MONITORING THE CONTENT OF BIOMINERALS IN KIDNEY STONES OF PATIENTS IN THE KHARKIV REGION DURING PEACEFUL AND WAR PERIODS

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A collection of 120 kidney stones extracted from patients living in the Kharkiv region from 2019 to 2024 was studied. The comprehensive use of modern analytical methods (IR spectroscopy, crystalloptics, gamma activation analysis) provided relevant information on the characteristics of kidney stones. A comparative analysis of the mineralogical composition of kidney stones over the periods 2019–2024 was made. Fundamentally new information about the features of kidney stones during this period was obtained.

INTRODUCTION

Urolithiasis is one of the leading diseases in urology. According to various epidemiological studies, the prevalence of this disease in the modern population exceeds 15%, depending on the region of Ukraine [1, 2].

Biominerals are structural elements of many living organisms (bones, teeth). Pathogenic biominerals, including kidney stones, calcifications of heart valves, blood vessels, joint tissues, and lung tissues, are also widespread.

Biominerals appearing in the human body have both genetic predispositions and represent the body's response to various dysfunctions of major functional systems. As a result, conditions are created in the body for crystallization processes and the formation of their products-pathogenic crystalline phases or biominerals.

The purpose of this study was to investigate the elemental composition and mineral phases of kidney stones from 2022-2024 and make a comparative analysis of these indicators with previous studies from 2019-2021.

MATERIALS AND METHODS

A collection of 120 kidney stones from patients living in the Kharkiv region was studied. A detailed characterization of the crystalloptical and structural-phase states of the selected samples was provided.

For recording absorption spectra in the IR range, an IR spectrophotometer IKS-29 (LOMO) operating at the NSC KIPT was used. The spectra were recorded in the spectral range of 4000…400 cm^{-1} (middle-infrared region). Approximately 10 mg of the sample was required for the infrared spectroscopy (IRS) analysis of kidney stones. Powdered samples were prepared by grinding specimens in agate mortars to a particle size of ~1…10 µm. The samples were prepared as transparent pressed tablets from a mixture of KBr (as a matrix) and the studied substance (1% concentration, 100 mg total). The tablets were rectangular (25×5 mm), pressed at 9200 kg/cm². A pure KBr tablet, pre-dried at 180 °C for 10 h, was used in the comparison channel of the instrument to eliminate matrix absorption bands. Grinding and mixing of powders were performed in a special enclosed box, and pressing was conducted immediately before spectral registration. Calibration was carried out using the spectrum of polystyrene with known absorption peak frequencies, with a correction of $5\cdot10$ cm^{-1}. Crystalloptical studies were performed using a POLAM-L211 microscope with immersion liquids (sets IJ, OVIJ).

RESULTS AND DISCUSSION

The macro- and microscopic characteristics of the samples varied: surface colors ranged from brown, gray-brown, beige, and yellow-orange, while internal coloration was either homogeneous or heterogeneous, from grayish-beige to reddish-brown. Microscopically, the samples often consisted of three phases:

1. Clot-like main mass.
2. Fine-crystalline semi-transparent ragmented mass.
3. Large transparent grains with a radial-banded texture.

Previous studies presented the elemental composition of kidney stones obtained by gamma activation analysis, identifying impurity elements with a mass fraction of at least 1%, including Si, Mg, Ca, Na, K, P, S, F, etc. [3]. Infrared absorption spectra analysis identified a wide range of compounds, including calcium oxalates, calcium phosphates, uric acid, and urates, with aragonite and fluorapatite found in some samples. All stones were very hard, except those containing uric acid and urates.

Fig. 1 shows the IR spectrum of a kidney stone from a patient (2019 year), composed of calcium oxalate and calcium phosphate. Fig. 2 presents the IR spectrum of a kidney stone from a patient (2024 year), composed entirely of calcium oxalate.

Figs. 3 and 4 show microphotographs of immersion preparations of kidney stones from patients in 2019 and 2024.

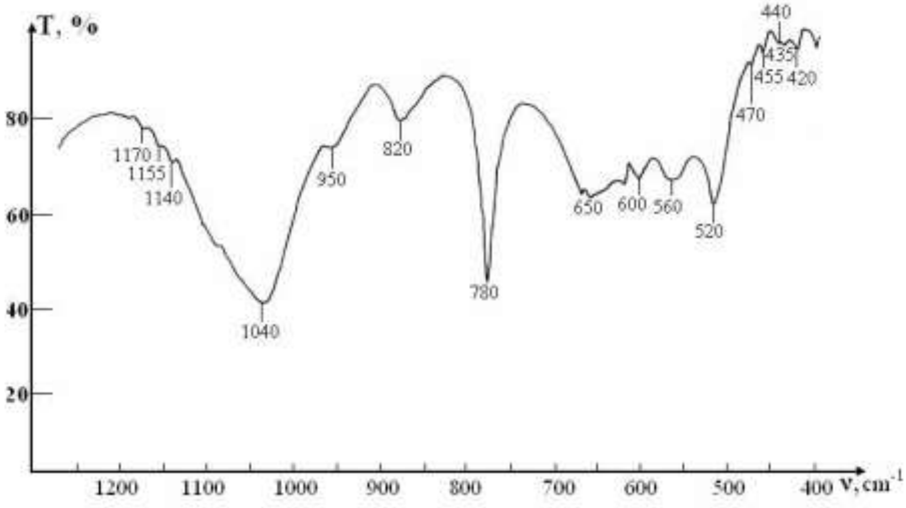

Fig. 1. IR spectrum of a patient's kidney stone (2019 year), consisting of Ca oxalate and Ca phosphates

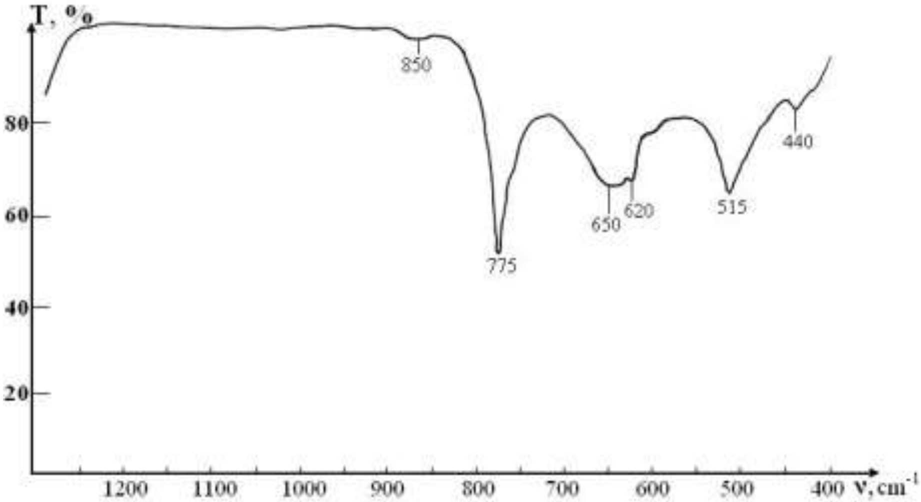

Fig. 2. IR spectrum of a patient's kidney stone (2024 year), consisting of calcium oxalate

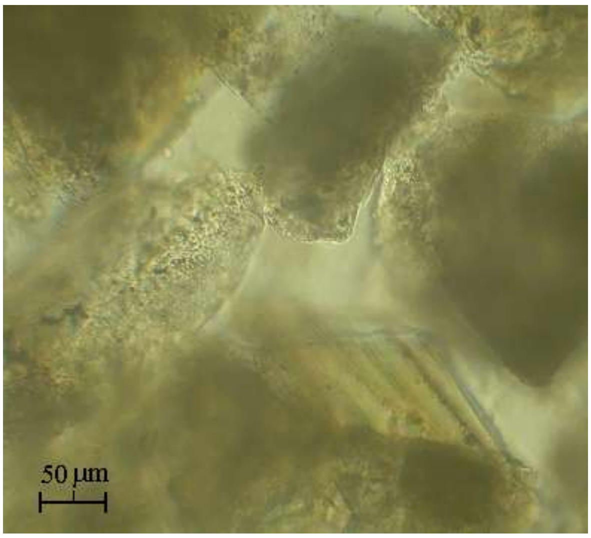

Fig. 3. Microphotograph of a kidney stone from 2019 year, consisting of large apatite (calcium phosphate) grains and whewellite (calcium oxalate monohydrate).Under transmitted light without an analyzer

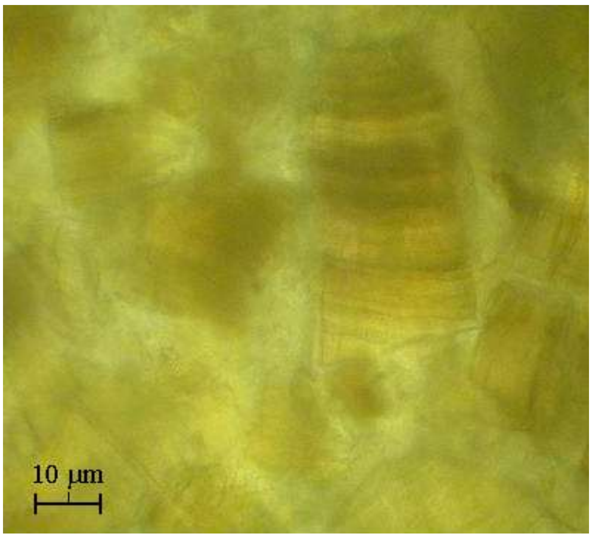

Fig. 4. Microphotograph of a kidney stone from 2024 year, consisting of whewellite (calcium oxalate monohydrate).Under transmitted light without an analyzer

Over the past three years of active military conflict in the Kharkiv region, most kidney stones from patients have been characterized by:

1. A lower degree of mineral ordering and crystallinity.
2. The almost complete absence of previously common crystalline calcium phosphates (apatite, aragonite, etc.).

CONCLUSIONS

The results indicate significant changes in the external and internal structures, micromorphology, and phase composition of kidney stones during wartime. These changes include reduced crystallinity and the absence of calcium phosphates, likely reflecting both stress-related physiological responses and environmental instability factors affecting patients.

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