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Shift of zinc in serum and tissues in course of experimental acute pancreatitis

In recent years the significance of trace elements in human physiology and pathology has been increasing. It is due to their functions. Copper and zinc seem to be in the center of attention. In the human organism there is 1.3–2.3 g of zinc (2, 3, 9). It is found in all tissues and liquids, but its distribution lacks proportion, yet, in particular organs, in physiologic conditions, the level is constant. The highest level of zinc concentration can be found in retina, choroids, prostatic gland, liver, kidneys. 70–80% of it can be found in bones, muscles and skin (13). Particular significance of zinc is associated with its presence in many enzymes, being a composition ingredient, as well as an activator of many enzymes, due to its function of generating metal-enzymes. Either lack or insufficiency of zinc is an immediate cause of many disorders in organism functioning, such as: height inhibition or its delay, lack of appetite, weakening of procreative functions, immunologic disorders.

MATERIAL AND METHODS

The experiment was conducted upon 200 male rats, of Wistar breed, weight 250-350 g, according to Heinkel and Aho's method (1). Four groups of rats were separated: Z – healthy (20), K1 – control (60), K2 – control (60), D – experimental (60). The animals were anesthetized with diethyl ether . The procedure was performed in sterile conditions. After the peritoneal cavity had been opened, the needle (0.5 x 16) leading to the bile--pancreatic duct through duodenum was inserted. In order to induce overpressure in the bile-pancreatic duct in the neighbourhood of the liver hilus, the light of the duct was being closed with small forceps. Next perfusion was started, in the D group, 5% solution

of sodium taurocholan was injected. The solution was being administered in the constant intraduct infusion of the flow of 0.1 ml/min in the amount of 0.1 ml for every 100 g of a rat's mass. The rats from K2 group were administered with physiological saline in the same manner and the same amount. The K1 group had only the needle inserted, but no substance was administered to them.

After 6, 12, 24, 48 hours since the acute pancreatitis was induced, the rats were anesthetized again (15 after each period), thoracotomy was performed and the blood from the left chamber was taken. Then after it turned into a clot, it was centrifuged for 20 minutes at 2000 rot./min. The blood serum obtained in such a manner was then frozen in –25°C until it was analyzed. The whole heart and right lung were taken out from the chest. The peritoneal cavity was reopened and the pancreas, liver and left kidney were taken out.

The method of the spectrophotometry of atom absorption was applied to mark the concentration of the chosen elements in the collected material. The SP 192 Pye Unicam spectrophotometer was used. The collected data were then statistically analyzed, in order to define the arithmetic average and the standard deviation in the control group, as well as in the examined groups. The statistic significance was defined by the application of the t-student test and C. Cochren-Cox's test; accepting the value $p<0.05$ for which the differences were taken as statistically significant.

RESULTS

Statistical characteristics concerning the obtained data are presented in Tables 1, 2 and 3. Because there was no statistically significant differences between group Z and K1, these data in examined organs were not given.

Table 1. Zinc concentration in blood serum (* $p<=0.05$ if compared with healthy rats)

Groups		after 6 h	after 12 h	after 24 h	after 48 h
Z healthy	0.030	X	X	X	X
K1 control	X	0.030	0.029	0.030	0.030
K2 control	X	0.023	0.023	0.025	0.027
D-exp.	X	0.013 *	0.014 *	0.020 *	0.026 *

Table 2. Zinc concentration in tissues (in mg/g of tissue) in K2 animals (* $p<=0.05$ if compared with healthy rats)

Groups	healthy	after 6 h	after 12 h	after 24 h	after 48 h
Pancreas	36.97	27.72	26.17	27.95	28.16
Kidney	29.18	22.81	24.86	25.17	25.93
Liver	25.02	32.76 *	33.49 *	32.87 *	34.24 *
Heart	18.92	17.53	18.99	18.61	19.54

Table 3. Zinc concentration in tissues (in mg/g of tissue) in experimental animals (* p<=0.05 if compared with healthy rats)

Groups	healthy	after 6 h	after 12 h	after 24 h	after 48 h
Pancreas	36.97	23.90 *	22.17 *	23.73 *	22.68 *
Kidney	29.18	20.63 *	22.38 *	23.17	24.27
Liver	25.02	37.95 *	38.38 *	39.48 *	41.52 *
Heart	18.92	16.62	18.45	16.51	18.17

DISCUSSION

When marking zinc concentrations in the course of acute pancreatitis, the shift of this element in tissues was observed. The fall of zinc in blood serum, pancreas, kidneys, heart and lung was noticed. The zinc increase was present in the liver only. Statistically significant differences were observed in the pancreas and liver in D and K2 groups , and in blood serum and kidneys in D group at 6^{th} and 12^{th} hour of the experiment. Differences observed in the heart muscle and lungs were not statistically significant.

There are many reasons which may influence the fall of zinc concentration in blood serum. The following should be related to: a disease stress which increases the excretion of the zinc in urine, and the fall of these element delivery due to starvation (5, 8, 9, 12). There may be also intestine – pancreatic disorders of zinc circulation. Namely, the ion with pancreatic liquid and bile is secreted to the light of the intestine where it is re-absorbed, being a significant source of this element (10).

A decisive element which induces hypozincemia is the fact that significant quantities of zinc are shifted towards the liver for acute protein synthesis which in turn, may lead to the decrease of the zinc level in the liver by approx. 50%. This research justified the essential increase in the zinc level in the liver. The fall of albumin and alpha 2 macroglobulin concentration being major zinc transporters in blood serum (hypoproteinemia is also acknowledged in acute pancreatitis) is another element which leads to the zinc decrease in blood serum.

In the available literature there are no data on the zinc concentration among the AP patients. Tests performed in cases of other diseases (chronic digestive system diseases) justify that zinc deficiency may lead to many metabolic disorders, such as the decrease in the secreting function of pancreas, hyperglycemia, the decrease of protein catabolism and strong inflammatory reaction. Such symptoms are characteristic of acute pancreatitis (5, 7).

The fall of zinc level in acute pancreatitis may result from decreased activity of superoxide dismutasis. Zinc is a microelement which is present in the active center of that enzyme. It has a very important function, as nowadays a huge role of AP development is attributed to free radicals, and dismutasis is a major antioxidant (4, 6, 11, 14).

In the K1 group defined differences were of a random character and they were not statistically significant. This justifies the fact that the procedure has not influenced the level of zinc concentration.

In conclusion it should be stated that in the course of experimental acute pancreatitis there appear disorders in homeostasis of zinc manifested by hypozincemia accompanied by a significant shift of this element quantities from blood serum and tissues to the liver. The peak of theses changes falls onto the first 12 hours of the experiment, in other words, onto the period of the highest advancement of acute pancreatitis.

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SUMMARY

The experiment was conducted upon 200 male rats of Wistar breed, weight 250-350 g, according to Heinkel and Aho's method. Four groups of rats were separated: Z – healthy (20) , K1 – control (60), K2 – control (60), D – experimental (60). After 6, 12, 24, 48 hours since the acute pancreatitis was induced, the rats were anesthetized again (15 after each period), thoracotomy was performed and the blood from the left chamber was taken. Then after it turned into a clot, it was centrifuged for 20 minutes at 2000 rot./ min. The blood serum obtained was then frozen in -25°C until it was analyzed. The whole heart and right lung were taken out from the chest. The peritoneal cavity was re-opened and the pancreas, liver and left kidney were taken out. The method of the spectrophotometry of atom absorption was applied to mark the concentration of the chosen elements in the collected material. The SP 192 Pye Unicam spectrophotometer was used. The collected data were then statistically analyzed in order to define the arithmetic average and the standard deviation in the control group as well as in the examined groups. The statistic significance was defined by the application of the t-Student test and C. Cochren-Cox's test; accepting the value $p<0.05$ for which the differences were taken as statistically significant. When marking zinc concentrations in the course of acute pancreatitis, the shift of this element in tissues was observed. The fall of zinc in blood serum, pancreas, kidneys, heart and lung was observed. The zinc increase was present in the liver only. Statistically significant differences were observed in the pancreas and liver in D and K2 groups, and in blood serum and kidneys in D group at 6^{th} and 12^{th} hour of the experiment. Differences observed in the heart muscle and lungs were not statistically significant.

Przesunięcia tkankowe cynku z surowicy w przebiegu doświadczalnego ostrego zapalenia trzustki

Celem pracy było zbadanie zmian stężeń cynku w surowicy i tkankach szczura oraz kierunku przesunięć tkankowych w przebiegu doświadczalnego ostrego zapalenia trzustki. Ostre zapalenie trzustki u szczurów wywołano podając pod ciśnieniem 5% taurocholan sodu do przewodu żółciowo-trzustkowego. W przebiegu doświadczenia stwierdzono statystycznie istotny spadek stężenia cynku w surowicy, trzustce i w nerkach oraz wzrost jego stężenia w wątrobie. Szczyt tych zmian zaobserwowano w pierwszych dwunastu godzinach doświadczenia, czyli w okresie największego nasilenia procesu zapalnego.