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Zinc and copper in the human placenta membranes

Trace elements are important components of the organisms, and proper concentration of these elements, as well as their mutual balance in the tissues is crucial to the correct development of these organisms. Disorders caused by their deficiency or excess are a considerable medical problem. Until recently stress was laid on proper composition of macroelements in food. Now, increasingly more attention is being paid to microelements as being equally vital to the preservation of good health (3, 11).

The influence of trace elements on systemic metabolism and on the physiological functioning of the organism has urged their quantitative determination in the body fluids and tissues.

The main aim of the presented study was to determine the distribution of microelements like zinc and copper in the human placenta membranes.

MATERIAL AND METHODS

The membranes (chorion and amnion, n = 38)) were collected after normal delivery of pregnancies between 37 and 41 weeks.

Determination of the microelements concentration. Tissue samples were subjected to desiccation for 72 hrs at 80°C, ashed at 450°C, and then dissolved in a concentrated HCl mixed with distilled water (1:1, v/v). The concentrations of zinc and copper were determined by the spectrophotometric method using atomic absorption spectrophotometer (Pye Unicam SP-192, U.K.) (10). The results obtained were analysed statistically using Wilcoxon test. The differences were recognised as significant at $p < 0.05$ (Table 1).

RESULTS

Table 1 and Figure 1 show the content of the examined microelements in the chorion and in the amniotic sac. The zinc level in the chorion is about 50% higher in comparison with their content in the amniotic sac. Likewise, a higher level in the chorion was found for copper (about 100%). Among the median contents of zinc and copper in the examined layers of the placenta the difference is statistically important.

Table 1. Concentration of zinc and copper (mg/kg of wet tissue) in placenta membranes (n = 38)

Investigated parameters	Range	Mean value (n = 38)	Standard deviation SD
Zn-am	2.46 - 15.15	6.43	2.39
Cu-am	0.20 - 1.05	0.58	0.20
Zn-cho	3.53 - 23.90	9.96	4.26
Cu-cho	0.52 - 2.39	1.18	0.35

Abbreviations used: Zn-am, Cu-am – concentration of zinc and copper in amnion; Zn-cho, Cu-cho – concentration of zinc and copper in chorior

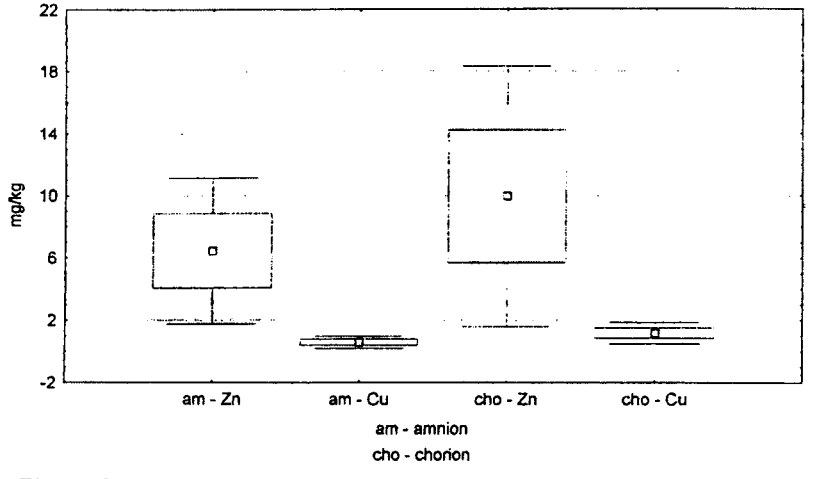

Fig. 1. Concentration of zinc and copper (mg/kg of wet tissue) in placenta membranes (n = 38)

DISCUSSION

Pregnancy is a physiological state characterised by a higher demand for bioelements necessary for the growth of the foetus, placenta and mother's tissues. To fulfil this requirement, mother's organism undergoes adaptive changes involving an increased absorption of bioelements in the alimentary tract, a reduction of their loss, tissue redistribution and effective mother-foetus transfer (13).

In our studies we have noted considerable differences in the distribution of bioelements in the examined placenta membranes. These differences may follow from the membrane activity, protein content and micro-molecular ligands binding the microelements, as well as the influence of hormones and other factors on the transporting systems (8, 9).

The period of pregnancy is connected with increased copper (Cu) retention by mother's organism. An increased Cu and ceruloplasmin level in mother's serum takes place, especially in the third trimester of pregnancy. The foetus accumulates Cu at the rate of 50 μg/kg/24 hrs and stores it mainly in the liver. However, the level of copper and ceruloplasmin in the blood serum remains constant. Copper intake by the foetus from mother's organism depends on the presence of the transporters in the placenta. (9, 15). It is possible that ceruloplasmin and metallothionein take part in this process.

Zinc (Zn) is extremely important in the process of foetus growth and development. The influence of zinc on the growth, development and differentiation of the cells is multidirectional: a) by affecting replication processes it regulates the overall metabolism; b) by affecting replication processes it regulates division and differentiation of chondrocytes, osteoblasts and fibroblasts – the cells participating in the development of bone tissue and in the process of mineralization; c) by affecting transcription processes it regulates structural and functional protein synthesis (e. g. somatomedin C, collagen, alkaline phosphatase, osteocalcin); d) it influences the synthesis, secretion and activity of anabolic and catabolic hormones, which participate in the development of cartilage and mineralisation (the hormone of growth, insulin, thyroid hormones, androgens, 1.25-dihydrozycholecalciferol) (3, 5, 11).

Living organisms have developed mechanisms of utilising vital trace elements such as zinc and copper, and reducing to the minimum the toxic influence of heavy metals like cadmium, mercury and lead (4,7). The ability of binding excessive metallic ions, thus limiting the number of their free ions, is possessed by metallothioneins – intracellular proteins rich in cysteine residue (1).

In normal conditions metallothioneins isolated from the liver mainly contain zinc and copper. This observation helped to draw the conclusion that the primary function of metallothionein is its involvement in the homeostasy of the elements necessary for correct growth and metabolism of the organism (12, 14).

The content of metallothionein in the membranes of the placenta is relatively high and in many cases it approximates their content in the liver and kidneys (6). The pres-

ence of metallothioneins in the placenta membranes indicates an important role they play in the development of the foetal egg. Chan and Cherian (2) suggest that metallothionein occurring during pregnancy plays and important part in storing and transport through the placenta of the necessary metals (zinc, copper) needed for the growth and development of the embryo. In the studies of laboratory animals the above-mentioned authors showed that a certain fraction of metallothioneins occurring in the placenta partly moves on to the plasma and raises the overall content of metallothioneins in it. Besides, the fraction originating from the placenta is characterised by a greater affinity toward zinc and copper.

CONCLUSION

1. Higher level of zinc and copper in the chorion may be adaptive for this layer of the membrane.

REFERENCES

1. Bremner J., Beattie J. H.: Metallothionein and the trace metals. Ann. Rev. Nutr., 10, 63, 1990.
2. Chan H., Cherian M. G.: Mobilization of hepatic cadmium in pregnant rats. Toxicol. Appl. Pharmacol., 120, 308, 1993.
3. Floriańczyk B.: Wpływ mikroelementów na metabolizm. Mag. Med., vol. VII, 5, 47, 1996.
4. Floriańczyk B.: Pompy ATPazowe dla jonów miedzi. Now. Lek., 5, 561, 1996.
5. Floriańczyk B., Bednarek A.: Udział cynku w procesie wzrostu organizmu. w: Biopierwiastki w naszym środowisku. Poli ART studio s.c., 226-232, Lublin 1997.
6. Floriańczyk B. et al.: Poziom metalotionein w błonach łożyska ludzkiego. Zbiór Prac X Sympozjum Sekcji Gestozy i Nadciśnienia w Ciąży. Polskie Towarzystwo Ginekologiczne, 138-141, Lublin 1998.
7. Goyer R. A.: Nutrition and metal toxicity. Am. J. Nutr. (Suppl.), 61, 646S, 1995.
8. McArdle H. J.: The metabolism of copper during pregnancy – a review. Food Chem., 54, 79, 1995.
9. McArdle H. J., Erlich R.: Copper uptake and transfer to the mouse fetus during pregnancy. J. Nutr., 121, 208, 1991.
10. Pinta M.: Absorpcyjna spektrometria atomowa. PWN, Warszawa 1977.
11. Prasad A.: Zinc: An overview. Nutrition, 11, 93, 1995.
12. Roesijadi G.: Metallothionein and its role in toxic metal regulation, Comp. Biochem. Physiol., 113C, 117, 1996.

13. Swanson C. A., King J. C.: Zinc and pregnancy outcome. Am. J. Clin. Nutr., 46, 763, 1987.
14. Thiele D. J.: Metal-regulated transcription in eukaryotes. Nucleic Acids Res., 20, 1183, 1992.
15. Uauy R. et al..: Essentiality of copper in humans. Am. J. Clin. Nutr., 67 (suppl.), 952s, 1998.

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SUMMARY

This paper determines the distribution of bioelements such as zinc and copper in the membranes of the placenta, i.e. the chorion and the amniotic sac. The study material was taken in the course of labour from women with normal pregnancy. In the material taken, the level of microelements was determined by nuclear absorption spectrometry. In the chorion a higher level of zinc and copper was found in comparison with the amniotic sac.

Cynk i miedź w błonach łożyska ludzkiego

W pracy określono rozmieszczenie biopierwiastków (cynku, miedzi) w błonach łożyska (kosmówka, owodnia). Materiał do badań pobierano w trakcie porodu od kobiet z ciążą niepowikłaną. W pobranym materiale określono poziom mikroelementów za pomocą atomowej spektrometrii absorpcyjnej (ASA). W kosmówce stwierdzono wyższe poziomy cynku oraz miedzi w porównaniu z owodnią.