ation damage of the kidney and liver was not alleviated by previous Cd administration but was rather deepened.

In all three groups of experimental rats (Cd, Ir, Cd+Ir), hypertrophy and hyperplasia of the kidney after UN proceeded most quickly in the animals operated on the 14th -21st day after the treatment, which manifested itself in a relative increase (in comparison with control hypertrophic kidney), and in some cases also in an absolute increase (in comparison with control intact kidney) in DNA and RNA content in the hypertrophic kidney. At the same time after Cd administration and/or Ir, the DNA and RNA content was higher even in the intact kidney, probably due to active reparation of damage evoked by these noxa. We suppose that in these cases the process of hypertrophy and hyperplasia proceeded more quickly after UN in consequence of the activation of reparation processes in the intact kidney after corresponding treatments. Obviously, some parts of metabolic pathways are common for regeneration after the damage induced by various treatments including UN, and that is why the new synthesized or activated systems (enzymes, factors) could by used concurrently.

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References

- Bedford, J. S., Phil, D. (1991) Sublethal damage, potentially lethal damage, and chromosomal aberrations in mammalian cells exposed to ionizing radiations. *Int. J. Radiat. Oncol. Biol. Phys.* **21**, 1457-1469.
- Bernard, A., Schadeck, C., Cardenas, A., Buchet, J.P., Lauwerys, R. (1991) Potentiation of diabetic glomerulopathy in uninephrectomized rats subchronically exposed to cadmium. *Toxicol. Lett.* **58**, 51-57.
- Bucher, N. L. (1991) Liver regeneration: an overview. J. Gastroenterol. Hepatol. 6, 615-624.
- Choie, D. D., Richter, G. W. (1972) Cell proliferation in rat kidney induced by lead acetate and effects of uninephrectomy on the proliferation. *Am. J. Pathol.* **66**, 265-275.
- Cornforth, M. N. (1998) Radiation-induced damage and the formation of chromosomal aberrations. In: *DNA Damage and Repair II*, eds. Nickoloff, J. A., Hoekstra, M. F., pp. 559-585, Humana Press, Totowa, New Jersey.
- Drasch, G. (1983) An increase of cadmium body burden for this century an investigation of human tissues. *Sci. Total Environ.* **26**, 111-119.
- Dudley, R. E., Gammal, L. M., Klaassen, C. D. (1985) Cadmium-induced hepatic and renal injury in chronically exposed rats. Likely role of hepatic cadmium-metallothionein in nephrotoxicity. *Toxicol. Appl. Pharmacol.* 77, 414-426.
- Duračková, Z. (1998) The DNA damage induced by free radicals and their metabolites. In: Free Radicals and Antioxidants in Medicine (I), eds. Bergendi, L., Ferenčík, M., Nouza, K., pp. 107-119, Slovak Academic Press Bratislava. (in Slovak)
- Fasanyaodewumi, C., Latinwo, L. M., Ikediobi, C. O.,Gilliard, I., Sponholtz, G., Nwoga, J., Stino, F., Hamilton,N., Erdos, G. V. (1998) The genotoxicity and cytotoxicity

- of dermally-administered cadmium: effects of dermal cadmium administration. *Int. J. Mol. Med.* **1,** 1001-1006.
- Fedoročko, P., Domonkošová, A., Kundrátová, T., Macková, N. O., Brezáni, P., Fedoročková, A. (1996) Effects of cadmium on haemopoiesis in irradiated and non-irradiated mice: 1. Relationship to the number of myeloid progenitor cells. *Physiol. Res.* **45**, 93-100.
- Friedman, P. A., Gesek, F. A. (1994) Cadmium uptake by kidney distal convoluted tubule cells. *Toxicol. Appl. Pharmacol.* **128**, 257-263.
- Hall, E. J. (1997) What will molecular biology contribute to our understanding of radiation-induced cell killing and carcinogenesis? *Int. J. Radiat. Biol.* **71**, 667-674.
- Harper, J. (1984) Basic program of a robust multiple comparison test for statistical analysis of all differences among group means. *Comput. Biol. Med.* **14**, 437-445.
- Heine, W. D., Stöcker, E., Heine, H. D. (1971) Tageszeitliche Rhytmen der Zellproliferation in der kompensatorisch regenerierenden Niere nach unilateral Nephrektomie. Virchows Arch. Abt. Zellpath. 9, 75-96.
- Inda, A. M., Garcia, A. L., Errecalde, A. L., Badrán, A. F. (1997) Effect of tissue and plasma factors on kidney proliferation. *Biocell* 21, 13-18.
- Ishido, M., Homma-Takeda, S., Tohyama, C., Suzuki, T. (1998) Apoptosis in rat renal proximal tubular cells induced by cadmium. *J. Toxicol. Environ. Health Part A* 55, 1-12.
- Ishido, M., Tohyama, C., Suzuki, T. (1999) Camium-bound metallothionein induces apoptosis in rat kidneys, but not in cultured kidney LLC-PK1 cells. *Life Sci.* **64**, 797-804.
- Koizumi, T., Shirakura, H., Kumagai, H., Tatsumoto, H., Suzuki, K. T. (1996) Mechanism of cadmium-induced cytotoxicity in rat hepatocytes: cadmium-induced active oxygen-related permeability changes of the plasma membrane. *Toxicology* 114, 125-134.
- Kropáčová, K., Mišúrová, E. (1992) Influence of age and gamma irradiation on the proliferative activity in regenerating rat liver. *Physiol. Res.* **41**, 135-140.
- Latinwo, L. M., Ikediobi, C. O., Singh, N. P., Sponholtz, G., Fasanya, C., Riley, L. (1997) Comparative studies of in vivo genotoxic effects of cadmium chloride in rat brain, kidney and liver cells. *Cell Mol. Biol.* **43**, 203-210.
- Macková, N. O., Leníková, S., Fedoročko, P., Brezáni, P., Fedoročková, A. (1996) Effects of cadmium on haemopoiesis in irradiated and non-irradiated mice: 2. Relationship to the number of circulating blood cells and haemopoiesis. *Physiol. Res.* 45, 101-106.
- Matsubara, J., Tajima, Y., Karasawa, M. (1987) Metallothionein induction as a potent means of radiation protection in mice. *Radiat. Res.* 111, 267-275.
- Nordberg, G. F. (1993) Cadmium carcinogenesis and its relationship to other health effects in humans. *Scand. J. Work Environ. Health* **19**, 104-107.
- Otsuka, M., Meistrich, M. L. (1990) Cell proliferation and abnormal nuclei induced by radiation in renal tubule epithelium as an early manifestation of late damage. *Radiat. Res.* 123, 285-291.
- Saplakoglu, U., Iscan, M., Iscan, M. (1997) DNA single-strand breakage in rat lung, liver and kidney after single and combined treatment by nickel and cadmium. *Mutat. Res.* **394**, 133-140.
- Shaikh, Z. A., Vu, T. T., Zaman, K. (1999) Oxidative stress as a mechanism of chronic cadmium-induced hepatotoxicity and renal toxicity and protection by antioxidants. *Toxicol. Appl. Pharmacol.* **154**, 256-263.

- Sudo, J., Hayashi, T., Kimura S., Kakuno, K., Terui, J., Takashima, K., Soyama, M. (1996) Mechanism of nephrotoxicity induced by repeated administration of cadmium chloride in rats. J. Toxicol. Environ. Health 48, 333-348.
- Tang, W. F., Sadovic, S., Shaikh, Z. A. (1998) Nephrotoxicity of cadmium-metallothionein: protection by zinc and role of glutathione. *Toxicol. Appl. Pharmacol.* 151, 276-282.
- Theocharis, S. E., Margeli, A.P., Spiliopoulou, Ch., Skaltsas, S., Kittas, Ch., Koutselinis, A. (1996) Hepatic stimulator substance administration enhances regenerative capacity of hepatocytes in cadmium-pretreated partially hepatectomized rats. *Digestive Dis. Sci.* 41, 1475-1480.
- Tsanev, R., Markov, G. (1960) To the question of quantitative spectrophotometrical estimation of nucleic acid. *Biokhimiya* **25**, 151-159. (in Russian)
- Vašák, M., Hasler, D. W. (2000) Metallothioneins: new functional and structural insights. *Curr. Opin. Chem. Biol.* 4, 177-183.

- Waalkes, M. P., Goering, P. L. (1990) Metallothionein and other cadmium-binding proteins: recent developments. *Chem. Res. Toxicol.* 3, 281-288.
- Ward, J. F. (1998) Nature of lesions formed by ionizing radiation. In: *DNA Damage and Repair II*, eds. Nickoloff, J. A., Hoekstra, M. F., pp. 65-84, Humana Press, Totowa, New Jersey.
- Yan, H., Carter, C. E., Xu, C., Singh, P. K., Jones, M. M., Johnson, J. E., Dietrich, M. S. (1997) Cadmium-induced apoptosis in the urogenital organs of the male rat and its suppression by chelaton. *J. Toxicol. Environ. Health* 52, 149-168.
- Zalups, R. K., Fraser, J., Koropatnick, J. (1995) Enhanced transcription of metallothionein genes in rat kidney: effect of uninephrectomy and compensatory renal growth. Am. J. Physiol. 268, 643-650.