THE BLOOD CLOTTING SYSTEM AND THE VALUE OF VITAMIN K IN BLOOD CLOTTING

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Abstract. *In case of violation of the integrity of the circulatory system, the hemostasis system provides a reduction in blood loss. Hemostasis is maintained in two ways: stopping bleeding with the help of platelets and blood clotting. This section focuses on the enzymatic reactions of blood clotting. Among the many useful and necessary substances for our body, there is a vitamin that is often forgotten. In the course of various studies, a certain substance was discovered that has the property of stopping bleeding. This substance was called vitamin K (from Koagulationsvitamin — vitamin of coagulation).*

Keywords: *clotting factors, bleeding, vitamin K.*

Vitamin K is a group of fat—soluble compounds formed in two main forms: phylloquinone (of plant origin, or vitamin K1) and menaquinone (of animal origin, or vitamin K2). Vitamin K is synthesized in the small intestine by special microorganisms — saprophytic bacteria. The main function of vitamin K in the body is to ensure normal blood clotting: it participates in catalytic processes that give the protein prothrombin and other proteins of the blood coagulation system the ability to bind calcium, which, in turn, is necessary for the "gluing" of platelets and the formation of a blood clot. In addition, vitamin K plays an important role in the formation and restoration of bones — it provides synthesis of bone protein, on which calcium crystallizes. This is very important for kids, as well as for careless adults who have received a fracture. Vitamin K is vital for women during menopause — at this time they often develop osteoporosis (rarefaction of bone tissue, which is dangerously long non-healing fractures). Vitamin K increases the strength of the walls of blood vessels. This is especially important for those who are actively engaged in physical education and sports — vitamin K reduces the risk of blood loss from injuries, and also enhances muscle contractions. Being a part of cell membranes, vitamin K participates in the formation of the main sources of energy in our body, normalizes the motor function of the gastrointestinal tract and muscle work, helps to avoid the formation of kidney stones. Vitamin K is often prescribed to pregnant women for prevention purposes — to prevent fetal death from bleeding.

Vitamin K is found in all green plants, and its content is more or less proportional to the content of chlorophyll in them. The leaves of snyti, nettle, linden, birch, raspberry and rosehip contain a lot of vitamin K. The most rich in this vitamin are green leafy vegetables, as well as green tomatoes, rosehip fruits, spinach leaves, oats, soy, wheat, rye, needles. Vitamin K is found in soy oil, liver (especially pork), eggs, walnuts, and all types of cabbage (white cabbage, cauliflower, kohlrabi, broccoli). There is a lot of vitamin K in herbs: alfalfa and shepherd's purse. Kelp and green tea are rich in them. There is much less vitamin K in root vegetables and fruits. Vitamin K is synthesized mainly by saprophytic bacteria of the human small intestine and comes in sufficient quantities with food. Vitamin K is non-toxic even in large quantities. Its deficiency

leads to blood clotting disorders and other health problems. Nosebleeds, gastrointestinal disorders, joint pain, gum sensitivity and bleeding, loss of strength, fatigue, deterioration of skin and hair, hemorrhages in the eyes, wounds and abrasions that do not heal for a long time, bruises, even with minor effects, painful menstruation in women – all these are symptoms of vitamin K2 deficiency. An overabundance of vitamin K2 occurs with prolonged uncontrolled intake of tablet forms of vitamin, which can lead to increased blood clotting, vascular thrombosis and cardiovascular disorders. Symptoms of excess vitamin K2 will be diarrhea, nausea, vomiting and dry skin, nausea. There are factors contributing to the lack of vitamin K2 - prolonged use of drugs that dilute the blood and inhibit the intestinal microflora, taking antibiotics, sulfonamides, cholelithiasis, hepatitis, cirrhosis of the liver, pancreatic tumors, functional disorders of the digestive tract, unbalanced nutrition and congenital pathologies. Blood clotting. Vitamin K takes an active part in the modification of a number of proteins of the blood coagulation system. Vitamin deficiency leads to a decrease in the quantitative content of prothrombin and an increase in the time it takes for blood clotting. During blood clotting, the enzymatic transformation of soluble fibrinogen plasma protein into a fibrin polymer, a network of insoluble protein fibers, occurs. The enzyme thrombin (factor IIa) takes part in this reaction, which proteolytically cleaves a small peptide fragment from the fibrinogen molecule, as a result of which binding sites are released, which allows the fibrin molecule to aggregate into a polymer. Then, with the help of glutamine transferase (factor XIII), is opeptide bonds of the side chains of fibrin amino acids are formed, which leads to the formation of an insoluble fibrin clot (thrombus). Blood clotting can be triggered in two different ways: due to a violation of the integrity of the tissue (extravascular pathway, in the diagram on the right) or by processes that begin on the inner surface of the vessel (intravascular pathway, in the diagram on the left). In both cases, a cascade of proteolytic reactions is triggered: active serine proteinases (indicated in the diagram by colored circles with a cut-out sector) are formed from inactive enzyme precursors (zymogens, conventionally designated in the diagram by circles) by cleavage of peptides (indicated in the diagram by colored circles with a cut-out sector), which in turn act on other proteins. Both reaction pathways require Ca2+ ions and phospholipids [FL (PL)] and both end with the activation of prothrombin factor Xa (factor II) with the formation of thrombin (IIa). The intravascular pathway is initiated by collagen, which is normally not exposed on the inner surface of blood vessels; its contact with blood leads to the activation of factor XII. The extravascular activation pathway begins with the release of factor III (tissue thromboplastin) from damaged tissue cells. Within a few seconds, this factor leads to blood clotting in the wound area. Coagulation factors II, VII, IX and X contain an unusual amino acid, γ-carboxyglutamine (Gla). Gla residues, which are formed as a result of posttranslational carboxylation of glutamic acid residues, are grouped in special protein domains. They attach Ca2+ ions and, as a result, bind the corresponding regulatory factors to phospholipids on the surface of the plasma membrane. In the figure, this is schematically represented by the example of a prothrombin complex (Va, Xa and II). Substances capable of binding free Ca2+ ions in the form of a complex, for example citrate, prevent this interaction with phospholipids and inhibit clotting. For the synthesis of Gla residues, vitamin K is needed as a cofactor. Vitamin K antagonists, such as dicumarin, suppress the synthesis of active coagulation factors and therefore also act as coagulation inhibitors.

A genetically determined deficiency of certain clotting factors leads to bleeding (hemophilia). Blood clotting control (not shown in the diagram). The process of blood clotting is in a constant balance between activation and inhibition. Very effective proteinase inhibitors are

available in plasma for inhibition. Serine proteinases of the coagulation system are inactivated by antithrombin. Its effect is enhanced by sulfated glucosaminoglycan — heparin (see p. 336). Thrombomodulin, located on the inner wall of blood vessels, inactivates thrombin, forming a stoichiometric complex with it. Protein c is responsible for the proteolytic destruction of factors V and VIII in plasma. This protein, in turn, is activated by thrombin and, thereby, a self-inhibiting mechanism of blood clotting is realized.

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