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Effect of Cadmium Chloride on Thyroid Activity of the Female Indian Palm Squirrel, *Funambulus pennanti* (Wroughton)

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In humans, exposure to Cadmium (Cd) occurs primarily through inhalation and ingestion. Acute Cd inhalation results in pulmonary edema and respiratory tract irritation; while chronic inhalation causes fibrotic and emphysematous changes in lung tissue as well as damage of renal proximal tubules (Zavon and Meadow 1970; Friberg et al.1974). Several workers have reviewed the toxic effects of Cd on mammals, including man (Friberg et al.1974;1979; Vallee and Ulmer 1972; Fox 1982; Arvidson 1983). In laboratory animals Cd produced kidney damage, testicular necrosis and atrophy, brain haemorrhage, hypertension, liver damage and reduced growth (Friberg et al.1974). It also induced changes in the adrenal and thyroid gland in rat (Rastogi and Singhal 1975; Der et al.1977). Cd is largely consumed through water and food, but in this study the wild rodent, Funambulus pennanti, were administered intraperitoneally a single dose of $CdCl_2$, and their thyroid structure and radioiodine I^{131} uptake were assessed.

MATERIALS AND METHODS

60 adult female, F.pennanti (115 + 10 gm body wt.) were collected from the campus of the Banaras Hindu University and its vicinity. They were divided into two groups of 30 each and acclimated to laboratory conditions (14L:10D and 22°C temperature) for ten days prior to initiating the experiment. They were fed with water soaked Bengal gram and water was given ad libitum. The first group was administered intraperitoneally a single dose of 0.0035 mM aqueous solution of cadmium chloride ($CdCl_2$), while the 2nd group (control) received only the vehicle, 0.9% normal saline. Five animals from each group were sacrificed on the 1st, 7th and 40th day and their thyroids were dissected out, fixed in Bouin's fluid. Five μ thick paraffin sections were prepared and

stained in Ehrlich's haematoxylin and eosin (H & E) for histological observation. Prior to termination of the experiment, five animals from each group were intraperitoneally administered a tracer dose of 5 μci of I^{131} and were sacrificed 24 hours after tracer injection. Thyroid was fixed in Bouin's fluid, and the percentage uptake of I^{131} was estimated using a gamma counter. Students 't' test was used for statistical analysis.

RESULTS AND DISCUSSION

In the control animals, the follicular epithelium was low and the lumen was filled with colloid (Fig. 1). The thyroid follicles, examined 24 hour after a single injection of Cd (0.0035 mM), exhibited hypertrophied epithelial cells and greatly reduced colloidal content (Fig. 2). However, after 7 days of treatment, follicular cell height was decreased, nuclei were intensely stained and the follicles were in a collapsed state (Fig. 3). Slight recovery was noticed on 40th day. The epithelial cell height was slightly increased, the follicular form was regained and the nuclei of the epithelial cells were lightly stained (Fig. 4). The radioiodine uptake was significantly reduced ($P < 0.05$ and $P < 0.01$) throughout this experiment in the $CdCl_2$ exposed squirrels. (Fig. 5).

The present study shows that Cd impairs thyroid activity in F. pennanti. Thyroid hypertrophy was seen within 24 hours of Cd treatment, which was followed by involution and collapse of follicles on the 7th day. However, 40 days after single injection of $CdCl_2$, signs of recovery of thyroid were observed. Some data are available on heavy metal toxicity on thyroid function in occupationally exposed men and experimental rodents (Zeltser 1962; Sandstead 1967; Sandstead et al.1969; Der et al. 1977; Robins et al.1983; Shrivastava et al.1987), and Slingerland (1955); Sandstead (1967); Robins et al. (1983) have reported reduced thyroidal I^{131} uptake.The percentage uptake of I^{131} was significantly reduced in the palm squirrel suggesting that Cd inhibits thyroid function in F. pennanti. Cd induced hypertrophy of the thyroid may be due to the higher level of TSH caused by the low levels of circulating thyroxine influencing the hypothalamo-hypophyseal feedback system. The probable mode of action seems to be the inhibition of various enzymatic systems, as Cd like other heavy metals, is a potent inhibitor of enzymes, containing sulphahydryl group (SH) (Vallae and Ulmer 1972). Further studies on these lines are needed to elucidate the its mode of action.

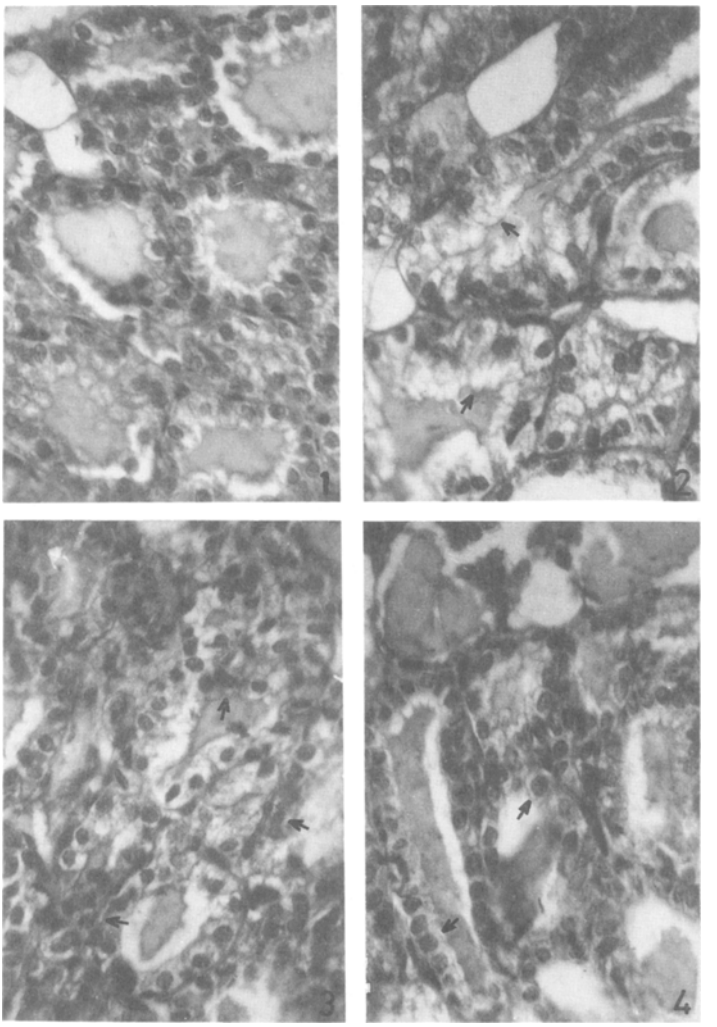

Fig. 1. Control thyroid with cuboidal follicular cells and varying quantities of colloid in the lumen. H & E X 500.

Fig. 2. Thyroid one day after a single injection of $CdCl_2$ showing increase in the epithelial cells height, vacuolated cytoplasm (arrows) and reduction in the colloid content. H & E X 500.

Fig. 3. Thyroid 7 days after a single injection of $CdCl_2$ showing collapsed follicles with reduced cell height and small intensely stained nuclei. H & E X 500.

Fig. 4. Thyroid 40 days after a single injection of $CdCl_2$ showing recovery (arrows). Follicular cell height is increased and nuclei are less darkly stained. H & E X 500.

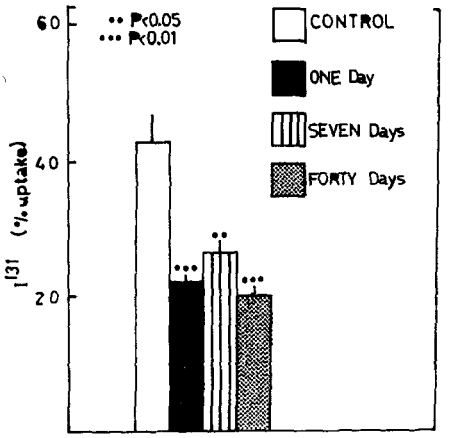

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Fig. 5. A single dose of 0.0035 mM $CdCl_2$ induced changes in the percentage of thyroid radioiodine I^{131} uptake assessed on the 1st, 7th and 40th day after treatment. Values are mean ± SEM of 5 animals per group.

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