

Katedra i Klinika Neurologii. Akademia Medyczna w Lublinie
Kierownik: prof. dr hab. n. med. Wiesław Kawiak

Maria PILARCZYK

Phosphorus Economy in a Healthy Man

Gospodarka fosforowa u człowieka w warunkach zdrowia

From 700—800 g of phosphorus contained in the human body, 80% is bound in the bones and teeth in the form of calcium and magnesium phosphates, and about 10% of this element is found in the muscles. Considerable amount of phosphorus is present in many chemical compounds which have a great effect on the body functions, such as: nucleic acids, nucleotides, diphospho- and triphosphonucleotides (ADP, ATP and others), phosphatides, phosphoproteins, some enzymes and many other compounds. Phosphates are also important for the processes of metabolism of many compounds and for energy transportation (2). Esters of phosphoric acid play a significant part in metabolic processes, e.g. in glycolysis or transformation of nucleic acids. Configuration $ATP \rightarrow ADP + \text{inorganic P}$ is particularly important for many cellular functions; ATP synthesis takes place first of all in the respiratory chain (4).

Phosphorus of the plasma is present in the organic form, bound with proteins in the form of phospholipids, it is also found in inorganic compounds of phosphate type, mostly as HPO_4^- and $H_2PO_4^-$, present in the ratio 4:1. Concentration of phosphates, in the calculation for P, is equal to 4 mg in 100 ml of serum in adults, slightly more in children. About 80% of the total content of inorganic phosphorus is found in the plasma in the filtrable form, the rest — in the form of colloid complex, mostly with calcium. In hyperphosphataemia, an increase in the fraction of these phosphates occurs which is yet quite fast removed from the circulation. Concentration of phosphorus in the plasma is age dependent: in adults it ranges from 2.5—4.0 mg/100 ml, whereas in children it is from 4.0—6.0 mg/100 ml. From among the factors which influence phosphorus level in the plasma insulin, adrenaline and glucose should be mentioned for their administration reduces phosphorus concentration. The state of the acid—base balance also exerts influence on the phosphorus level in the plasma: acidosis

elevates it, whereas respiratory alkalosis drastically lowers the level (1). The factors capable of controlling phosphorus level in the plasma are: vitamin D₃ — influences phosphorus economy by stimulating calcium absorption in the intestine and induces Ca transportation from the bone to the plasma; parathormone — in the kidneys it inhibits absorption of phosphates in the proximal urethra; calcitonin as a polypeptide produced by C cells of the thyroid gland — together with Ca it increases phosphorus deposition in the bone tissue (2). Most of phosphorus combines with Ca in the bones and therefore the metabolism of both these elements is in many respects alike. The kidneys are responsible for the excretion of most phosphorus from the body. Renal phosphorus excretion depends on its supply in the diet: increased consumption stimulates renal excretion (1).

All the cells of the body are capable of synthesizing phospholipids and this is connected with the role the compounds have mostly in forming biological membranes. The synthesis is carried out for the cells' so to say "internal use". The role of these compounds is not limited only to their passive functioning as building materials. Their removal from cellular structures, e. g. from mitochondria, leads to the inhibition of the activities of the enzymes which are found there. The processes of diglyceride phosphorylation and phosphatic acid dephosphorylation are said to have impact in the active transportation of sodium ion through semipermeable membranes. Inside the cells phospholipids are present mainly in the mitochondrial fraction. Phospholipids probably create some suitable environment in the mitochondria which makes possible the cooperation of the respiratory chain enzymes present there and oxidative phosphorylation. Short half-life period of phospholipids proves their vigorous partaking in various processes continuously taking place in the human body. In the liver the half-life period of phospholipids lasts only for about 20 hrs, in the blood — it is much shorter (4).

Apart from cerebroside and ganglioside, the nervous tissue is extremely rich in phospholipids. About 30% of phospholipids are present in the dry mass of the brain. Because of its structure, a phospholipid particle is amphiphatic, i. e. it contains both hydrophilic and hydrophobic parts. This is essential in the formation of phospholipid structures. In these structures the hydrophilic part is responsible for polar properties and affinity to water, whereas the hydrophobic part determines so-called liquidity of the formed unit. Phospholipids can spontaneously form double layers which are the basic structure of the membrane and they are also capable of building micellar formations which among others are also present in lipoproteins. The significance of phospholipids lies also in their stabilization of other lipids in the hydrous environment and in transportation. Phosphorus, as a component of lipids, is incorporated in the metabolism of fats, and due to production of phosphorylated glucose, adenylic acid and phosphocreatin it is also incorporated in the metabolism of saccharides (3).

In order to comply with the requirements of the body phospholipids are produced in the liver and, in a smaller degree, in the intestinal epithelium. Phospholipids present in the human body can be divided into two groups: phosphoglycerides and sphingolipids. ATP and CTP participate in the biosynthesis of phospholipids. Highly specific enzymes — phospholipases participate in chemical degradation of phospholipids. The ester bond with fatty acid is hydrolytically broken down (A_1 and A_2 phospholipase) or the bond with phosphoric acid breaks down (C phospholipase). It has not been clarified yet which way of phospholipids' degradation is dominant in mammals. Yet it seems that it is phospholipid which is most rarely influenced by the action of phospholipase.

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STRESZCZENIE

Badano gospodarkę fosforu nieorganicznego oraz fosforu związanego z lipidami u człowieka w warunkach zdrowia, uwzględniając ich występowanie w organizmie ludzkim, rolę, jaką pełnią, dystrybucję oraz uwarunkowania, jakim podlega ta gospodarka. Opierano się na najnowszych danych zawartych w piśmiennictwie polskim i zagranicznym.

