

Effects of progesterone on the ultrastructure of the golden hamster parathyroid gland

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Summary. The ultrastructure of the parathyroid glands in golden hamsters after administration of progesterone was investigated. In the parathyroid glands of the female hamsters after administration of progesterone, the mean serum calcium concentration was significantly higher when compared to that of the control hamsters. In the male experimental hamsters, the percentage area occupied by Golgi complexes and lipid droplets was significantly increased when compared to that of the control hamsters, respectively. In the female hamsters after administration of progesterone, the percentage area occupied by large vacuolar bodies was significantly decreased when compared to that of the control hamsters. In the male and female experimental hamsters, the mean number of secretory granules per 100 μm^2 of cytoplasm showed a significant increase compared with that of the male and female control hamsters, respectively. These findings suggest that the secretory activity of the parathyroid glands may be stimulated in response to hypocalcemia induced by progesterone.

Key words: Parathyroid gland, Progesterone, Golden hamster

Introduction

Female sex hormones are known to have marked effects on calcium metabolism. Our morphological report has suggested that estrogen treatment stimulates the secretory process in the parathyroid gland related to calcium and phosphorus metabolism (Emura et al., 1982). It has been reported that estrogens modulate not only parathyroid hormone (PTH) release but also PTH synthesis (Wild et al., 1989). In addition, it has been demonstrated that ovariectomy suppresses the synthesis and release of PTH (Emura et al., 1984) and that ovariectomy enhances calcium loss from the bone (Orimo et

al., 1972; Draper et al., 1980; Kawanobe et al., 1981).

This investigation was undertaken to study the effects of progesterone on the ultrastructure of the parathyroid glands of golden hamsters.

Materials and methods

Fourteen male and twelve female golden hamsters were divided into two groups, respectively. Seven male and six female hamsters served as control groups. The remaining two groups of seven male and six female hamsters were given progesterone (Nakarai chemicals LTD) intracutaneously, once daily at a dose of 25 mg/kg body weight in olive oil for 5 days. The control hamsters received the solvent alone. The parathyroid glands of the progesterone-treated hamsters and the control hamsters were removed under sodium pentobarbital anaesthesia (50 mg/kg body weight) 24 hrs after the last administration, immersed in a mixture of 2.5% glutaraldehyde and 1% cold OsO_4 in Millonig's buffer at pH 7.2 for 1 hr, dehydrated through ascending 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 salts, and examined with a Hitachi H-700 H electron microscope.

In all animals from each group, 20 micrographs (final magnification $\times 12,000$) were taken from different regions of the parathyroid glands. The area of cytoplasm, Golgi complexes, lysosomes, lipid droplets and large vacuolar bodies, and the number of secretory granules were estimated with the aid of an image analyser (Digigrammer Model-G, Mutoh).

The serum calcium levels of all animals were measured using a corning calcium analyser 940.

All values were presented as means $\pm$ SEM. In the serum calcium concentration and the percentage area occupied by Golgi complexes, lysosomes, lipid droplets and large vacuolar bodies, and the number of secretory granules in the control and experimental groups, the comparison of two mean values was made using Student's *t* test.

Results

Serum calcium level

The mean serum calcium concentrations (mg/100 ml) of the control and progesterone-treated groups are shown in Table 1. In the male progesterone-treated group, the mean serum calcium concentration appeared to be decreased. In the female progesterone-treated group, it was significantly low ($p<0.05$) compared with the control group.

Ultrastructure and morphometry

In the parathyroid glands of the control adult golden hamsters, the chief cells were oval or polygonal in

shape. The intercellular spaces were generally narrow, and occasional enlargements contained floccular material. The cytoplasm was scattered diffusely with

Table 1. Number of animals and serum calcium level (mg/100 ml)

	ANIMAL, n	SERUM CALCIUM LEVEL
<i>Male</i>		
Control group	7	11.54±0.05
Progesterone-treated group	7	11.22±0.14
<i>Female</i>		
Control group	6	11.18±0.18
Progesterone-treated group	6	10.61±0.15*

Values are means±SEM. *: $p<0.05$ versus control group (Student's *t* test).

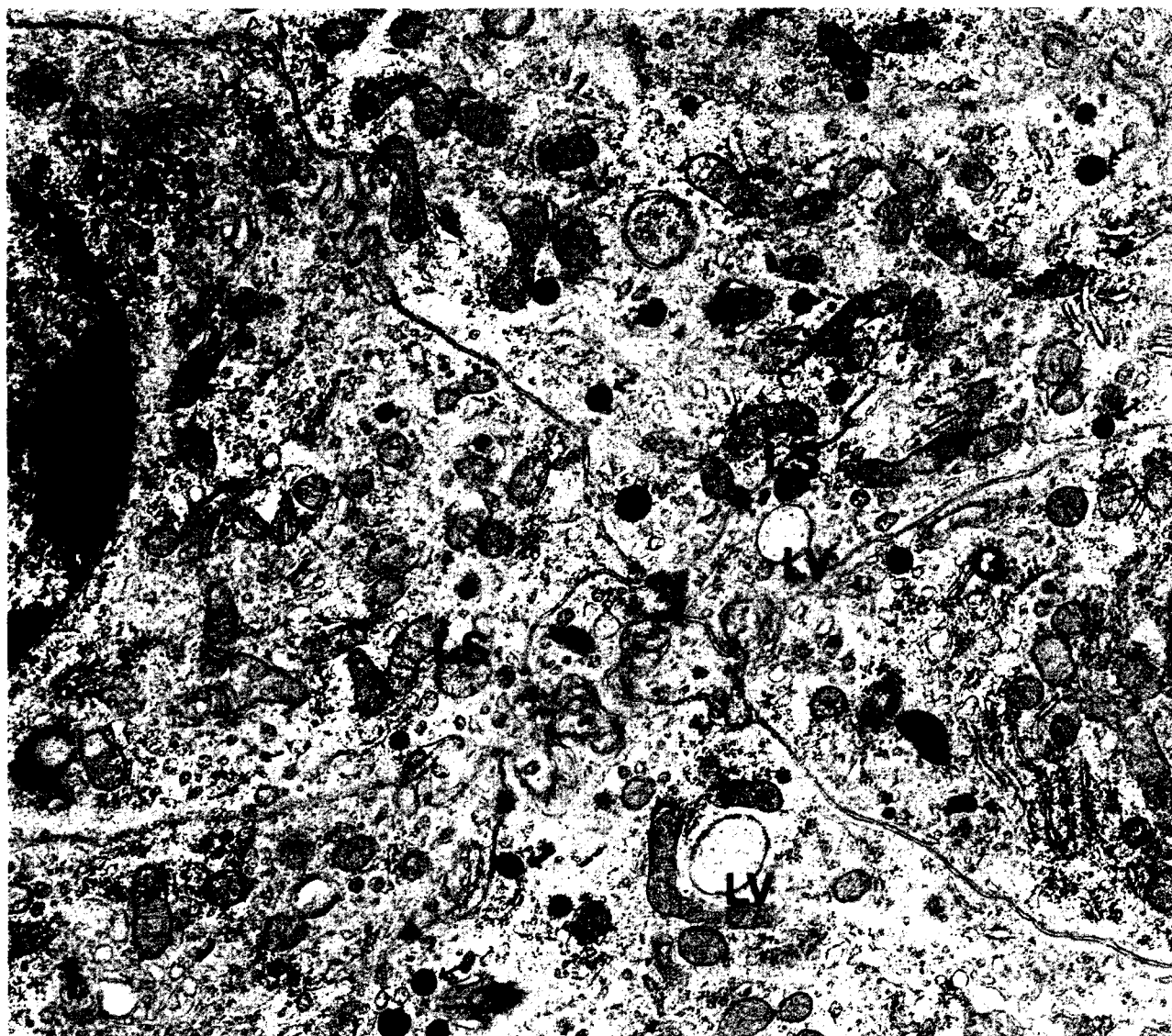


Fig. 1. Parathyroid chief cells from a male control golden hamsters, showing Golgi complexes (G), large secretory granules (LS), large vacuolar bodies (LV) and some secretory granules (arrows). x 17,000

free ribosomes and randomly with abundant mitochondria (Fig. 1). Cisternae of the granular endoplasmic reticulum were sometimes arranged in parallel arrays or randomly distributed in the cytoplasm. Most Golgi complexes were relatively well developed and contained several prosecretory granules. Secretory granules of 150-300 nm in diameter were frequently observed in the cytoplasm and sometimes located in a peripheral position adjacent to the plasma membrane. Large secretory granules filled with a finely particulate material showed a lower electron density than the secretory granules. Large vacuolar bodies contained floccular material and/or vesicles.

In the male hamsters, after administration of progesterone, most Golgi complexes were well

developed and associated with occasional prosecretory granules (Fig. 2). In the male and female after administration of progesterone, large vacuolar bodies and large secretory granules (storage granules) were sometimes observed in the cytoplasm (Fig. 2). Lipid droplets were sometimes observed. Many secretory granules were scattered in the cytoplasm and frequently located in the peripheral cytoplasm (Fig. 3).

The results obtained from the control and experimental groups are shown in Table 2. In the male experimental group, the percentage area occupied by Golgi complexes and lipid droplets, and the number of secretory granules showed a significant increase ($p < 0.05$) compared with that of the control group, respectively. There were no significant differences

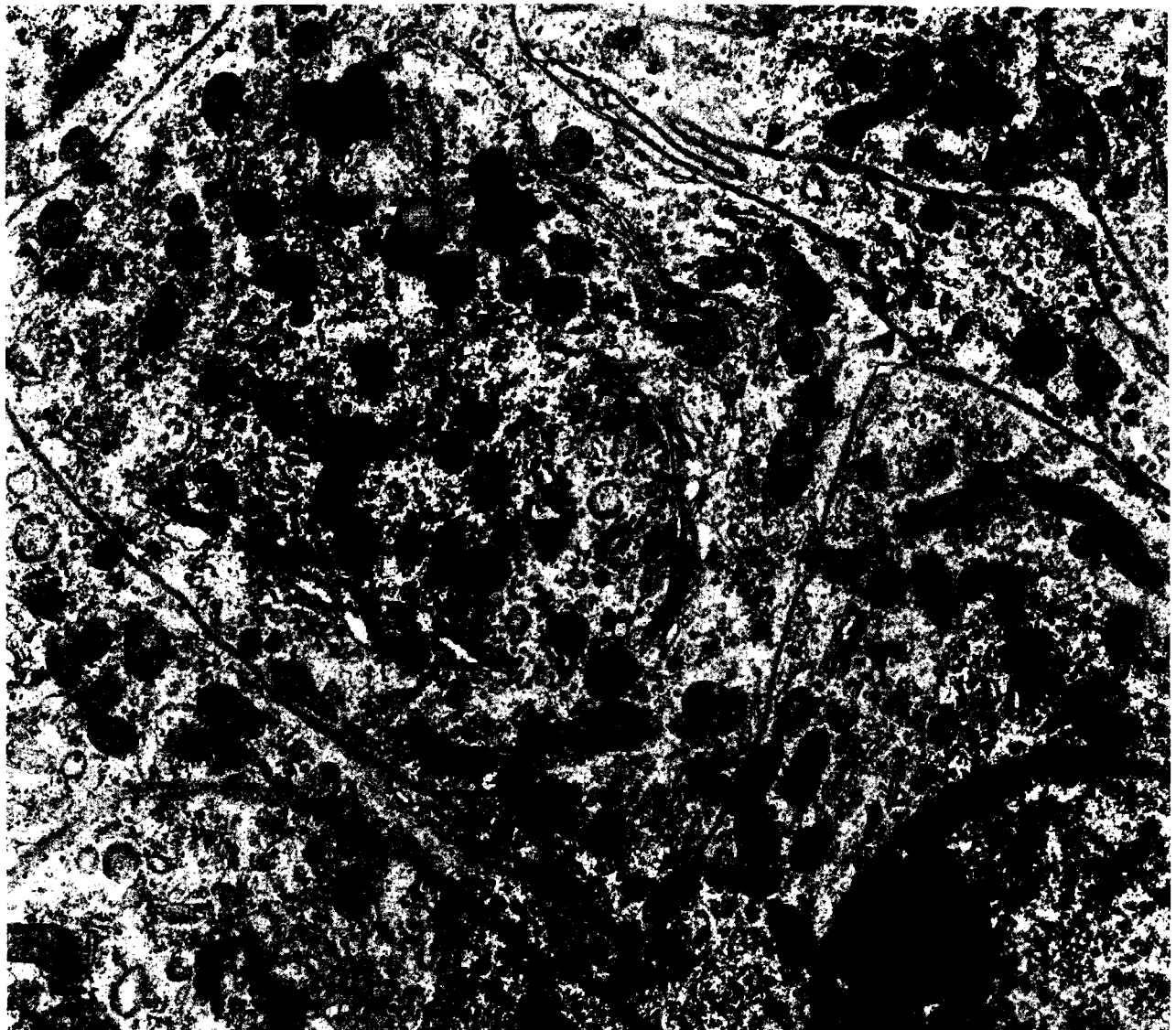


Fig. 2. Parathyroid chief cells from a male experimental golden hamster. Relatively well-developed Golgi complexes (G), large secretory granules (LS) and some secretory granules (arrows) located in the peripheral cytoplasm are observed. $\times 17,000$

between the control and experimental groups with regard to lysosomes and large vacuolar bodies. In the female experimental group, the percentage area occupied by large vacuolar bodies showed a significant decrease ($p<0.05$) and the number of secretory granules showed a significant increase ($p<0.05$) compared with that of the control group. There were no significant differences between the control and experimental groups with regard to Golgi complexes, lysosomes and lipid droplets.

Discussion

Brunner et al. (1992) have reported that progesterone is capable of inducing membrane synthesis leading to

enlargement of the RER and Golgi complex; this implies enhanced capacity for PTH secretion.

In the present study, the mean calcium level in the male experimental group appeared to be decreased, but the difference was not significant, and the Golgi complex showed a significant increase compared with that of the control group. The mean calcium level of the female experimental group showed a significant decrease, but the Golgi complex showed no significant difference compared with that of the control group. These findings are fairly consistent with the observations of an increase in functional activity of the parathyroid gland, though it may be thought that in the parathyroid glands after administration of progesterone there is a

Table 2. Percentage area occupied by the Golgi complex (G), lysosome (LY), lipid droplet (L) and large vacuolar body (VB).

	G	LY	L	VB	SG
<i>Male</i>					
Control group	4.17±0.30	1.19±0.08	0.14±0.05	0.31±0.04	9.80±0.79
Progesterone-treated group	5.51±0.34*	1.20±0.06	0.29±0.04*	0.28±0.05	12.16±0.68*
<i>Female</i>					
Control group	4.41±0.33	1.10±0.10	0.15±0.05	0.39±0.05	6.96±0.44
Progesterone-treated group	4.17±0.14	1.06±0.04	0.08±0.02	0.22±0.02*	9.04±0.75*

The percentage area is presented as percentage of cytoplasmic area. SG: number of secretory granules per 100µm² in the cytoplasm. Values are means ±SEM. *: $p<0.05$ versus control group (Student's *t* test).

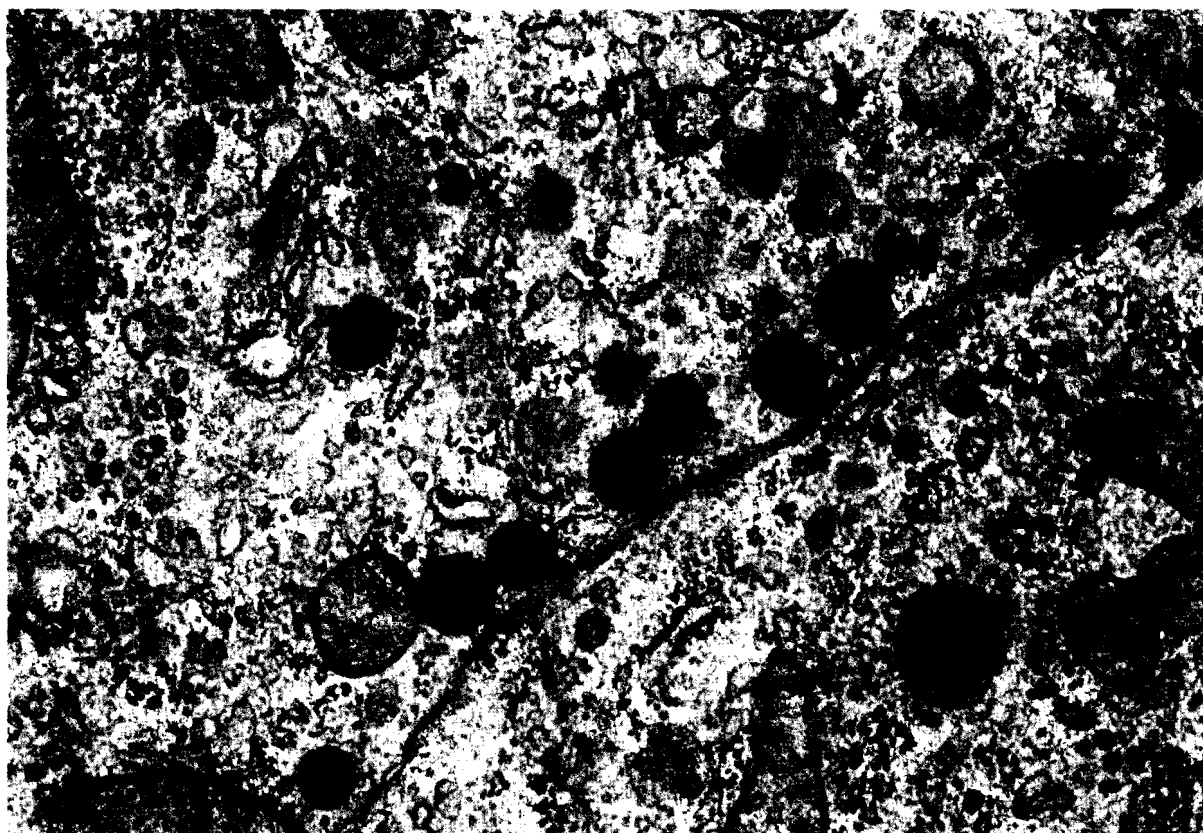


Fig. 3. Parathyroid chief cells from a male experimental golden hamster. The secretory granules are situated close to the plasma membrane. x 38,000

difference between the male and female (Shoumura et al., 1991, 1992). Furthermore, the lipid droplets of the male experimental group showed a significant increase compared with that of the control group. The hypoactive chief cells of the parathyroid glands generally show an increase in the lipid droplets (Emura et al., 1988, 1989). However, it has been described that in the parathyroid glands of bats during early hibernation the active chief cells are characterized by many lipid droplets (Nunez et al., 1972). Additional investigations are required to clarify a role of the lipid droplets in the synthesis and release of parathyroid glands.

Recently, we investigated the effects of different ages on large vacuolar bodies in the parathyroid glands of golden hamsters after short-term treatment with calcium or prostaglandin E₂ (Emura et al., 1992, 1994). The result suggested that large vacuolar bodies in the parathyroid glands of the golden hamsters are increased in response to acute hypercalcemia (Emura et al., 1992, 1994). Our study showed that in the female experimental group, the large vacuolar body was significantly decreased when compared to that of the control group. Accordingly, it is thought that the secretory activity of the parathyroid gland may be stimulated in response to hypocalcemia induced by progesterone.

It has been reported that the parathyroid glands of calcium-treated hamsters show a decrease in the Golgi complexes and an increase in the number of secretory granules (Emura et al., 1992). In the present study, the Golgi complexes and the number of secretory granules in both male and female the experimental groups showed a significant increase compared with that of the control groups, respectively. Many secretory granules in the parathyroid glands after administration of progesterone were present in the peripheral cytoplasm, and some granules were situated close to the plasma membrane. The number of secretory granules in the chief cells of the parathyroid gland does not appear to correlate with the functional states of the gland (Roth and Raisz, 1966; Altenähr and Seifert, 1971), and in active chief cells of the parathyroid gland secretory granules have a tendency to gather beneath the plasma membrane (Isono and Shoumura, 1980; Emura et al., 1982, 1984). Therefore, these results suggest that the secretory activity of the parathyroid gland may be stimulated in the progesterone-treated hamsters.

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