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Some biochemical parameters of kidney function in rats after acute poisoning with tin chloride

Niektóre parametry biochemiczne świadczące o funkcji nerek szczurów po ostrym zatruciu chlorkiem cyny

INTRODUCTION

Humans have had a contact with metals almost since the beginning of our existence. Heavy metals are present in our daily life and if we take a little quantity of it from air or diet, we have very serious problems with our health. Also tin chloride is widely used as a reducing agent to label radiotracers in nuclear medicine, as base for colors, dental cryogenic agents, conserving agent for soft drinks and in food, etc [1,7,13].

According to published data [1,2] canned foods are the major source of tin for general population. Corrosion of the tin packaging promotes the penetration of this metal into food which we eat. Recent studies [6,11] suggest that tin (from inorganic compounds) can be toxic for animals and humans. Tin chloride is known to inhibit the immune response in rodents and induce tumor generation in thyroid gland. Tin chloride is capable to induce the generation of reactive oxygen species (ROS) responsible for the oxidative stress and many chronic diseases (cardiovascular disease, cancer, cataract or neurological diseases). In literature [3,7-9] there are many conflicting results about genotoxic, cytotoxic, neuro- and nefrotoxic effects of tin.

The published data confirm [3,6,12] that bone, liver and kidney are the most sensitive organs to toxicity of tin. El-Demerdash et al. [6], have shown abnormal hepatic and kidney architectures in rats intoxicated by tin chloride. The aim of this study was to assess the function of kidneys in rats acutely intoxicated by tin chloride.

MATERIAL AND METHODS

The experimental study was carried out on male Wistar rats (200–240 g) under standard laboratory conditions (21 ± 1°C) with free access to food and water ad libitum. The animals came from a licensed producer (Górzkowska, Breeding of Laboratory Animals, Warsaw, Poland). The experiments were

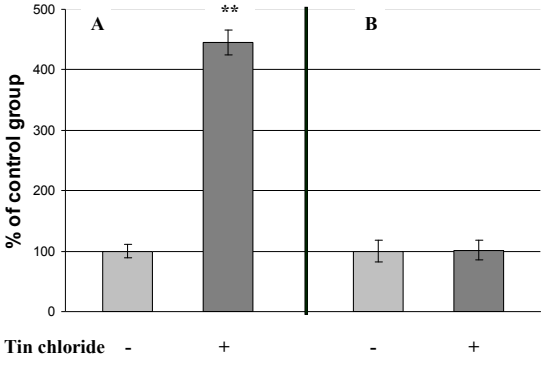
approved by the I Local Ethical Commission for Experiments on Animals in Medical University on Lublin.

The aqueous solutions of tin chloride (63.2 mg/kg) were prepared ex tempoure and administered intraperitioneally (ip) at a volume of 0.5 ml/100g b.w. of rats. The control groups received the same amounts of water for injection. After 24 hours or 11 days from the injection, animals were decapitated and blood was taken to polystyrene test-tubes. The blood samples from each animal were allowed to clot for 45 min at room temperature. Serum was separated by centrifugation at 2000 rpm for 10 min and collected into plastic tubes. The concentrations of urea (Cormay Diagnostic S.A., Lublin, Poland), creatinine (Cormay Diagnostic S.A., Lublin, Poland) and beta-2-microglobulin (β-2-M, ELISA, IBL, Hamburg, Germany) were determined in the animals serum.

Statistical analysis of the differences between samples were performed by Kruskal-Wallis test. Two levels were considered significant: $p \leq 0.05$ (*) and $p \leq 0.001$(**).

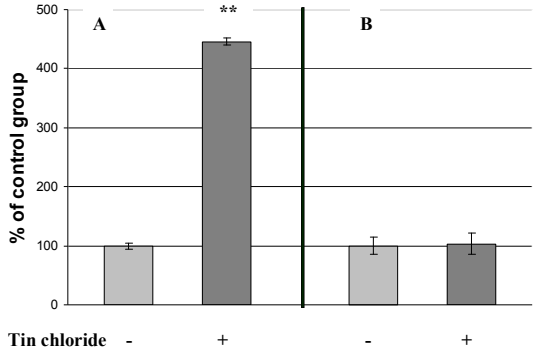
RESULTS

The results show that acute intoxication with tin chloride after 48 h caused a very significant increase in the concentrations of urea and creatinine but didn't affect the beta-2-microglobulin level in the serum of intoxicated animals, compared with the control group (Figs. 1–3). However, 11 days after acute intoxication of rats with tin chloride we observed significant increase of beta-2-microglobulin level in the blood serum (Fig. 3). The concentration of urea and creatinine didn't change in serum of animals treated with tin chloride compared to control group (Figs. 1,2).



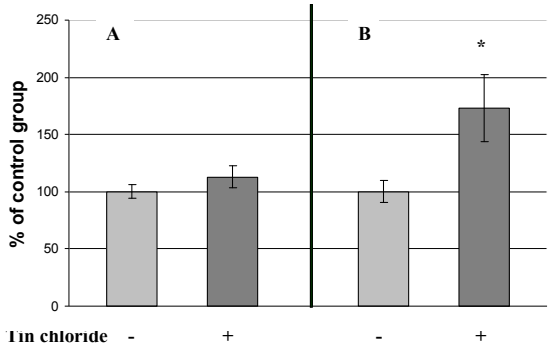
* * < 0,001 versus control group

Fig. 1. Serum concetration of urea in rats after
A) 48 h
B) 11 days
intoxication with tin chloride (63,2 mg/kg ip)



* * < 0,001 versus control group

Fig. 2. Serum concetration of creatinine in rats after
A) 48 h
B) 11 days
intoxication with tin chloride (63,2 mg/kg ip)



* * < 0,001 versus control group

Fig. 3. Serum concetration of beta-2-microglobulin in rats after
A) 48 h
B) 11 days
intoxication with tin chloride (63,2 mg/kg ip)

DISCUSSION

Inorganic tin is present in our daily life. In literature some acute effects of tin have been described in people who consumed a lot of canned food, i.e. fruit and vegetable juice [1,2,13]. Ingestion of juice containing tin caused some symptoms of gastrointenstinal irritation such as nausea, vomiting and diarrhea. The published data [1,6,12] showed significant correlation between the amount of canned food consumed and dysfunction of digestive, urinary, nervous, skeletal and immunology system. According to literature data [1,6,12] bone, liver and kidneys are the most sensitive organs to toxicity of tin.

The study assessed some biochemical parameters of kidney function in rats acutely intoxicated with tin chloride. It is known that urea and creatinine are generally indicators of kidney function and their concentration in serum depends on the level of glomerular filtration. However, beta-2-microglobulin is a better indicator of kidney function than urea and creatinine.

Excess of beta-2-microglobulin in serum is observed in early abnormal renal function, when concentration other biochemical parameters is normal. Beta-2-microglobulin is an early indicator of exposure to a nephrotoxic agent such as tin chloride [4,5,10].

The present study showed significant increase in urea and creatinine concentration in blood serum 48 h after acute intoxication of rats with tin chloride. That excess of urea and creatinine concentration in serum already 48 h after acute intoxication might depend on other factors not connected with kidney dysfunction. Already 24 h after intoxication, animals don't eat and see. The anorexia continued for 5 days and this symptoms can be the result of increased protein catabolism. Forty eight hours after acute intoxication, beta-2-microglobulin level in the serum of intoxicated animals was comparable to microglobulin concentration in control group. Barely after 11 days significantly increased beta-2-microglobulin in blood serum was observed.

On the basis of the present results it may be suggested that acute tin chloride intoxication of rats can damage the function of kidneys after 48 h and 11 days from poisoning.

CONCLUSIONS

1. Acute intoxication with tin chloride significantly changed kidney biochemical parameters.
2. The nephrotoxic effects of tin chloride were observed already after 48 h from acute intoxication of rats.
3. Eleven days after acute tin chloride intoxication only significantly increased beta-2-microglobulin concentration was observed.

REFERENCES

1. Blunden S., Wallace T.: Tin in canned food: review and understanding of occurrence and effect. Food Chem. Toxicol., 41,1651, 2003.
2. Boogaard P., Boisset M., Blunden S. et al.: Comparative assessment gastrointenstinal irritant potency in man of tin (II) chloride and tin migrated from packaging. Food Chem. Toxicol., 41,1663, 2003.
3. Chmielnicka J., Zaręba G., Nasiadek M.: Combined effect of Tin and lead on heme biosynthesis in rats. Ecotoxicol. Environ. Saf., 29, 165,1994.
4. Cylwik B., Szmitkowski M.: The diagnostic usefulness of β2-microglobulin In clinical practice [in Polish]. Pol. Merk. Lek., 2, 224, 1997.
5. Donadio C., Lucchesi A., Ardini M. et al.: Beta-2-microglobulin and retinol-binding protein as indicators of glomerular filtration rate:comparison with plasma creatinine. J. Pharm. Biomed. Anal., 24, 835, 2001.
6. El-Demerdash F.M., Yousef M.I., Zoheir M.A.: Stannous chloride induces alterations in enzyme activities, lipid peroxidation and histopathology in male rabbit: Antioxidant role of vitamin C. Food Chem. Toxicol., 2, 25, 2005.
7. Guedes A.P., Cardoso V.N., De Mattos J.C.P. et al.: Cytotoxic and genotoxic effects induced by stannous chloride associated to nuclear medicine kits. Nucl. Med. Biol., 3, 915, 2006.

8. Olędzka R.: Effect of metals and other xenobiotics of the bioavailability of microelements [in Polish]. Bromat. Chem. Toksykol., 32, 207, 1999.
9. Silva C.R., Oliveira M.B.N., Melo S.F. et al.: Biological effects of stannous chloride, a substance that can produce stimulation or depression of the central nervous system. Brain Res. Bull., 59, 213, 2002.
10. Wiela-Hojeńska A., Hurkacz M.: Role of beta-2-microglobulin in diagnostics and therapy [in Polish]. Post. Hig. Med. Dośw., 52, 507, 1998.
11. Witkowska J., Czerwińska D., Kiepurski A. et al.: Harmful elements versus iron, zinc and copper-interactions In animal and human organisms.Part I. mercury, tin, nickel, selenium, fluoride, aluminium. Roczn. PZH, 42, 15, 1991, [in Polish].
12. Yamaguchi M., Saito R., Okada S.: Dose effect of inorganic tin on biochemical indices in rats. Toxicology, 16, 267, 1980.
13. Zieliński W., Brzeziński J.: Toxic effects of Tin. Part I. Inorganic tin compounds [in Polish]. Roczn. PZH, 34, 95, 1983.

SUMMARY

Kidney is the main target organ for many heavy metals. The toxic effect of tin on kidneys is still not clear. The aim of this study was to assess the function of kidneys in rats acutely intoxicated by tin chloride. The study was carried out on male Wistar rats. Animals were given intraperitioneally (ip) tin chloride in a dose of 63.2 mg/kg b.w. After 48 h or 11-days from acute intoxication, the rats were decapitated and blood was collected. Ready-made diagnostic kits were used for biochemical measurements: urea, creatinine and beta-2 microglobulin in the blood serum. Forty eight hours after acute intoxication with tin chloride, significantly increased concentration of urea and creatinine, and not beta-2-microglobulin in the serum of rats, was observed. However, after 11 days from acute tin chloride intoxication, only significantly increased concentration of beta-2-microglobulin in the serum of rats was observed. Acute tin chloride intoxication of rats can damage the function of kidney.

Keywords: acute tin chloride intoxication, rats, biochemical parameters, damage of kidney function

STRESZCZENIE

Nerka jest głównym narządem docelowego działania wielu metali ciężkich. Nieliczne prace dotyczące nefrotoksycznego działania chlorku cyny stały się inspiracja tych badań. W pracy oceniano niektóre parametry biochemiczne świadczące o funkcji nerek szczurów po ostrym zatruciu chlorkiem cyny. Badania przeprowadzono na szczurach, samcach szczepu Wistar (200-240 g). Chlorek cyny w dawce 63,2 mg/kg m.c. podawano dootrzewnowo (ip). Po 48 godz. lub 11 dniach od ostrego zatrucia szczury dekapitowano a krew pobierano do badań. W surowicy krwi przy użyciu gotowych zestawów diagnostycznych oznaczono stężenia : mocznika, kreatyniny i β-2-mikroglobuliny. W pracy wykazano, po 48 godz. od zatrucia istotny wzrost stężenia mocznika i kreatyniny oraz brak zmian w stężeniu β-2-mikroglobuliny w surowicy szczurów. Natomiast po 11 dniach od ostrego zatrucia notowano tylko istotny wzrost poziomu beta-2-mikroglobuliny w surowicy krwi szczurów. Uzyskane zmiany w parametrach biochemicznych sugerują, że ostre zatrucie szczurów chlorkiem cyny może uszkadzać funkcje nerek.

Słowa kluczowe: ostre zatrucie chlorkiem cyny, szczury, biochemiczne parametry, uszkodzenie funkcji nerek