June 2015 Vol. 22 No. 2 47-51
Journal of Northeast Agricultural University (English Edition)

Effects of Sub-chronic Aluminum Exposure on Renal Structure in Rats

Li Yan-fei[1], Liu Jian-yu[1, 2], and Cao Zheng[1]

[1] College of Veterinary Medicine, Northeast Agricultural University, Harbin 150030, China

[2] Police Dog Technical School of Ministry of Public Security, Shenyang 110034, China

Abstract: To investigate the effects of aluminum (Al) exposure on renal structure of rats, 60 Wistar rats were randomly divided into four treatment groups and were orally exposed to 0 (control group, GC), 64.18 (low-dose group, GL), 128.36 (middle-dose group, GM), and 256.72 (high-dose group, GH) mg·kg^{-1} BW $AlCl_3$ in drinking water for 120 days. The body weight of different rats was recorded, the kidney pathologic structure and the ultrastructure were observed. The results showed that the body weight of different rats was markedly lower in Al-treated rats than those in GC (P<0.05; P<0.01). After masson staining, the collagen was deposited in the renal interstitium and aggravated with Al dose increases in Al-treated rats. Under electron microscope, the infolding of the plasma membrane was slight swollen, the mitochondrion was abundant with different sizes, the mitochondrion cristae was fused, the microvillus was swollen and fused in GH. Our findings indicated that sub-chronic Al exposure slowed the weight of rats and caused the kidney pathologic damage in rats.

Key words: sub-chronic, aluminum exposed, rat, renal structure

CLC number: S852.2 **Document code:** A **Article ID:** 1006-8104(2015)-02-0047-05

Introduction

Aluminum (Al) is the third most abundant element in earth crust and is widely used in daily life. Al can accumulate in kidney, brain, bone, liver, etc (Kumar and Gill, 2009; Linardaki *et al*., 2013). Kidney is the important excretory organ that excretes metabolic waste, generates urine, and regulates the balances of electrolyte and acid-base (Bolignano *et al*., 2014). Some researches had demonstrated that Al accumulated in animal bodies could injure and suppress the renal structure and function (Bohrer *et al*., 2008), but mechanism hadn't been cleared. In this experiment, a rat model of Al exposure was built through drinking water in order to study the damage of Al to the renal structure.

Materials and Methods

Animals and treatments

A total of 60 healthy male Wistar rats (5 weeks old) weighed 110-120 g were used after 1 week of the feeding with a standard diet. They were randomly allocated into four groups (n=15): control group (GC), low-dose group (GL), medium-dose group (GM), and high-dose group (GH). The rats were orally administrated with 0, 64.18, 128.36, and 256.72 mg·kg^{-1} BW $AlCl_3$ in drinking water (distilled water) for 120 days. Rats were freely accessed to food and water. The

Received 10 January 2015
Supported by the Science and Technology Program of Heilongjiang Educational Bureau (12541025); the Natural Science Foundation of Heilongjiang Province (C201425)
Li Yan-fei (1967-), female, professor, supervisor of Ph. D student, engaged in the research of veterinary medicine. E-mail: yanfeili_200@126.com

health status of the rats was monitored daily, and the body weight of the rats was recorded monthly.

Tissue sampling and processing

After 120 days, rats were subsequently euthanized by cervical dislocation and were weighed. The kidneys were collected, about 2.0×1.5×0.3 cm^3 size was put into 10% formaldehyde fluid for masson staining, about 1.0×1.0×1.0 mm^3 size was put into 2.5% glutaraldehyde solution to observe the ultrastructure.

Observation of kidney pathologic structure

The kidney pathologic structure was observed by masson staining according to the method by Zhang *et al* (2005).

Observation of kidney ultrastructure

The ultrastructure was observed according to the method by Yamada *et al* (2014).

Statistical analysis

Data were presented as mean±standard deviation (SD) and analyzed by using one-way analysis of the variance (ANOVA) followed by Student's *t* test (SPSS 17.0 software, SPSS Incorporated, Chicago, IL, USA) considering the interactive effects and differences between Al-treated groups and GC. $P<0.05$ was considered statistically significant and $P<0.01$ was markedly significant.

Results

Clinical symptoms and body weight

Clinical symptoms of the most Al-treated rats were anorexia, drearment, shaggy hair, stumble, astasia, and pale tail. The serious symptoms were principally shortness of breath, dyspnea, and generalized convulsion. However, the control group rats grew well.

The body weight of all the rats increased throughout the experiment period, while the body weight of Al-treated rats was lower than that in GC. The body weight of the rats was lower in GL ($P<0.05$), GM and GH ($P<0.01$) than that in GC (Table 1).

Result of masson staining

The collagens in GC were located mainly in renal tubular basement membrane, renal capsule, glomerular mesangial area, and around the small blood vessels (Fig. 1). In Al-treated rats, the collagen was deposited in the renal interstitium and aggravated with Al dose increases in Al-treated rats (Figs. 2-4). The collagen fiber was green, red blood cell was orange, and cytoplasm was red.

Table 1 Body weight changes of rats (g)

Group	30 days	60 days	90 days	120 days
GC	265.0±2.2	331.0±4.8	367.0±4.6	408.0±3.0
GL	259.0±2.9*	324.0±2.9*	360.0±2.8*	402.0±2.5*
GM	207.0±5.4**	272.0±4.7**	323.0±4.7**	375.0±2.9**
GH	190.0±2.5**	245.0±4.7**	294.0±3.5**	351.0±2.4**

* $P<0.05$ is considered statistically significant compared with GC, and ** $P<0.01$ is markedly significant compared with GC.

Kidney ultrastructure

The podocyte, microvillus, nuclear envelope, rough endoplasmic reticulum, microfilament and the mitochondria structure of the kidney are shown in Figs. 5-8 for GC and Figs. 9-12 for GH. The