

СЕКЦІЯ XXI. МЕДИЧНІ НАУКИ ТА ГРОМАДСЬКЕ ЗДОРОВ'Я

PERSPECTIVES OF METAPHYLAXIS OF NEPHROLITHIASIS RECURRENCE AND RECOVERY OF KIDNEY FUNCTION IN PATIENTS WITH KIDNEY DISEASE

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During the last decades, there have been qualitative changes in the treatment of urolithiasis, which are associated with the introduction of highly accurate methods of diagnosing the disease and minimally invasive methods of removing urinary stones into the wide urological practice. However, the medical and social significance of urolithiasis has not decreased, and the incidence of urolithiasis continues to increase in almost all countries of the world. There is no doubt about the successful use of modern technologies in the treatment of urolithiasis, but their possibilities are not limitless. All this creates conditions for finding new forms and methods of complex treatment of urolithiasis. Urolithiasis has a pronounced tendency to relapse due to the lack of effective pathogenetic methods of treatment. According to various authors, the total rate of urinary stone recurrence is 14% in the first year of observation, 35% in the fifth year, and 52% by the 10th year. All this creates conditions for finding new forms and methods of complex treatment of urolithiasis. The effectiveness of the treatment of urolithiasis is not limited to one goal - to rid the patient of urolithiasis from any localization and does not guarantee the absence of recurrences of stone formation. Urinary stone disease is a complex polyetiological disease, the basis of which is a whole series of metabolic disorders, as a result of which urinary calculi are formed. Most often, these are individual features of disorders inherent in each organism, which significantly complicates the effectiveness of treatment of this disease. Treatment of urolithiasis should be pathogenetic, not symptomatic, and should be aimed at recurrence-free treatment. Treatment in the period following stone removal (destruction) must necessarily be aimed at rehabilitation of kidney function and metaphylaxis of this disease. The modern concept of metaphylaxis of urolithiasis requires a mandatory study of the mineral composition of urolithiasis and further diagnosis of lithogenic disorders depending on the type of calculus. Determination of these factors is the basis for assessing the degree of risk of developing nephrolithiasis or its recurrence. This approach makes it possible to determine the cause of stone formation and purposefully prescribe anti-recurrence therapy, which reduces the risk of repeated stone formation by 10-15%.

Data on the chemical composition of the urinary stone, that is, on its metabolic type, are of great importance for the selection of both invasive methods of treating urolithiasis and methods of preventing the recurrence of stone formation. However, urinary stones are not always available for analysis, which complicates the choice of optimal treatment methods and leads to the need to find (develop) ways to assess the chemical composition of urinary stones in patients in vivo. One of the directions of such a search is a comprehensive analysis of lithogenic metabolic factors, the long-term influence of which leads to the

formation of urinary stones.

Existing treatment regimens include necessarily selected individual diet therapy and antibacterial therapy within a month after the removal (destruction) of the stone, drugs that improve renal hemodynamics and increase the contractility of the ureters, non-hormonal anti-inflammatory agents and diuretics that contribute to the disaggregation of crystals. In the following, depending on the form of urolithiasis, courses of taking drugs to prevent the formation of stones in order to correct metabolic disorders are recommended. If, in patients with a low risk of recurrence of stone formation, such a scheme of metaphylaxis is sufficiently effective, then for patients with a high risk, a thorough assessment of metabolic disorders is extremely necessary to determine an individual treatment scheme and effective metaphylaxis of possible recurrence of stone formation.

In order to improve the results of treatment of patients with urolithiasis, we performed the following studies. On the basis of the laboratory of the Research Institute of Geotechnical Mechanics named after M.S. Polyakov of the National Academy of Sciences of Ukraine, we conducted research on the determination of the chemical composition of urinary stones removed during the treatment of 45 patients with urolithiasis by infrared spectrometry. Measurements were carried out on an IR-Fourier spectrometer Nicolet iS10 of the American company Thermo Scientific in the mode of disturbed full internal reflection of the IR beam from a diamond crystal on the Golden Gate attachment of the English company Specac. Spectra were identified using the Nicodom IR Kidney Stones library in the Omnic 9 program.

The advantages of such research are as follows. The volume of the studied stones corresponds to the minimum amount of substance for the analysis of finely dispersed powders by the method of diffuse reflection. It is also possible to examine samples of a smaller volume using the broken total internal reflection method, but the spectral range will be somewhat narrowed, and the intensity of some bands may be reduced.

Kidney stones are usually a mixture of various salts, so for a more thorough qualitative analysis of the relative content of one or another component, either calibration against a reference set of samples or the use of a ready-made spectral base is required. For the analysis of kidney stones, we used the Czech Nicodom database, which currently has 668 spectra.

The vast majority of urinary stones contain calcium oxalate in its pure form or in combination with phosphates and uric acid. Calcium oxalate can crystallize in two different chemical and crystallographic forms: monohydrate $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ (whewellite) and dihydrate $\text{CaC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ (weddelite). These types of stones are opaque to X-rays. At the same time, crystals of uric acid, urates, as well as amorphous calcium phosphate and organic substances such as proteins are X-ray transparent.

In FTIR spectroscopy, these limitations are absent. It is suitable for determining all crystalline, amorphous or poorly crystallized components, mineral and organic molecules. This is quite important for the analysis of the molecular composition of stones, in the formation of which both inorganic and organic substances participate.

Changes in the molecule's own dipole moment during the process of oscillation of its atoms leads to the absorption of the substance in the mid-IR range. At the same time, 3 main types of vibrations are possible: valence (changes in bond length), planar and out-of-planar deformation (changes in the bond angle), as well as multiple variations of them. These types of vibrations are distributed according to the wavelength of the electromagnetic scale and form the corresponding IR spectrum. For heteronuclear bonds, the symmetry ban is removed, so they are active in the mid-IR region. Urinary stones are characterized by bonds of OH, NH, CH, CO, CN, PO, CS, SO, SiO, etc., which are part of mineral and organic components. The simultaneous presence of several types of vibrations in a molecule helps to identify its

functional groups.

Registration of IR spectra is possible in transmitted light, attenuated total internal reflection (ATR) and diffuse reflection (DRIFT) using appropriate spectrometer attachments. Each method has its pros and cons. The advantages of research in transmitted light are a sufficiently small amount of analyte and compliance with the Bouguer-Lambert-Beer law of linear dependence of the optical density on the concentration of the substance, which is important for quantitative analysis. Disadvantages include the length of the procedure for making a KBr (potassium bromide) tablet that is transparent in the mid-IR range.

That is, to determine the etiopathogenesis, it is advisable to use the study of the morphological structure of the kidney stone, its central core and peripheral layers on a flat surface of the section by the method of IR-Fourier microscopy. In addition, it is possible to additionally conduct an analysis of dry sediment of urine for early diagnosis of the disease.

It is known that one of the factors in the metaphylaxis of recurrence of stone formation is adequate blood supply to the kidneys and an appropriate increase in daily diuresis. The analysis of literary sources and previous own studies of kidney blood flow in patients with urolithiasis convincingly proved that unilateral damage to the paired kidney organ by any pathological process affects the state of blood circulation in the kidney parenchyma. The latter not only leads to a violation of the functional state of the affected kidney, but also causes the development of pathological morphological changes in the kidney tissue. However, the contralateral kidney is also negatively affected. The latter becomes a negative reason for slowing down the course of compensatory and adaptive reactions to restore the function of the paired organ. Even the kidney that remains after removal of the affected one cannot fully compensate for the total function and is not "healthy". Disruption of blood flow in both kidneys with their unilateral damage is caused primarily by the pathological effect of the disease on the affected kidney and the development due to the reno-renal reflex of persistent spasm of the vessels of the parenchyma of the contralateral kidney (especially in cases of acute disease). The release of vasoactive substances into the bloodstream causes a number of vascular reactions, the alternation of vasoconstriction and vasodilatation disrupts the course of adequate adaptive reactions to restore blood circulation in the kidneys. The additional impact of surgery also affects the adequate recovery of total kidney function. It is possible to positively influence the state of blood circulation in two ways: improving the rheological properties of blood and preventing or reducing spasm of renal parenchyma vessels.

Doppler examination and radioisotope renography performed in patients with urolithiasis showed a decrease in blood flow in the parenchyma of the affected kidney and was proportionally correlated with the degree of damage and the age of the patients. The indicator of the resistance index turned out to be the most informative. A decrease in the resistance index in the contralateral kidney by $10.5 \pm 0.09\%$ at the level of the renal artery, and by almost 2 times ($93.5 \pm 0.06\%$) at the level of the segmental and interlobular arteries indicated a relative discrepancy in the total capacity of the vascular network of the parenchyma even compensatory reconstruction of the blood flow channel of the opposite healthy kidney.

Taking into account the above, we have developed and implemented the following scheme for correcting the blood flow of both kidneys in patients with urolithiasis. To eliminate the spasm of the vessels of the renal parenchyma, drugs belonging to the group of sympatholytic substances and not causing an adrenolytic effect were prescribed. They were used 3 days before the surgical removal (destruction) of a kidney stone and during the following 2 weeks. Disaggregants (cavinton, trental, pentoxifylline) were prescribed. In the

remote period up to 3-4 months, patients were offered herbal preparations that have anti-inflammatory, antispasmodic, and antiseptic effects.

Therefore, the use of medical correction of blood flow in the kidneys of patients with urolithiasis after the removal (destruction) of stones made it possible not only to improve it by 7.8%, but also to create favorable conditions for adequate adaptive and compensatory reactions to restore the functional state of both kidneys.

Conclusions. Accurate analysis of the primary and secondary chemical composition and spatial distribution of stone components leads to an understanding of the physicochemical processes that form the basis of the pathogenesis of stone formation. Spectral monitoring of the chemical composition of urine is important for early diagnosis, effective personalized treatment and prevention of stone recurrence in patients with urolithiasis. The presented methods of determining the chemical composition of urinary stones and additional drug correction of kidney blood flow in patients with urolithiasis can improve the effectiveness of metaphylaxis and reduce the risk of recurrence of stone formation.

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