EFFECTS OF CADMIUM ON PULPAL POLYAMINES
IN RAT INCISOR

Hiroaki FURUTA
Department of Pharmacology, Tohoku University School of Dentistry,
Seiryo-cho, Sendai 980, Japan
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Although numerous studies of the effects of cadmium on the metabolism of hard tissues
have been reported, the mechanism(s) by which the metabolism is disturbed remains obscure
(1-3). Most reports on cadmium lesions in bone have ruled out the possibility of a direct
action of cadmium on bone metabolism and have emphasized that related lesions are
secondary to effects on systemic calcium metabolism (4). In dental tissues, several reports
have indicated the possibility of a direct action of cadmium on the metabolism of dental
tissues (5-7).

Pulp cells, including odontoblasts, in the rodent incisor play a significant role in the
formation of dentine. We investigated the effects of cadmium on pulpal polyamine
metabolism in rat incisor, as recent biochemical studies on the polyamines indicate that
levels of polyamines (putrescine, spermidine and spermine) change in parallel with the
cytological features of the tissues (8).

Male Wistar rats weighing about 200 g were used. After a single s.c. administration
of 0.05 mmole/kg CdCl₂ (aqueous solution and 0.1 ml/100 g), the animals were decapitated
between 2:00 and 3:00 p.m. at different intervals following injection. The respective incisor
pulps were immediately frozen on dry-ice. All pulp from the incisor was removed from
each animal and homogenized in ice-cold 0.4N HClO₄ (2 ml). The polyamine extraction
and separation procedure was carried out as previously reported (9). The amount of
polyamines was measured fluorometrically according to the method of Endo (10). Results
were expressed as nmole/g wet weight of tissues. All data were analyzed statistically using
Student’s t-test and significant differences between the mean values are indicated when p value
was less than 0.05.

Table 1. Pulpal contents of the polyamines after cadmium chloride injection
(5.7 mg Cd/kg, s.c.)

| Time after injection (hr) | Putrescine (nmole/g) | Spermidine (nmole/g) | Spermine (nmole/g) |
|--------------------------|----------------------|----------------------|---------------------|
| Control                  | 6a                   | 70.1±13.2b           | 700.7±95.4b         | 78.5±16.8b         |
| 3                        | 4                    | 110.5±14.0*          | 752.0±87.3          | 71.2±13.7          |
| 6                        | 7                    | 85.3±23.1            | 498.3±130.9*        | 75.3±25.3          |
| 12                       | 5                    | 51.3±13.8*           | 728.4±146.1         | 87.3±28.7          |
| 24                       | 7                    | 61.0±14.0            | 729.3±106.5         | 98.9±15.0*         |
| 48                       | 7                    | 63.6±21.3            | 719.5±134.8         | 76.3±20.5          |

a: Number of animals. b: Mean±S.D. *: Statistically significant difference, p<0.05.
FIG. 1. Time course of molar-ratio changes of pulpal polyamines in rat incisor (mean ± S.D.), after CdCl₂ (0.05 mM/kg, s.c.). *statistically significant differences between the control (mean) and experimental values. p<0.05.

Table 1 shows the relationship between the pulpal polyamine contents and times after cadmium injection. Three hours after a single injection of CdCl₂ (0.05 mmole/kg), a significant increase in putrescine (Put) was observed. However, this augmentation was not continuous and, after 12 hr, the Put level was below the control. On the other hand, change in spermidine (Spd) level was not significant at 3 hr. Six hours after injection, Spd showed a transient decrease and the content was about 70% that of the control. Spermine (Spm) levels changed slowly and were about 130% of control at 24 hr. All polyamine contents reverted to normal levels 48 hr after injection. Figure 1 demonstrates the time course of the molar ratio of Spd/Put and Spm/Spd. The molar Spd/Put ratio decreased rapidly, at 6 hr reached the lowest level and then increased. At 12 hr, the Spd/Put ratio was about 130% that of the control. On the other hand, the molar Spm/Spd ratio increased significantly 6 hr after injection, but returned to normal levels at 12 hr.

Put is an immediate precursor of Spd and Spd is a precursor of Spm (8). Recent biochemical studies suggested that enhanced Put levels increase Spd production both by acting as the precursor of this polyamine and by activating Spd enzymic synthesis (11, 12). In this study, cadmium administration induced increases in Put levels but decreases in Spd levels 6 hr after injection. On the other hand, effects of cadmium on the Spm levels were slight. These results suggest that cadmium has an inhibitory effect on the Spd synthetic pathway in pulpal polyamine metabolism.

Eisenmann and Yaeger reported that in acute poisoning a large dose of cadmium chloride (0.15 mmole/kg or 0.38 mole/kg, s.c.) disturbed the mineralization of rat incisor dentine and suggested that cadmium inhibits the dental matrix nucleation and disturbs the
calcification (5). Recently, Bawden and Hammarström observed that cadmium injected into young rats was taken up by the ameloblasts and odontoblasts, and suggested the possibility that cadmium has a direct action on dental tissue metabolism (6). In this study, a single injection of cadmium chloride (0.05 mmole/kg), which is too low to induce histological disturbances in calcification of rat incisor (7), disturbed the polyamine metabolism mainly in the Spd synthetic pathway in rat incisor pulp. Recent biochemical studies also suggested that polyamines may perform an important role in nucleic acid and protein synthesis (8). The present study supports the above suggestions (5, 6) and indicates that cadmium may directly disturb the pulpal cell metabolism, including odontoblasts.

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