ABSTRACT

Cadmium, a heavy metal, is an environmental pollutant of current toxicological interest. Humans are exposed to cadmium through air, water and food. Experimental studies in the laboratory animals have established its toxicity to testis and kidney. Its toxic effects to other organs and systems including the nervous systems have also been reported. Toxic effects of cadmium on the brain and the spinal cord have not yet been unequivocally established. The present study has, as such, been undertaken to evaluate the effects of cadmium on the brain and spinal cord of the albino rat.

Since the levels of cadmium in the atmosphere are not very high even in very highly industrialized regions it was considered prudent to study the effects of a moderate dose chronic exposure. The treatment was started early in life since higher concentrations of cadmium are considered to reach the brains of immature animals. In the rat the process of neurogenesis continues postnatally for at least about three weeks. The proliferating and migrating neurons are considered more vulnerable to toxic insults.
Previous studies on cadmium neurotoxicity have indicated behavioural alterations (Wong and Klassen, 1982) haemorrhagic lesions in the peripheral sensory and autonomic ganglia of the adult rats (Gabbiani, 1966) and haemorrhagic lesions in the cerebrum and cerebellum of newborn rats (Gabbiani et al., 1967 and Webster and Valois, 1981). The aforesaid were short term studies employing doses as high as 10-20 mg/kg body weight.

In the present study 8 litters of new born pups (culled to 8 per litter.) were used and cadmium chloride solution was injected intraperitoneally, biweekly, in 2 mg/kg body weight doses from day 1 to day 60. The pups wore under observations for any overt signs of toxicity. A behavioural study (spontaneous locomotor activity) was undertaken after two months of cadmium exposure before sacrificing the rats. Subsequently the rats were sacrificed and histological, electron microscopic and biochemical studies of various parts of the brain and spinal cord were carried out. The following results were obtained.

(1) **Effect on body weight:** Cadmium exposed rats showed comparatively lower body weights (-11.8%).

(2) **Effects on brain weight and weight of other viscera:** Reduction in the weights of brain (-14.3%), kidney
(19.5%) and testes (-50%) was noted. The weight of liver was however, increased (+5.7%).

(3) Spontaneous motor activity: A decrease in the spontaneous motor activity was found in the cadmium exposed rats. The effects involved both fine and crude movements.

(4) Light microscopic findings:

(a) The Olfactory bulb: It showed degeneration and loosening of its nerve fibre layer, distortion of olfactory glomeruli and clumping of the mitral cells.

(b) The archicortex (hippocampus and the dentate lamina). Degenerative changes including vacuolation, shrinkage and structural disorganisation were seen.

(c) The corpus striatum: The caudate-putamen complex showed areas of degeneration in which both the nerve cells and nerve fibres were effected.

(d) Cerebrum: Only the deeper portion of the neopallium showed some damage. The subjacent white matter was not involved.

(e) Brain stem: The diencephalon, pons and medulla oblongata were all unaffected by cadmium exposure.

(f) The cerebellum: Cadmium appeared to cause varying degrees of degeneration to all the three layers of the
cerebellar cortex. The Purkinje cells also appeared to be distorted, the granular layer was loosened and showed spaces. The white core showed dilated and distended blood vessels.

(g) **The spinal cord**: No structural damage to spinal cord appeared to follow cadmium exposure.

(5) **Ultrastructural findings**: Vacuolation and oedematous changes were seen in the neuron and the neuropil particularly in the pericapillary regions. The endothelium of the capillary was swollen and even at times showed disruption with the escape of the plasma proteins. Sections from the corpus striatum showed distention and demyelination of nerve fibres.

(6) **Biochemical findings**: Lipid values including the total lipids, gangliosides, phospholipids and cholesterol were found to be significantly lower following cadmium exposure. The rate of lipid peroxidation was, however, increased. This later finding is considered a strong evidence of damage to CNS following cadmium treatment.

Based on the finding of lipid peroxidation alone (Table 8) it can be said that the maximum damage due to cadmium involves the cerebellum followed by the cerebrum, brainstem and the spinal cord.