoles. It is conceivable that the water-clear cells are transformed from the chief cells.

ALBRIGHT et al. (1934) first described, by light microscopy, water-clear cell hyperplasia of the parathyroid glands in patients with primary hyperparathyroidism. The ultrastructure of these peculiar cells was later demonstrated by electron microscopy (HOLZMANN and LANGE, 1963; SHELDON, 1964; FACCINI, 1970; ROTH, 1970; THIELE and PICHLMAYR, 1974; ROTH and CAPEN, 1974; ALTENÄHR, 1981). In addition, it has been reported that the water-clear cell is absent in normal humans (ROTH and CAPEN, 1974; ROTH and SCHILLER, 1976; ALTENÄHR, 1981; ISONO et al., 1990) or other vertebrate parathyroid glands (ROTH and CAPEN, 1974; ROTH and SCHILLER, 1976; ISONO et al., 1990). However, our previous reports have demonstrated that the water-clear cell is present in the parathyroid gland of the golden hamster (EMURA et al., 1990, 1991).

The present study concerns the water-clear cell in the parathyroid gland of the adult rabbit.

MATERIALS AND METHODS

Ten healthy rabbits of both sexes, about one year of age and with an average body weight of 3 kg, were used in this study. The parathyroid glands of the rabbits were removed under sodium pentobarbital anesthesia. The glands were immersed in a mixture of 2.5% glutaraldehyde and 2% OsO₄ in Millonig's buffer at pH 7.4 for 1 h, 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 and lead mixture, and examined with a Hitachi H-700 H electron microscope.

RESULTS

The description of the chief cells of the parathyroid gland of the adult rabbit agrees with previous reports (ROSENQUIST and BOQUIST, 1973; YOUNG et al., 1973; ATWAL et al., 1975; ISONO and SHOUMURA, 1980; ISONO et al., 1982, 1990). The cells were oval, elongate or irregular in shape, and possessed a round, oval or spindle-shaped nucleus (Figs. 1, 2). The plasma membranes of adjacent chief cells pursued a relatively straight course with occasional interdigitations (Figs. 1, 2). Mitochondria were scattered and free ribosomes were dispersed in the cytoplasm (Figs. 1, 2). Cisternae of the granular endoplasmic reticulum containing a floccular material were either randomly distributed or occasionally arranged in parallel arrays (Figs. 1, 2). Most Golgi complexes were well developed and contained some prosecretory granules (Figs. 1, 2).
Fig. 1. A water-clear cell (WC) containing numerous vacuoles is seen among chief cells (CC). From the parathyroid gland of an adult rabbit. ER cisternae of the granular endoplasmic reticulum, L lipid droplets, stars Golgi complexes, arrows large secretory granules, arrowheads secretory granules. ×9,000
Fig. 2. A water-clear cell (WC) filled with irregularly shaped vacuoles. The cell is located close to a basal lamina of perivascular space which lies against the capillary vessel (CV). CC chief cells, L lipid droplets, stars Golgi complexes, ER cisternae of the granular endoplasmic reticulum, arrows large secretory granules, arrowheads secretory granules. ×9,000
Numerous secretory granules of 150-300 nm in diameter, a few larger granules of 300-400 nm in diameter, some vacuolar bodies, occasional lysosomes and several lipid droplets were contained in the cytoplasm (Figs. 1, 2).

A peculiar type of cell containing numerous vacuoles within the cytoplasm was occasionally found among the chief cells of the parathyroid gland of the adult rabbit (Figs. 1, 2). This type of cell will be called the water-clear cell, since it resembles the water-clear cell in hyperplastic parathyroid glands of patients that was reported on by several authors (HOLZMANN and LANGE, 1963; SHELDON, 1964; FACCIINI, 1970; ROTH, 1970; THIELE and PICHLMAYR, 1974; ALTENÄHR, 1981) and in the normal parathyroid gland in golden hamsters as described in our previous reports (EMURA et al., 1990, 1991).

The water-clear cells were observed in all the parathyroid glands of the ten adult rabbits used in this study, and the ratio of the number of the water-clear cells to that of the chief cells was approximately 1:80. The water-clear cell possessed an oval or round nucleus with occasional indentations (Figs. 1, 2). The cytoplasm was filled, for the most part, with oval, round or irregularly shaped vacuoles (Figs. 1–4). The cell, attached by desmosomes to the chief cells (Fig. 4), was generally situated close to a basal lamina of the perivascular space which lay against the capillary vessel (Figs. 2, 4). Irregularly shaped vacuoles resembled dilated cisternae of the granular endoplasmic reticulum in the chief cells (Fig. 3). Most vacuoles contained a finely particulate substance and a thread-like material. A portion of a vacuole occasionally invaginated into an adjacent vacuole (Fig. 5). Noteworthily, several ribosomes were seen attached to the surface of some of the irregularly shaped vacuoles (Fig. 6). In the cytoplasm, mitochondria and free ribosomes lay between the vacuoles (Figs. 1–6). The Golgi complexes were well developed, containing many coated vesicles and a few

Fig. 3. Irregularly shaped vacuoles in a water-clear cell. Note their resemblance with the dilated cisternae of the granular endoplasmic reticulum in the chief cell. Vacuoles contain a finely particulate substance and a thread-like material. L lipid droplets. ×18,000
prosecretory granules (Figs. 1, 2, 4). Secretory granules and lipid droplets were sometimes observed and large secretory granules were occasionally found in the cytoplasm (Figs. 2, 4).

Chief cells containing dilated cisternae of the granular endoplasmic reticulum and irregularly shaped vacuoles were occasionally observed (Fig. 7). These cisternae and vacuoles included a finely particulate substance and a floccular material (Fig. 7).

DISCUSSION

It has been reported that the water-clear cells are absent in normal humans (ROTH and CAPEN, 1974; ROTH and SCHILLER, 1976; ALTENÄHR, 1981; ISONO et al., 1990) or other vertebrate parathyroid glands (ROTH and CAPEN, 1974; ROTH and SCHILLER, 1976; ISONO et al., 1990). In the present study, however, water-clear cells containing numerous vacuoles within the cytoplasm were demonstrated between the chief cells in the parathyroid gland of the rabbit. The same cells have also been observed in our previous reports on the parathyroid gland of the golden hamster (EMURA et al., 1990, 1991). Further studies seem thus worthwhile in order to clarify the presence of the cells in other animal species.

The present study showed that the vacuoles of the water-clear cells contained a finely particulate substance and a thread-like material. This finding is fairly consistent with the observations by SHELDON (1964) and ROTH (1970) in humans and EMURA et al. (1990, 1991) in the golden hamster. In addition, ROTH (1970) and EMURA et al. (1990, 1991) demonstrated the fusion of adjacent vacuoles which was also observed in the present study.

In the present study, several ribosomes were seen attached to the surface of some of the irregularly
shaped vacuoles in the water-clear cell, and these vacuoles resembled the dilated cisternae of the granular endoplasmic reticulum which were seen in occasional chief cells. This finding suggests the possibility that the vacuoles may be derived from the cisternae of the granular endoplasmic reticulum, as postulated by Roth (1970) and Emura et al. (1990, 1991). A cloudy swelling is morphologically characterized by the slight swelling of the cell, with granularity and cloudiness of the cytoplasm, and represented, as the primary morphologic alteration, either by swelling of the endoplasmic reticulum or swelling of the mitochondrion. It is described that this change may be caused by a host of factors including: infection; febrile illness; poisoning; physical injury, such as excessive cold or heat; anoxia; malnutrition or circulatory disturbances (Robbins, 1967). In the present material obtained from healthy rabbits, the cytoplasmic organelles appeared normal except for dilated cisternae of the granular endoplasmic reticulum. The present study further demonstrated, in occasional chief cells, dilated cisternae of the granular endoplasmic reticulum and irregularly shaped vacuoles containing a finely particulate substance and flocular material. These cells are presumed to be transitional forms between the chief cells and water-clear cells. Accordingly, it seems likely that the water-clear cells are transformed from the chief cells, as suggested by Roth and Marshall (1969), Roth (1970) and Emura et al. (1990, 1991).

Fig. 5. A water-clear cell of the rabbit parathyroid gland. A portion of the vacuoles invaginates into adjacent vacuoles (arrows). Vacuoles contain a finely particulate and thread-like material. × 20,000

Fig. 6. A water-clear cell of the rabbit parathyroid gland. Ribosomes (circles) are attached to the surface of irregularly shaped vacuoles. Vacuoles contain a finely particulate and thread-like material. × 30,000
REFERENCES


---

Fig. 7. Dilated cisternae of the granular endoplasmic reticulum (ER) observed in the chief cell of the rabbit parathyroid gland. The cisternae contain a finely particulate substance and floccular material. L lipid droplets, CV capillary vessel. ×13,000


