ACCUMULATION OF CADMIUM AND MORPHOLOGICAL CHANGES OF KIDNEY OBSERVED BY SCANNING ELECTRON MICROSCOPE

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Abstract - Effects of Cadmium on rat kidney were investigated. Cadmium was administrated intravenously or per os. Accumulation of cadmium in the kidney and liver was found to depend on the administration periods. Cadmium was more highly concentrated in the cortex than in the medulla and renal pelvis. Cell damage caused by the cadmium administration was clearly observed as cytoplasmic matrix depletion. Both proximal and distal convoluted tubules in the kidney cortex were morphologically disordered.

Key words cadmium, kidney, scanning electron microscope

Cadmium is one of the toxic metals. The abnormal nutrition of bone and/or disorder of kidney have been thought to be caused by this heavy metal. In the case of plant, the growth inhibition and the serious reduction of crop yields by cadmium have been reported. One of our authors reported that large starfish shaped cells of *Euglena gracilis* were observed in cadmium containing medium[1]. These were poly-nuclear cells resulting from abnormal cytokinesis by cadmium toxicity. In the case of animal as well as human, renal damage was observed after long term exposure of this element. The target organ for chronic toxicity of Cd is known to be the renal tubules[2]. Acute nephrotoxicity caused by administration of Cd-containing MT has been also reported to localize in the proximal tubules. In this paper we describe the damage of rat kidney cell by cadmium administration.

MATERIALS AND METHODS

Six-week-old male rats of wistar strain were used mainly throughout the experiment, which were housed in environmentally controlled room maintained on a 12 hour light/dark cycle. Feed and water were provided as needed. Cadmium was administrated intravenously or per os. In the case of intravenous administration, cadmium chloride in a 0.5ml physiological saline solution was injected through tail vein at a dose of 2.7mg Cd/kg body weight a day. As for the other, drinking water containing 200µg/ml cadmium was given freely. The animals were sacrificed by vascular perfusion with 3% glutaraldehyde under Nembutal anesthesia, in which process blood were replaced and kidney was fixed freshly. The kidney was divided into two equal parts, one for metal analysis and the other for scanning electron microscope(SEM) observation. Cadmium concentration of cortex, medulla and renal pelvis, was measured by AAS after acid digestion. For preparation of SEM sample, the kidney was cut into small pieces followed by 1% OsO₄ fixation, dehydration, critical point drying and coating with gold.

RESULTS AND DISCUSSION

In the case of orally administrated group, the body weight increase of six-

week-old rat was almost normal whereas that of three-week-old was very depressed, which indicates that the immature rats were affected more severely by cadmium in comparison with the mature ones. Cadmium was administered by drinking water for a few months. Cadmium was found to be concentrated in the liver and the kidney, concentrations being 35 $\mu\text{g/g}$ wet and 69 $\mu\text{g/g}$ wet, respectively. About 90% of total cadmium in rat body was accumulated in the liver. The morphological changes in SEM image were mainly observed in the cell of distal convoluted tubules.

In the case of intravenous administration, cadmium was more highly accumulated in liver and kidney (Fig. 1). The distribution of cadmium in the kidney was shown in Fig. 2. This toxic metal was concentrated in the cortex, the reason of which could be explained that the metal bound to small molecule such as metallothionein was reabsorbed both at proximal and distal convoluted tubules. The toxicity of cadmium may be ascribed that some of cadmium metallothionein are degraded to release the cadmium in toxic form.

Fig. 1 Effect of Administration Frequency on Cadmium Concentration in Rat Tissues

Fig. 3 SEM Image of Damaged Cell Distal Convoluted Tubule

Fig. 2 Distribution of Cadmium in Kidney as a Function of Administration Frequency

Fig. 4 SEM Image of Damaged Cell Near Proximal Convoluted Tubule

Fig. 3 and Fig. 4 show the SEM images of distal convoluted tubule and near part of proximal convoluted tubule. Cell damage caused by the cadmium administration was observed. Cytoplasmic matrix was depleted so that cell skeleton was clearly identified. It is interesting that only once an intravenous injection caused heavy cell damage.

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