Histopathological Changes in Incisive Teeth of the Newborn Pups of Cadmium-Applied Female Rats during Pregnancy

Cambios Histopatológicos en Dientes Incisivos de Crías Neonatos
de Ratas Hembras bajo Suministro de Cadmio durante la Preñez

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SUMMARY: Cadmium Chloride is a well known teratogen compared to other metals. Cadmium affects placental function, may cross the placental barrier and modify fetal development. In this study, 12 female wistar albino rats weighted between 180-200gr were used. They were divided into two groups as experimental and control groups each comprising 6 female animals. 2mg/kg/day cadmium chloride dissolved in 1ml isotonic solution were intravenously injected from tail vein of experimental rats during 17-21 days of pregnancy. At first day of birth, the total body weights of control and experimental newborn pups were taken. This study aims to evaluate morphologically the effects of cadmium chloride on the incisive teeth development of pups born to the cadmium-applied female rats during pregnancy.

KEY WORDS: Cadmium; Tooth; Pregnancy.

INTRODUCTION

Human exposure to cadmium due to environmental factors is known to affect several tissues in the body. The major sources of exposure to cadmium are contaminated food and water, tobacco, and industrial fumes and dusts (Goyer & Cherian, 1995). It has been shown that long-term exposure of pregnant female rats to Cd results in foetal growth retardation and teratogenic effects. Cadmium is also accumulated in calcified tissues, like bone and teeth (Fosse & Wesenberg, 1981). During pregnancy, cadmium is retained in the placenta, which acts as an important, but not complete, barrier to protect the fetus from cadmium exposure. It has been shown in rodents as well as in humans (Loiacono *et al.*, 1992).

Some investigators, environmental cadmium exposure was associated with caries scores in deciduous teeth but not in the permanent teeth. Furthermore, some epidemiologic investigations of environmental lead exposure have also observed significant associations with caries only in deciduous teeth (Gemmel *et al.*, 2002; Youravong *et al.*, 2006), suggesting that deciduous teeth may be more sus-

ceptible than permanent teeth to environmental toxins. The aim of this study is to investigate the histological changes in incisive teeth of fetus whose mothers treated with cadmium during pregnancy and also to determine the developmental defects in fetal teeth.

MATERIAL AND METHOD

In this study, 12 female wistar albino rats weighted between 180-200gr were used. They were coupled with male rats. Vaginal smears were examined under microscopy to determine the pregnancy. Pregnant female rats were placed in different cages at 1st day of pregnancy. They were divided into two groups as experimental and control groups each comprising 6 female animals. 2mg/kg/day cadmium chloride dissolved in 1ml isotonic solution were intravenously injected from tail vein of experimental rats during 17-21 days of pregnancy. 1ml isotonic solution without heavy metal were similarly injected into control rats. Throughout the

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experiment, a 12-h light and dark cycle was maintained, with lights on from 06:00 to 18:00 h. The temperature was maintained at 23 °C, and the relative humidity ranged between 55 and 60%. Standard rat chow and tap water were available ad libitum to the experimental animals.

Histological changes were observed degeneration in enamel, dentin and cement layers of the upper incisive teeth of newborn pups of the cadmium applied rats (Fig.1).

At first day of birth, newborn pups were divided into two groups. The total body weights of control and experimental newborn pups were taken (Table I). The maxillary regions were dissected under ketamine hydrochloride anesthesia and placed in 10% formaldehyde solution. They were placed in parafine inclusion melted at 58°C after treatment with xylol, the 4-6µm sections were taken by rotary microtome and the sections were stained with Hematoxyline-Eosin (H-E) dyes and then observed under Olympus BH2 light microscopy to determine histological changes.

Table I. Total body weights of experiment and control groups.

Groups	$\bar{X}$	SD
Experiment (n=30)	8.23	3.09
Control (n=20)	10.34	3.37

RESULTS

Results show that the average body weights and standard deviations of control and the experimental group pups of the cadmium applied female rats during pregnancy. It is clearly seen that the body weights of experimental group pups are lower than those of control group ($P < 0.001$).

A clear slendering of enamel organ, indistinct ameloblast cells, hyperplasia and mitotic increase in odontoblast cells were observed. In addition, free-floating erythrocytes in pulpa tissue and mononuclear lymphocyte

Fig. 1. Degeneration in enamel, dentin and cement layers of the upper incisive teeth of newborn pups (H-E X41).

Fig. 2. Hyperplasia in ameloblast cells, mitotic increase in odontoblast cells (H-E X41).

Fig. 3. A dense infiltration of lymphocyte between pulp and dentin, dilatation in blood vessels of pulp tissue (H-EX82).

infiltration were seen in most places (Fig. 2). A dense infiltration of lymphocyte between pulp and dentin, dilatation in blood vessels of pulp tissue were observed (Fig. 3). The mitotic activity of all area is dense and there is no pathological symptom in the sections of control group.

DISCUSSION

Cadmium is perhaps one of the most toxic industrial and environmental metals and it continues to be a health hazard. In this study, a significant lower body weight of pups of animals intoxicated with cadmium was observed. Reduced pup weight was also observed in rats by Crowe & Morgan (1997), and in newborn lambs by Floris *et al.* (2000). The decrease in birth weight could be due to a deficit in iron and/or zinc in cadmium-contaminated dams. It has been shown that cadmium induces maternal zinc retention, which is responsible for fetal zinc deficiency and impaired fetal growth (Sorell *et al.*, 1990).

Some of researcher showed the effects of different metals on teeth during embryonic stage and also claimed that cadmium may cause a blockage during teeth eruption and root eruption (Hamada, 1989). Katsuta *et al.* (1996) studied the effects of cadmium in molar and incisive teeth and observed a reduction at iron pigment in ameloblast cells and damage at enamel organ of incisive teeth. Following iron reduction, cadmium accumulation increased in teeth. The necrosis of dental pulp was developed from coronal region to apical in both molar and incisive teeth. In our study we observed slendering in enamel organ, mononuclear cell infiltration in pulp tissue rarely bleeding sites (Fig. 2). Furthermore, a free-floating erythrocytes and lymphocyte infiltration in vessels of dentin pulp and periodontal membrane were observed due to cadmium effects (Fig. 3).

In a rat study, where the effect of lead on enamel formation was investigated, no macroscopical changes could be seen other than indications of altered mineralization. A relative increase in the amount of protein was detected, possibly resulting in a decrease in the micro hardness of the rat enamel (Gerlach *et al.*, 2002). The intraperitoneal injection of cadmium induces the synthesis of metallothionein in the papillary epithelial layer of the secretory zone, in a single layer of epithelial cells of the presecretory zone and within ameloblasts of the postsecretory zone of the enamel organ in rat incisor teeth (Tamura *et al.*, 1999). Prospective epidemiologic studies are needed to confirm these findings and to understand the mechanisms behind the observed association between cadmium and dental histopathology.

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RESUMEN: Cloruro de cadmio es un teratógeno conocido en comparación con otros metales. El cadmio afecta la función placentaria, pudiendo atravesar la barrera placentaria y modificar el desarrollo del feto. Fueron utilizadas 12 ratas hembras Wistar albinas, entre 180-200g de peso. Se dividieron en dos grupos de seis hembras cada uno, grupo experimental y control. Se inyectó, a través de una vena de la cola de las ratas del grupo experimental por vía endovenosa 2mg/kg/día de cloruro de cadmio disuelto en 1 ml de solución isotónica, durante 17-21 días de gestación. Al primer día de nacimiento, se pesaron las crías de los grupos control y experimental. Este estudio tiene como objetivo evaluar morfológicamente los efectos del cadmio sobre el desarrollo de los dientes incisivos de crías recién nacidas de ratas hembras a quienes se les inyectó cadmio durante la preñez.

PALABRAS CLAVE: Cadmio; Dientes; Preñez.

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