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THE CONCENTRATION OF MERCURY IN KIDNEY CANCEROUS AND CONTROL TISSUES OF HUMAN

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ABSTRACT

The aims of this study was determinate the average accumulation of mercury in kidney healthy and cancerous tissues of human in relation age and sex.

Both inorganic and organic forms of mercury are highly toxic to humans; however, inorganic mercury is not as easily absorbed by the body. Inorganic mercury, such as mercury vapor, is toxic if inhaled in large concentrations. As the body tries to rid itself of these toxins, gaseous mercury is oxidized to divalent mercury, which accumulates in the kidneys and can cause kidney damage.

Tissues were taken during surgery and post-mortem from Military Hospital, PROSMED Health Center and Oncology Centre of Maria Skłodowska - Curie in Cracow. Fragments of tissues cancerous (tissues away from the tumor, tissues surrounding the tumor, tissues tumor) and tissues normal (control group) were taken from kidney and then frozen. Average mass of each sample hesitated from 0,5-1g. Samples were taken from 98 (n=98) cancerous patients and from 22 (n=22) healthy patients (control tissues). Mercury contents were detected using CVAAS methods. All results were expressed in ppm.

Mean content of mercury in men (20-50 years old) in control tissues is 0,015±0,00001 ppm. The average content of mercury in tissues away from the tumor is 0,12±0,091 ppm. The average content of mercury in tissues surrounding the tumor is 0,099±0,064 ppm. The average content of mercury in tumor tissues is 0,036±0,021 ppm. Mean content of mercury in men (50-90 years old) in control tissues is 0,023±0,009 ppm. The average content of mercury in tissues away from the tumor is 0,164±0,154 ppm. The average content of mercury in tissues surrounding the tumor is 0,106±0,094 ppm. The average content of mercury in tumor tissues is 0,035±0,031 ppm. Mean content of mercury in women (20-50 years old) in control tissues is 0,0005±0,0003 ppm. The average content of mercury in tissues away from the tumor is 0,174±0,005 ppm. The average content of mercury in tissues surrounding the tumor is 0,151±0,061 ppm. The average content of mercury in tumor tissues is 0,011±0,009 ppm. Mean content of mercury in women (50-90 years old) in control tissues is 0,021±0,013 ppm. The average content of mercury in tissues away from the tumor is 0,093±0,069 ppm. The average content of mercury in tissues surrounding the tumor is 0,086±0,073 ppm. The average content of mercury in tumor tissues is 0,068±0,063 ppm.

Mercury content is much higher in patients with tumors (both men and women) in comparison to healthy tissues of both sexes. In all groups, mercury concentration was the highest in tissues away from the kidney tumor, in comparison to mercury content in adjacent mucous membrane and tumor tissues of this organ. The results suggest that some types of cancerous tissues may accumulate more effectively toxic elements.

Key words: kidney, mercury, CVAAS, cancerous tissues

Introduction

Around 208,500 new cases of kidney cancer are diagnosed in the world each year, accounting for just under 2% of all cancers **(Lindblad and Adami)**. The most recent estimates of incidence of kidney cancer suggest that there are 63,300 new cases annually in the EU25. In Europe, kidney cancer accounts for nearly 3% of all cancer cases **(Ferlay et al., 2007)**. In the UK kidney cancer is the eighth most common cancer in men (5,377 new cases diagnosed in 2008), and the ninth most common cancer in women (3,380 new cases in 2008), giving a male: female ratio of over 3:2. The number of cases of kidney cancer in men in the UK has doubled from 7 per 100,000 to 14.8 per

100,000 between 1975-1977 and 2006-2008. In women the rates have more than doubled over the same period, rising from 3.2 to 7.5 per 100,000 **(Cancer Research)**. The incidence of kidney cancer is also increasing in the United States. This is thought to be a real increase, not only due to changes in the way the disease is diagnosed **(Lynch et al., 2007)**.

Historically medical practitioners would expect a person to present with what is known as the classic triad of symptoms **(Cohen and McGovern, 2005)**. This triad of symptoms includes: hematuria which is when there is blood present in the urine. Flank pain, which is pain on the side of the body between the hip and ribs. An abdominal mass, similar to bloating but larger. It is now known that this classic triad of symptoms only occurs in 10-15% of cases, and can be indicative of the Renal cell carcinoma (RCC) in an advanced stage **(Cohen and McGovern, 2005)**. Today RCC is fairly asymptomatic (meaning little to no symptoms) and is generally detected incidentally when a person is being examined for other ailments **(Motzer et al., 1996)**. VHL is a rare disease that runs in some families. It is caused by changes in the VHL gene. An abnormal VHL gene increases the risk of kidney cancer. It also can cause cysts or tumors in the eyes, brain, and other parts of the body. Family members of those with this syndrome can have a test to check for the abnormal VHL gene. For people with the abnormal VHL gene, doctors may suggest ways to improve the detection of kidney cancer and other diseases before symptoms develop.

Both inorganic and organic forms of mercury are highly toxic to humans; however, inorganic mercury is not as easily absorbed by the body. Inorganic mercury, such as mercury vapor, is toxic if inhaled in large concentrations. Inhaled gaseous mercury is absorbed into the blood. Once in the circulatory system, it can pass through the blood-brain barrier and accumulate in the brain, damaging the central nervous system. As the body tries to rid itself of these toxins, gaseous mercury is oxidized to divalent mercury, which accumulates in the kidneys and can cause kidney damage **(Honda et al., 2006)**. Most people are not exposed to inorganic mercury but rather absorb methylmercury through the consumption of fish and shellfish. Methylmercury is easily absorbed in the digestive tract, where it forms a complex with the amino acid cysteine. This new complex resembles a large neutral amino acid found in the body, methionine, and can more easily gain entry into cells. As with inorganic mercury, once in the bloodstream, methylmercury will accumulate in the brain and cause damage to the central nervous system. Methylmercury is naturally removed from the body over time. Eventually, this methylmercury-cysteine complex is transported to the liver where it is secreted into bile, after which enzymes break the complex down into its amino acid and methylmercury parts. Some of this methylmercury then comes in contact with the bacteria in the intestine and is broken down into inorganic mercury and carbon. The inorganic mercury is poorly absorbed in the digestive tract and 90 percent is excreted in the feces. The rest of the methylmercury that does not interact with bacteria is reabsorbed by the body and goes through the process again. It takes about 30 to 40 hours for methylmercury to be distributed to the tissues of the body **(Clarkson and Magos, 2006)**.

Material and methods

Tissues were taken during surgery and post-mortem from Military Hospital, PROSMED Health Center and Oncology Centre of Maria Skłodowska - Curie in Cracow. Permission for research was given by Local Bioethical Commission. Fragments of tissues cancerous (tissues away from the tumor, tissues surrounding the tumor, tissues tumor) and tissues normal (control group) were taken from kidney and then frozen. Average mass of each sample hesitated from 0,5-1g. Samples were taken from 98 (n=98) cancerous patients and from 22 (n=22) healthy patients (control tissues).

Mercury contents were detected using CVAAS methods. All results were expressed in ppm. Hypothesis falsification were made by U Mann-Whitney test, and Kruskal-Wallis ANOVA.

Results

Results were analyzed statistically by using Statistica 10 program. In statistical description the following statistics were used: the arithmetic mean and standard deviation. Normality of the distribution was examined by Shapiro-Wilk test. Because none of the normal distributions were noticed, Kruskal-Wallis test for independent trials was used. Statistical analysis was to use the U

Mann-Whitney test, to check the differences in the average content of mercury between the two age groups separately for men, healthy and sick. Results are shown in Figure 1, Figure 2, Figure 3 and Figure 4.

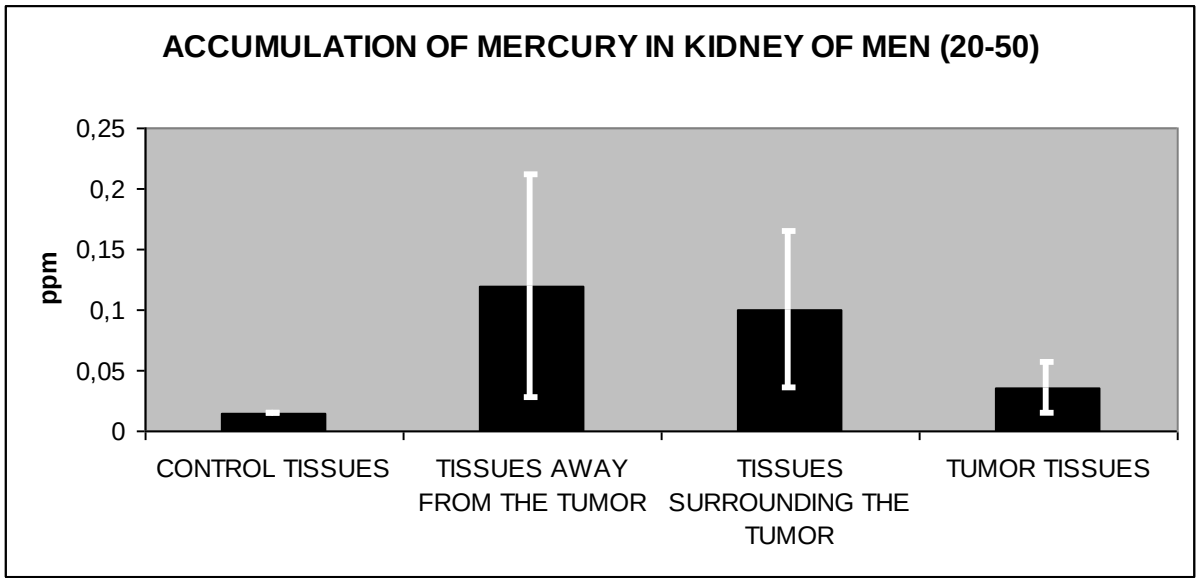

Fig. 1

Accumulation of mercury in kidney of men (20-50 years old).

Mean content of mercury in men (20-50 years old) in control tissues is 0,015±0,00001 ppm. The average content of mercury in tissues away from the tumor is 0,12±0,091 ppm. The average content of mercury in tissues surrounding the tumor is 0,099±0,064 ppm. The average content of mercury in tumor tissues is 0,036±0,021 ppm.

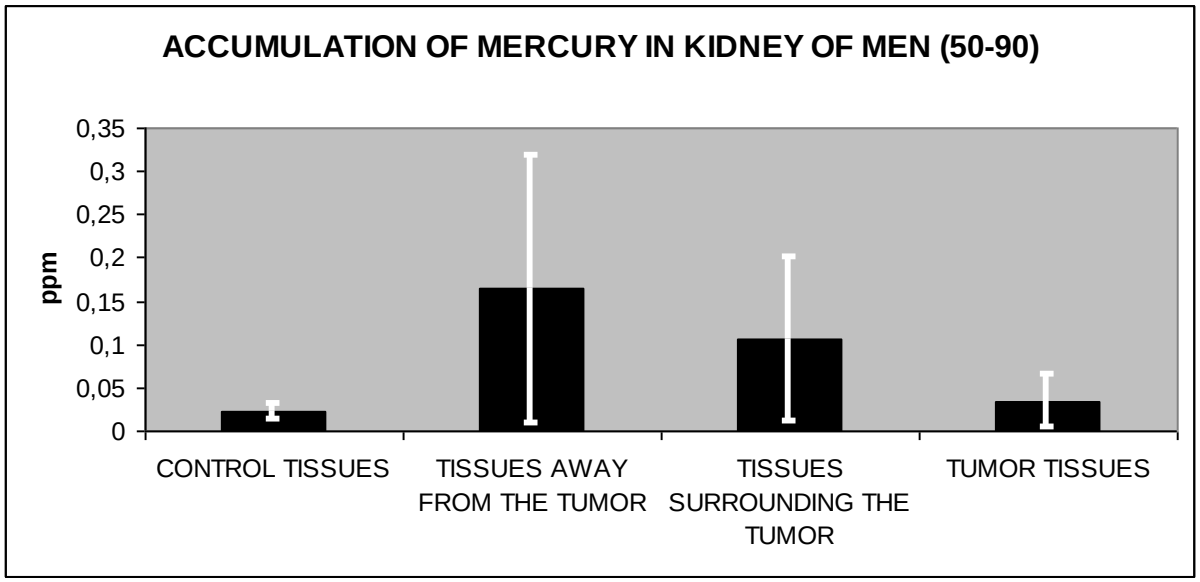

Fig. 2

Accumulation of mercury in kidney of men (50-90 years old).

Mean content of mercury in men (50-90 years old) in control tissues is 0,023±0,009 ppm. The average content of mercury in tissues away from the tumor is 0,164±0,154 ppm. The average content of mercury in tissues surrounding the tumor is 0,106±0,094 ppm. The average content of mercury in tumor tissues is 0,035±0,031 ppm.

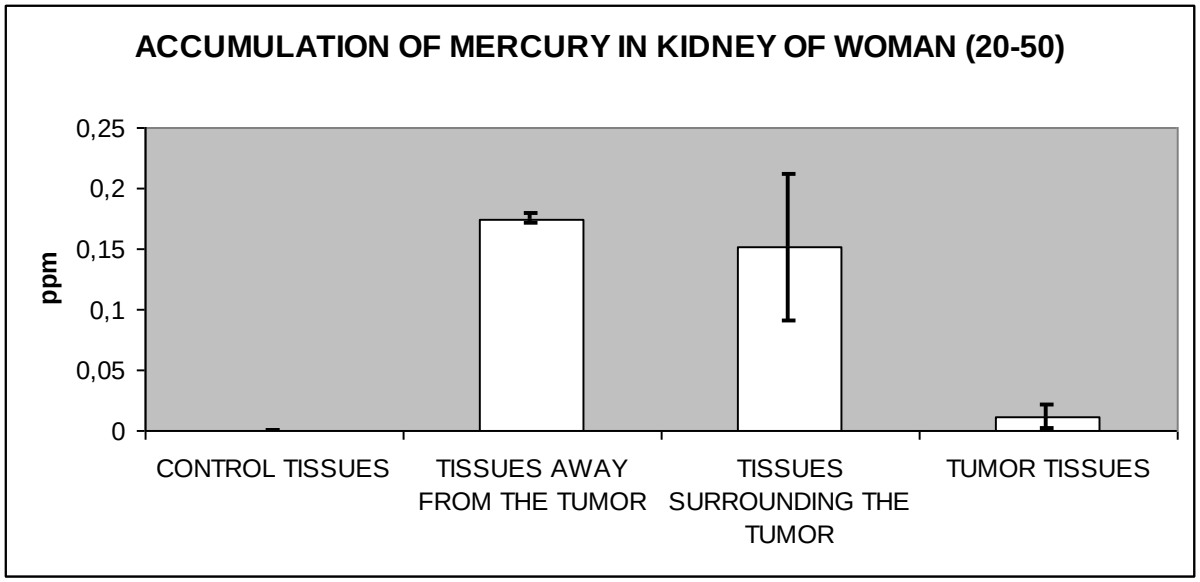

Fig. 3

Accumulation of mercury in kidney of women (20-50 years old).

Mean content of mercury in women (20-50 years old) in control tissues is 0,0005±0,0003 ppm. The average content of mercury in tissues away from the tumor is 0,174±0,005 ppm. The average content of mercury in tissues surrounding the tumor is 0,151±0,061 ppm. The average content of mercury in tumor tissues is 0,011±0,009 ppm.

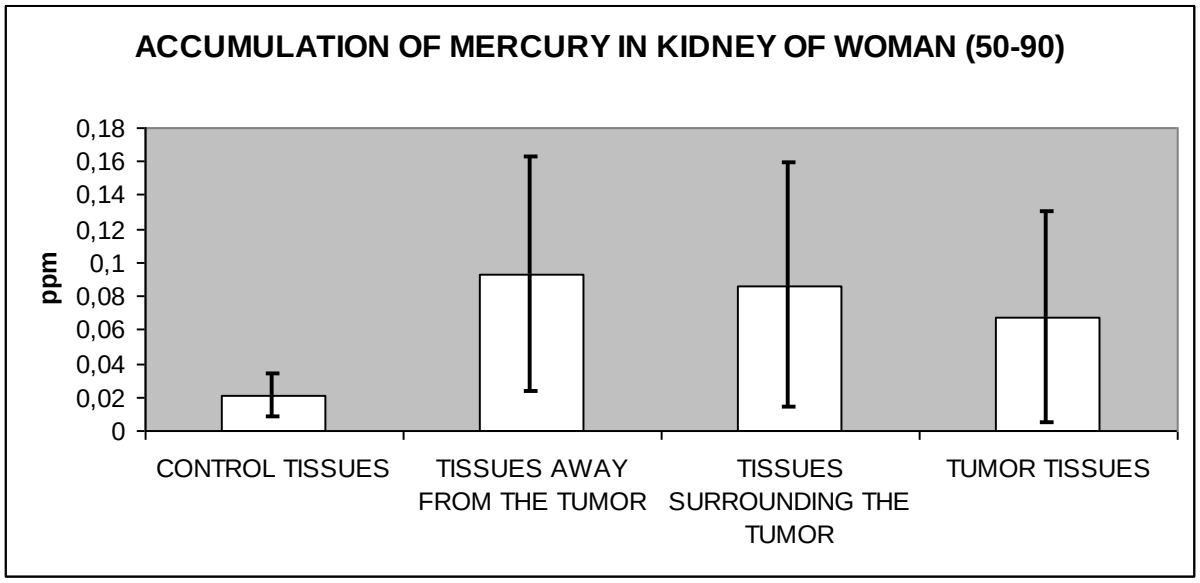

Fig. 4

Accumulation of mercury in kidney of women (50-90 years old).

Mean content of mercury in women (50-90 years old) in control tissues is 0,021±0,013 ppm. The average content of mercury in tissues away from the tumor is 0,093±0,069 ppm. The average content of mercury in tissues surrounding the tumor is 0,086±0,073 ppm. The average content of mercury in tumor tissues is 0,068±0,063 ppm.

Discussion and conclusions

In men 20-50 years old, mean concentration of mercury is higher in cancerous tissues, especially in tissues away from the tumor (0,12 ppm) compared with healthy tissues (control group) (0,02 ppm). Also in men 50-90 years old, mean concentration of mercury is higher in tissues away from the tumor (0,164 ppm) compared with healthy tissues (control group) (0,023 ppm). It shows too

low level of this element in normal tissues of kidney of healthy people, what can protect before initiation of carcinogenesis in kidney.

In women 20-50 years old, mean concentration of mercury is the highest in tissues away from the tumor (0,174 ppm) compared with tumor tissues (0,011 ppm) and healthy tissues (control group) (0,0005 ppm). In women 50-90 years old, mean concentration of mercury is higher also in tissues away from the tumor (0,093 ppm) compared with healthy tissues (control group) (0,021 ppm).

Many adverse health effects are associated with the accumulation of mercury in the body, though these vary depending on the amount of mercury one is exposed to, time of exposure, chemical form of the mercury, and age of the subject **(Shea et al., 2004)**. To date, these more severe symptoms have only been observed in people who consumed fish that were contaminated directly by methylmercury from anthropogenic sources, not from methylmercury that accumulated through the natural methylation process **(Clarkson and Magos, 2006)**. Taking into consideration relationship between mercury and its influence on carcinogenesis it is proved that only organic form of this metal may accumulate in kidney and can cause cancer of this organ. Our analysis also point such connection, because we detected higher level of Hg in cancerous tissues. Mercury content is much higher in patients with tumors (both men and women) in comparison to healthy tissues of both sexes. In all groups, mercury concentration was the highest in tissues away from the kidney tumor, in comparison to mercury content in adjacent mucous membrane and tumor tissues of this organ. The results suggest that some types of cancerous tissues may accumulate more effectively toxic elements.

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