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Changes in serum levels of zinc, selenium, copper and magnesium in individuals with chronic alcoholic and chronic idiopathic pancreatitis

Stężenie cynku, selenu, miedzi i magnezu w surowicy chorych z przewlekłym alkoholowym i idiopatycznym zapaleniem trzustki

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Streszczenie

Cel badania. Określić stężenie cynku, selenu, miedzi i magnezu w surowicy chorych z przewlekłym alkoholowym i idiopatycznym zapaleniem trzustki. Określić nasilenie zmian morfologicznych według klasyfikacji Cambridge.

Materiał i metody. Na czczo oceniano stężenia w surowicy u 40 pacjentów z idiopatycznym przewlekłym zapaleniem trzustki, 40 pacjentów z alkoholowym przewlekłym zapaleniem trzustki i 40 zdrowych osób z grupy kontrolnej, przy pomocy atomowej spektrofotometrii absorpcyjnej z atomizacją płomieniową lub elektrotermiczną. Rozpoznanie ustalano na podstawie wywiadu, EUS, TK i ECPW.

Wyniki. Stężenie wszystkich badanych metali śladowych było statystycznie istotnie obniżone w alkoholowym przewlekłym zapaleniu trzustki, a tylko stężenia magnezu i cynku były obniżone w idiopatycznym przewlekłym zapaleniu trzustki.

Wniosek. W kolejnych badaniach należy wyjaśnić istotne statystycznie obniżenie stężenia cynku i magnezu w idiopatycznym przewlekłym zapaleniu trzustki oraz rolę tego zjawiska w patogenezie tego typu przewlekłego zapalenia trzustki.

Słowa kluczowe: mikroelementy, cynk, miedź, selen, magnez, przewlekłe alkoholowe zapalenie trzustki, przewlekłe idiopatyczne zapalenie trzustki

Summary

The aim of the study. To investigate serum levels of copper, zinc, magnesium and selen in chronic idiopathic and alcoholic pancreatitis. The severity of morphologic changes assessed according to Cambridge classification.

Material and methods. Fasting serum levels from 40 patients with idiopathic chronic pancreatitis, 40 patients with alcoholic chronic pancreatitis and 40 healthy controls were investigated by atomic absorption spectrophotometry with flamed or electrothermic atomisation. Diagnosis was established by personal history, EUS, CT and ERCP.

Results. All followed trace elements were statistically decreased in chronic alcoholic pancreatitis, but only magnesium and zinc were decreased in idiopathic chronic pancreatitis.

Conclusion. Statistically significant decrease of zinc and magnesium in idiopathic chronic pancreatitis is necessary to explain in further studies for their roles in this type of chronic pancreatitis.

Key words: micronutrients, zinc, copper, selen, magnesium, chronic alcoholic pancreatitis, chronic idiopathic pancreatitis

INTRODUCTION

Micronutrients – essential trace elements play a significant role in the functioning of the human organism. They are involved in a number of cellular processes

such as nucleic acid synthesis, cellular antioxidative defence against the action of reactive oxygen species, cell growth and renewal, etc. (1). The involvement of zinc in cellular immunity is of a very complex nature;

there is a decrease in the count of T-lymphocytes and T4/T8 lymphocyte subpopulation when there is zinc deficiency in the organism. The involvement of zinc is absolutely essential in the case of zinc-dependent metalloenzymes such as carbonic anhydrase, alcohol dehydrogenase, alkaline phosphatase, thymidine kinase or Cu/Zn superoxide dismutase (2, 3, 4).

Similarly to zinc, copper is an integral part of copper-dependent metalloenzymes. Copper, through cytochrome oxidase, affects the energetic efficiency of respiratory chains, is involved in catecholamine metabolism, is part of the antioxidant barrier against the negative effect of oxidative stress, and acts on the stability of cell membranes (5, 6).

Magnesium is an extraordinarily significant biogenic element related to oxidative energetic processes, including the oxidation of glucose, lipids as well as proteins; it is involved in the function of some ion channels, including calcium channels; and, last but not least, it has a profound effect on vascular flow changes in both the cardiac and peripheral arteries. In terms of gastroenterological changes, magnesium is an element with a significant relationship to the function of some exocrine secretory glands.

Selenium is a constituent of the enzyme glutathione peroxidase (GSHPx) which is one of the major components of the body's antioxidant system. It is a component of important amino acids, such as methylselenocysteine or selenocysteine; however, the main organic compound in the body containing selenium is selenomethionine (7).

From what has been mentioned above, it is obvious that the elements in question may also play a major role in the area of inflammatory pancreatic disease where changes in, for instance, vascular perfusion, tissue ischaemia, oxidative stress or changes in cellular oxidative processes may contribute not only to the development, but particularly to the modification of the course and progression of the disease (8, 9, 10).

As the above-mentioned elements are introduced into the organism through food, it can be assumed that, given the dietary patterns in alcoholics, their content may be reduced in individuals with the alcoholic form of chronic pancreatitis (11). The aim of our study was to compare the serum concentrations of zinc, copper, selenium and magnesium in individuals with the alcoholic form of chronic pancreatitis to those in individuals with the idiopathic form of the disease where the contribution of alcohol to the development of the disease can be excluded.

MATERIAL AND METHODS

A total of 120 individuals were investigated out of whom 40 made up the control group. No manifestations of gastrointestinal, hepatic and pancreatic diseases were confirmed in control subjects; neither had they any manifestations of eating disorders. Another group studied were 40 patients with the alcoholic form of chronic pancreatitis in whom regular alcohol intake

exceeding a daily amount of more than 70 g and occurring for more than five years was demonstrated; the third group consisted of 40 individuals who have been diagnosed with idiopathic chronic pancreatitis and in whom no regular alcohol intake was demonstrated either by directed questioning or by laboratory tests. The mean ages in all the groups investigated were insignificantly different; it was 43.7 years in the control group, 41.9 years in the group with alcoholic form of the disease and the mean age in idiopathic form of the disease was 47.3 years.

The diagnosis of chronic pancreatitis was established based on meeting the criteria on CT scanning; by endosonographic examination – more than 4 criteria according to Wiersema (12); and based on the finding of endoscopic retrograde cholangiopancreatography. According to the Cambridge criteria (13), the individuals evaluated had a moderate grade of morphological changes of the pancreas.

After a 12-hour fast, coagulable blood was collected from the cubital vein of all the subjects. The serum concentrations of zinc and magnesium were determined using atomic absorption spectrophotometry (AAS) with flame atomization. AAS with electrothermal atomization was used to determine copper and selenium.

The statistical evaluation was performed using the Student's T-test.

RESULTS

The serum level of zinc was statistically significantly decreased ($p < 0.001$) in both the group of individuals with the alcoholic form of chronic pancreatitis and in those with the idiopathic form. The serum level of zinc was statistically less significantly decreased also in individuals with the alcoholic form as opposed to the idiopathic form (fig. 1).

A statistically significant decrease with a $p < 0.01$ was also detected when evaluating the serum levels of magnesium in both forms of chronic pancreatitis versus controls; however, no significant differences were found between the alcoholic and idiopathic forms (fig. 2).

The serum concentration of copper was also statistically significantly decreased in individuals with the alcoholic form of the disease compared to the control group; however, no significant difference was demonstrated between the control group and that with the idiopathic form (fig. 3). A similar result was observed when evaluating the concentration of selenium. Statistical significance was determined between the low level of selenium in individuals with the alcoholic form when compared to the control group; however, no difference was demonstrated between the control group and the patients with the idiopathic form (fig. 4).

DISCUSSION

Essential trace elements play a significant role in a number of cellular processes ranging from intracellular

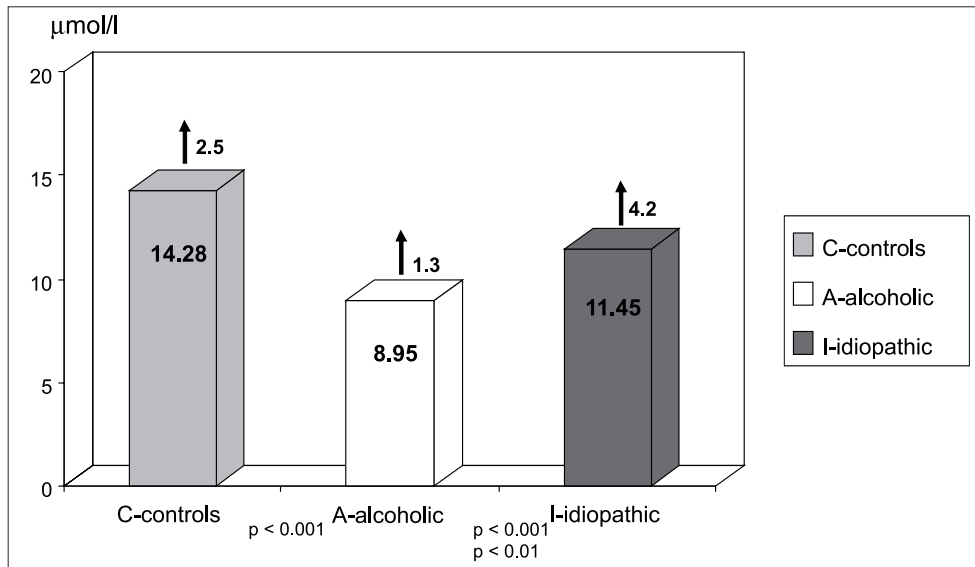


Fig. 1. Changes in zinc plasma levels in persons with chronic pancreatitis.

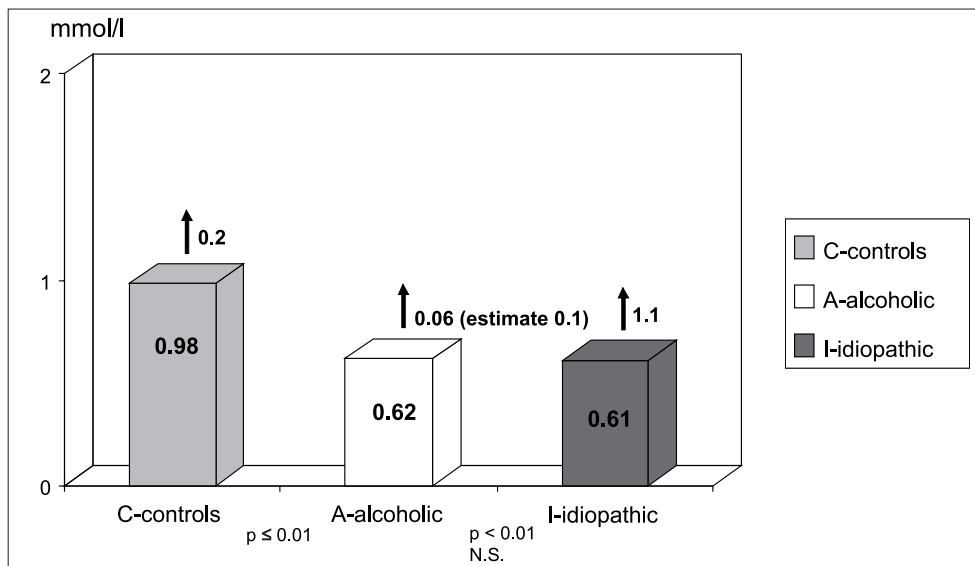


Fig. 2. Magnesaemia in persons with chronic pancreatitis.

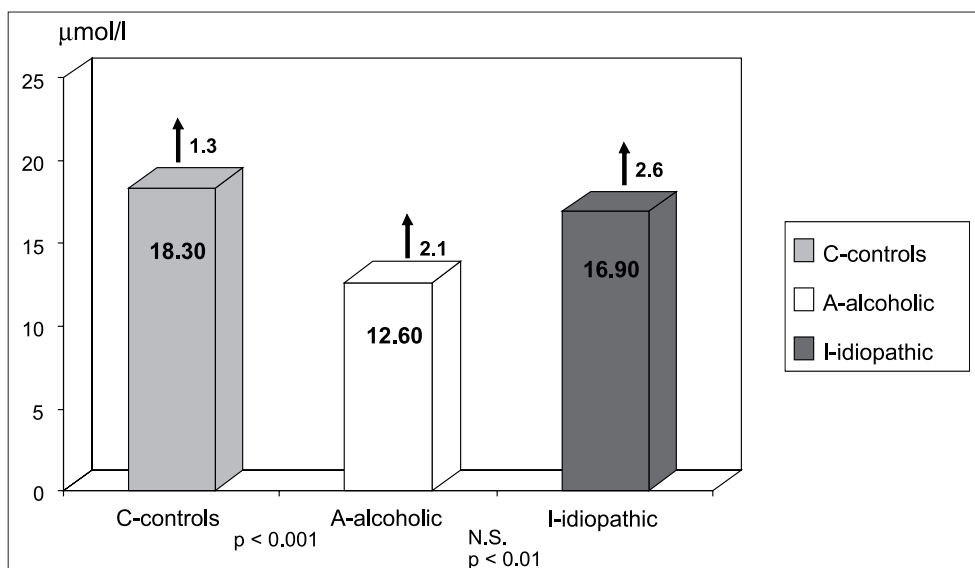


Fig. 3. Changes in copper plasma levels in persons with chronic pancreatitis.

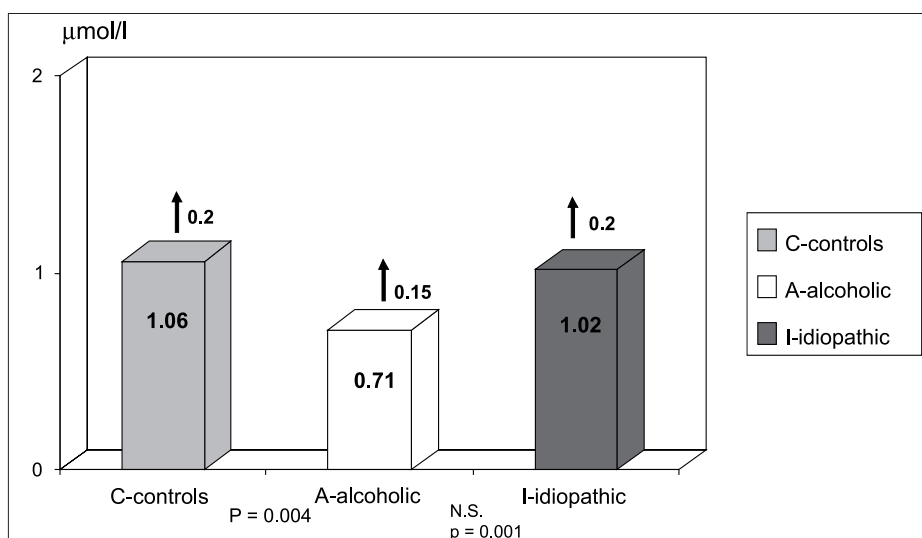


Fig. 4. Selenium blood levels in persons with chronic pancreatitis.

respiration to cell membrane stability. Zinc is generally required for the function of the enzymes involved in nucleic acid metabolism and is a factor involved in ontogenesis since it affects the function of genes necessary for cell proliferation and development. Copper is part of the enzyme lysyl oxidase, an essential enzyme in the cross-linking of connective tissue. Lysyl oxidase catalyzes the oxidation of lysyl and hydroxyl residues in elastin and collagen polypeptide chains. Copper is part of the enzyme cytochrome oxidase involved in energetic cellular processes. Glutathione peroxidase (Se) is among important, natural scavengers of oxygen radicals. Considering that oxidative stress is one of the factors affecting pancreatic fibrogenesis and, thus, one of the basic factors affecting the development of morphological changes in chronic pancreatitis, selenium is of particular importance in pancreatology. Generally growing interest in the potential role of Se in many chronic diseases (15).

Finally, the role of magnesium in cellular processes is also crucial, particularly the content of magnesium in the enzymes involved in energetic metabolism, including oxidation of glucose, lipids and proteins, is essential for the functioning of these enzymes. Of interest is the participation of magnesium in affecting the function of vascular receptors and the subsequent effect on vasodilation, and also its involvement in the function of, for instance, calcium and potassium cell channels is of significance (16). Deficiency of magnesium has been described in chronic alcoholics; therefore, its decrease in those with the alcoholic form of chronic pancreatitis is not surprising. On the other hand, however, the demonstration of a decreased magnesium level in the idiopathic form of chronic pancreatitis is of major importance, particularly in terms of the above-mentioned involvement of magnesium in the function of potassium and calcium cell channels and the resulting effect on the secretory functions of the gland (17).

Micronutrients, their blood serum levels or their presence in the tissues are among the possible markers of pancreatic injury (18, 19). In 2004, Dominquez-Munoz

published the results of a study in which the level of zinc in the duodenal juice following the stimulation of the gland with secretin and cerulein was determined (20). They showed that the determination of zinc in the duodenal aspirate is a test allowing the quantification of the bicarbonate output in the pancreatic juice following exogenous stimulation of the gland with enterohormones. A year later, Pungpapong et al. reported similar results using the determination of zinc in the pancreatic juice (21). The relationship between the secretion of pancreatic enzymes and zinc absorption in persons with mucoviscidosis was described by Easley et al. (22). The authors demonstrated a direct relation between the duodenal presence of pancreatic enzymes and zinc absorption in these patients.

Girish et al. described that zinc deficiency in chronic pancreatitis correlates with exocrine and endocrine insufficiency (23).

The role of micronutrients for cellular functions, including the direct effect on a number of regulatory mechanisms affecting organ functions, was documented in numerous studies (24, 25, 26). However, the content of micronutrients in pancreatology and their relation to pancreatic exocrine as well as endocrine secretion and/or the development of changes accompanying chronic pancreatitis remain an understudied area.

CONCLUSION

Decreased exogenous intake of micronutrients in the diet can be assumed in ACP; however, decreased levels due to inadequate intake of micronutrients are less likely in ICP. Given the role of magnesium and zinc in some energetic enzymatic cellular processes and, in particular, the role in affecting the function of potassium and calcium channels, it can be presumed that the elements in question play a major role in the development of structural changes and in the modulation of pancreatic functions in individuals with the idiopathic form of the disease. Further studies into this area are required.

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