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FEATURES OF THE STRUCTURE OF URINARY STONES IN RESIDENTS OF INDUSTRIALLY DEVELOPED REGIONS SUFFERING FROM OXALATE UROLITHIASIS

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Introduction. Minerals of biogenic origin are integral elements of the structure of many living organisms. Along with genetically physiogenic minerals, pathogenic biominerals are also common. These include, in particular, urinary stones — uroliths, which are formed as a result of the development of urolithiasis. Urolithiasis is called the "disease of civilization" for a reason. According to the World Health Organization, the incidence of this disease has increased 1.5 times over the past 12 years. It affects one person in a hundred in the world. For many centuries, information about the symptoms of the disease and methods of its treatment has been accumulated, many issues of mineralogy, in particular, the ontogeny of uroliths, remain insufficiently studied. Today, the ontogeny of minerals is a developed branch of genetic mineralogy. The available information makes it possible to reconstruct the conditions of their genesis and growth based on the external shape and features of the internal structure of minerals and mineral aggregates. The rich experience of researching inorganic compounds can and should be effectively used in biology and medicine to highlight possible mechanisms of biomineralization in processes of pathogenic origin based on their geological analogues.

The aim of the study. To determine the features of the structure of urinary stones in residents of an industrially developed region who suffer from oxalate urolithiasis.

Research methods. To perform the work, a comparative analysis of the morphology of more than 246 renal uroliths of the Dnipropetrovsk region was performed and their petrographic study was performed. The morphology of uroliths was studied using a stereoscopic binocular microscope MBS-9. Microscopic examination of urolith sections is performed using an optical polarization microscope MIN-8.

Research results and their discussion. It is common in the structure of urinary stones of residents of the Dnipropetrovsk region to have a core ("pocket") around which is a shell (body) of urolith of varying thickness. As a rule, regardless of the mineral composition of the urinary stone itself, the nuclei consist of an accumulation of organic matter (a kind of "matrix") impregnated with finely dispersed.

During the study of kidney stones of residents of the Dnipropetrovsk region using optical petrography methods, we identified the following oxalates: juvelite, uedelite; urates: uricite, pseudomalachite, ammonourate, natrourate monohydrate; phosphates: struvite, hydroxylapatite, brushite, vitlokite, as well as xanthite, cystine, quartz, gypsum and goethite. Monomineral formations occurred very rarely (<1%).

The microstructure of the vast majority of uroliths was cryptocrystalline. They represented a cryptocrystalline aggregate, which consisted mainly of individual cryptocrystalline grains of oxalates: veddyllite and wavellite with minor impurities of uric acid dihydrate (which mainly enriched the 5th generation, which was located in the peripheral part of the urolith). Organic matter was usually distributed very unevenly. Its main part was accumulated in the 5th generation of stone formation in the form of separate flaky inclusions and interlayers. In other generations of stone formation, organic matter was localized mainly in the form of inclusions in the hollow space between aggregates of mineral matter, highly dispersed film inclusions between individual grains and their microblocks ("organic shirt"), at the same time, a slightly smaller amount of organic matter was localized in microcavities and "organic core".

The peculiarities of the construction of the central part of the oxalate urolith consisted in the fact that in most of them it was possible to trace various fragments of the gradual generation of stone formation. This was especially pronounced under conditions of urolith formation in conditions of more or less stable supersaturation of urine with constituent minerals without sharp fluctuations in their concentration. Pronounced areas of stone generation came into view. The first generation was represented by a concentrically zonal aggregate of barrel-shaped wavellite formed around a fragment of the "organic core". The mineral substance of the second generation of stone formation in the form of log-like aggregates of wavelite of concentric zonal structure radially covered the aggregate of the first generation. For the third generation of stone formation, the structure was often characterized by combinations of spherical aggregates with layered and tuber-like alternations, which were immersed in organic matter. In the mineral ratio, a slight advantage of wavelite over weddelite was observed.

The peculiarities of the construction of the peripheral part of oxalate uroliths consisted in the fact that in the fourth generation, variations in the composition of the mineral component in the total content and forms of concentration of organic matter were clearly recorded. The fifth generation of stone formation was characterized by a sharp increase in the content of the organic component (up to 62%), the presence of uric acid dihydrate crystals, the predominance of calcium oxalate dihydrate oxalates (weddelite), a finer-grained mineral part and smaller aggregates.

In addition, on micrographs of the peripheral part of oxalate uroliths, the main part of the mineral component was represented by the mineral substance of multi-grained oxalate crystals (wevelite and weddellite) with a minor admixture of urates - dispersed crystals of uric acid dihydrate in the form of small acute-angled crystals and their aggregates, concentrated around the outer surface of the stone and often spatially close to cells enriched with organic matter. Organic matter was mainly concentrated in separate layers along the perimeter of the stone, less often in the form of thin films ("organic shirt") on the surface of crystals and their microblocks, as well as in the form of numerous finely dispersed inclusions in the microblocks of individual crystals.

It should be noted that in conditions of high saturation of urine with components in the kidney bowl, the mechanism of layer-by-layer growth of crystals should dominate. At the same time, the morphology of the future individual will be determined mainly by the point at which the growth of the next growth layer will begin.

In the formation of urinary stones, not only thermodynamic, but also kinetic factors play an important role. This greatly complicates the physicochemical analysis of potential crystallization phenomena and forces us to take into account the degree of supersaturation of the solution, the presence of inhibitors that prevent the formation of microcrystallites and their aggregation, the nature of the organic matrix, the phenomenon of epitaxy, as well as the position in which the nucleation and growth of urolith occurred.

It is known that in the case of crystallization of minerals from environments with high supersaturation, the crystal can grow not only due to the incorporation of individual atoms, but also by the deposition of mostly associates — so-called two-dimensional nuclei — on the growth edge. Their joining also takes place mainly near the tops and edges of the crystal. Layer-by-layer growth according to this mechanism proceeds from the edges to the centers of the faces, causing specific morphological manifestations of layer-by-layer growth. As a result of high saturation and high speed of two-dimensional nucleation, the growth layers break off before reaching the center of the growth face. They are overlapped by successive layers, the result of which is the edge growth of crystals. This leads to the destruction of flat faces and the appearance of dendrite-like skeletal forms and the splitting of crystals. In conditions of very high supersaturation, the presence of both chemical and mechanical impurities (primarily organic matter), low temperature of the environment, the crystallized face will lose its stability and break up into a series of differently oriented microblocks.

Urinary stone spherulites, as a rule, were heterogeneous. Several zones are usually distinguished in their structure. The zonal structure is formed by the alternation of essentially mineral and mainly organic layers, as well as mineral layers of different composition. Layering can be observed at different levels of research — during the visual study of samples of large stones, and in the process of studying some areas of the samples. The layered structure in urinary stones of the spherulite type is recorded most clearly, somewhat worse - in granular aggregates. The central ("nuclear") part of such uroliths is most often represented by an accumulation of organic matter, which plays the role of a kind of "seed". In this case, the spherulite first forms as a polycrystalline aggregate of several split individuals. The sub-individuals that make up the spherulite have a conical shape, but in the process of increasing the splitting intensity, they interact with each other, obeying the law of geometric selection. Optimally oriented individuals, the elongation of which coincides with the radius of the future spherulite, will later transform into the thinnest fibers.

Conclusions. The size, shape, mineral composition and structure of the uroliths of residents of the Dnipropetrovsk region are quite diverse. Most often, spherulites and drusen-like aggregates, as well as their combinations, occur. Areas of attachment to renal papillae are usually observed on the surface of spherulite formations of urinary stones. As a rule, drusen aggregates are formed in the free space of the renal pelvis. The presence of 15 mineral species was established in the composition of kidney stones using optical petrography methods, among which oxalate and urate compounds predominate. Monomineral formations occur very rarely — less than 1%. The central part of uroliths is usually represented by accumulations of organic matter containing finely dispersed mineral components. A characteristic feature of all mineral individuals without exception is their multi-scale microblocking and the presence of inclusions of organic matter.

Oje, a complex of various-scale studies, combining the morphological analysis of the sample and its petrographic study, aimed at identifying the structural features and mineral composition of the urolith, makes it possible to confidently establish the main regularities of its ontogenesis and to determine an adequate and unambiguous decision in the choice of methods and methods of prevention of this disease and metaphylaxis relapses of stone formation.

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