Histopathological alterations in kidneys have been studied in squirrels with repeated intraperitoneal injections of cadmium acetate at a dose of 1.0 mg Cd/kg of body weight. Cloudy swelling, necrosis, denudation and destruction of tubular epithelium, focal aggregates of inflammatory cells, perivascular inflammation by chronic inflammatory cells and perinephric haemorrhage with infiltration by phagocytes containing haemosidirin were noticed after different exposure intervals. Squirrels revealed significant increase in body weight and kidney weight (P<0.05).

Heavy metals in the past few years have been found to produce significant health and environmental hazards. Out of several metals like mercury, lead, chromium, nickel, copper, cobalt, aluminium, tungsten, barium, beryllium, bismuth etc., cadmium to a greater extent affects health and happiness of mankind. Since 1930, greater consumption of cadmium in various industrial products viz., electroplating, batteries, alloys, paints and plastics has enhanced cadmium production. Fungicide production also involves the use of cadmium. Cadmium has been described to be associated in various pathological conditions viz., hepatic and renal dysfunction, hypertension, atherosclerosis, growth inhibition, cancer, haemorrhage of the central nervous system, amyloidosis, changes in plasma and urinary proteins, anemia and testicular necrosis. In cadmium intoxication, regardless of the administrative route, the largest quantity has been observed to accumulate in liver and kidney, which results in interlobular hepatic and interstitial renal fibrosis. The author has described liver and kidney lesions after 24 hours and after one week of cadmium acetate exposure in squirrels.

The present study describes histopathological alterations in kidneys of squirrels (Funambulus pennanti, Wroughton 1905) after chronic cadmium acetate administration.

**Materials and Methods**

Twenty laboratory-bred squirrels of both sexes with body weight of 100±10 g were kept in steel-wired cages (60×48×40 cms) and allowed to feed on wheat-flour bread and tap water *ad libitum*. The animals were divided into two groups: group-1 of 12 squirrels was injected intraperitoneally with a daily dose of cadmium acetate (1.0 mg
Cd/Kg of body weight), and, group-2 of 8 squirrels served as control. The control group received distilled water by the same route. Six animals of group-1 and four from group-2 were sacrificed after 4 and 7 weeks by decapitation after light ether anesthesia. Kidneys were removed from the animals of both groups as quickly as possible and weighed. Smaller pieces were cut and fixed in alcoholic Bouin’s fluid and 10% formal-saline. Paraffin sections of kidneys of treated and control groups were cut at 3-4 μ and stained with haematoxylin-eosin. Body weight of the animals of both groups was recorded weekly.

RESULTS

Effect of cadmium acetate exposure revealed significant weight gain in kidneys (Table-1).

Table 1: Effect of cadmium on kidney weight in squirrels

<table>
<thead>
<tr>
<th>Groups</th>
<th>Kidney Weight (g)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
<td>Final</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.12</td>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>± 0.07</td>
<td>± 0.09</td>
<td></td>
</tr>
<tr>
<td>Cd</td>
<td>1.20</td>
<td>2.13*</td>
<td></td>
</tr>
<tr>
<td>Treated</td>
<td>± 0.08</td>
<td>± 0.12</td>
<td></td>
</tr>
</tbody>
</table>

* Significantly different from the control (P<0.05)
± Standard deviation

Fig. 1: Effect of chronic cadmium exposure on body weight gain in squirrels.
RENAL LESIONS AFTER CADMIUM POISONING

Squirrels showed increase in final body weight (Fig. 1) after chronic cadmium exposure.

Marked degree of cloudy swelling of tubular epithelium with necrosis (Fig. 2), denudation and destruction of epithelium was observed along with focal aggregates of inflammatory cells; and some of the tubules revealed tubular casts (Fig. 2) after four weeks of cadmium exposure. Whereas, after seven weeks of cadmium administration, these changes were more pronounced and marked reaction of inflammatory cells in the intertubular spaces and in the vicinity of blood vessels (Fig. 3) were noticed. Perinephric
haemorrhage with infiltration by phagocytes containing haemosidrin was observed in the renal capsule. The context revealed intense patchy inflammatory reaction by mononuclear cells (Fig. 4).

**DISCUSSION**

The present findings revealed increase in kidney weight after cadmium exposure. Wilson *et al.*\(^{10}\) reported similar finding in cadmium exposed albino rats. Histology sections revealed cloudy swelling of tubular epithelium and intraluminal casts.

Control and cadmium treated groups increased in body weight by 1.13 and 1.03 folds, respectively. Final weight gain of cadmium treated squirrels was significantly (P<0.05) different from the controls. Present finding suggests the stunted growth rate after chronic exposure. Stunted growth rate after cadmium intoxication was also reported in rats\(^{11,12}\) and rabbits\(^{13,14}\).

Cloudy swelling of tubular epithelium was noticed as early as four weeks after cadmium exposure and more marked after exposure time. This degeneration, appeared to have represented, some sort of water and protein disturbance in the cells. Kawai and Kimura\(^{15}\) reported gradual development of generalized cloudy swelling of the proximal convolution of tubules after a single injection of cadmium chloride. A similar finding has been reported by the present author in hepatocytes of squirrel after cadmium acetate exposure.\(^{9}\) The tubules showed marked reaction of chronic inflammation by mononuclear cells suggesting tubular degeneration. Tublar epithelium revealed marked degree of cloudy swelling and accompanied by patchy inflammatory reaction by mononuclear cells and tubular casts. Schwarz and Otto\(^{16}\) reported the increase in number of leucocytes after repeated feeding of cadmium for eight weeks in cats. Focal inflam-
RENAL LESIONS AFTER CADMIUM POISONING

matory reaction by mononuclear cells was also noticed by Sugawara, N. and Sugawara, C.\textsuperscript{11)} in the interstitium of renal cortex in rats. The tubular casts were having resemblance with the proteinous cast, which, suggests the possibility of proteinuria in these animals. Studies on proteinuria in animals and man were reported by Piscator\textsuperscript{17)}, who observed that it was of a so called "tubular" type, i.e., a reflection of an impaired function of the kidney tubules.

Infiltration by lymphocytes was evident in the vicinity of blood vessels. This lesion might have appeared due to the effect of cadmium on endothelial lining of vessels which could give rise to infiltration of lymphocytes. Gabbiani et al\textsuperscript{13)} observed early selective lesions of endothelial lining after intravascular injection of a toxic dose of cadmium.

Perinephric infiltration was accompanied by eosinophils, lymphocytes and plasma cells. Sugawara, N. and Sugawara, C.\textsuperscript{11)} reported focal collection of inflammatory cells in the interstitium of renal cortex of rats after twenty seven weeks, which received paste-form food containing 50 ppm of cadmium. Haemosidirin-laiden phagocytes, and, generalized haemorrhage in perinephric region, suggest the possibility of cadmium binding to the proteinous material of haemoglobin, which could have evoked intracellular haemosidirin containing fine yellowish-brown crystals. Chronic exposure of cadmium in experimental animals, resulted in the localization of this metal mainly in erythrocytes in the blood.\textsuperscript{19,21)} The binding of cadmium in the erythrocytes was also reported by Carlson and Friberg.\textsuperscript{22)} Nordberg et al\textsuperscript{23)} reported that erythrocyte cadmium is bound mainly (64\%) to a low molecular weight protein, and, that only a relatively small amount of cadmium (17\%) is found in fractions corresponding to haemoglobin. They also reported that in some other mice, given only half the daily dose of cadmium, about 40\% of the erythrocytes cadmium was found in fractions corresponding to the molecular weight of metallothionein. The present study suggests the latter possibility of combining cadmium to the proteinous material of haemoglobin.

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References

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