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Evaluation of Minerals and some Biochemical parameters in the serum of Renal stones from Iraqi patients

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ABSTRACT

Urolithiasis is a Global health issue, a frequent and painful illness involving kidney or urinary tract stones. Anatomical, environmental, genetic, viral, metabolic, dietary, and socioeconomic variables are among its causes. There is a 50% chance of recurrence within five years, and the frequency varies between 4 and 20% worldwide. This study aims to correlate stone composition with blood biochemical parameters in urolithiasis patients. 85 blood samples were collected and divided between 45 patients with kidney stones and 40 controls. Urea, uric acid, creatinine, GFR, calcium, sodium, and phosphate were taken as effective parameters against the disease. presents a comparison between female patients with kidney stones and the control group, showing no statistically significant differences in age, weight, or GFR levels ($p > 0.05$). However, levels of urea, uric acid, creatinine, calcium, sodium, and phosphate were significantly higher in the patients ($p < 0.05$). comparison between male patients with kidney stones and the control group, levels of urea, uric acid, creatinine, and sodium were significantly higher in the patients ($p < 0.05$). The level of both Uric acid and creatinine is significantly high, in addition to electrolytes and calcium Increase in kidney stone disease. We note that urea, uric acid, and creatinine They are excellent indicators for detection Kidney stones because they are vital signs Kidney disease. As for electrolytes, represented by calcium, sodium, and phosphate, it depends mainly on nutrition and increasing their quantities, and this increase leads to their accumulation in the kidneys, and thus stones are formed.

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1. INTRODUCTION

One of the most prevalent illnesses in society is urolithiasis which is a well-known illness that has been a part of human history [1], and it continues to be a significant issue in contemporary medicine [2, 3]. A urinary biochemical imbalance between the promoters and inhibitors of the lithogenesis process leads to the production of stones in the kidneys or urinary system, which is the pathology's defining feature [4,5]. One of the most common and unpleasant urological conditions affecting the urinary system is kidney stone disease, which causes a significant amount of morbidity and mortality worldwide [6]. The complex etiology it shows includes socioeconomic elements that are equally essential as well as anatomical, environmental, genetic, infectious, metabolic, and dietary aspects [5-9]. But over the past 50 years, the epidemiological profile of urolithiasis has changed significantly, affecting 4–20% of the population with a range of 7–13% in North America, 5–9% in Europe, and 1-2% in Asia, with a 50% recurrence rate in the first five years [10-12].The most prevalent type of kidney stones is oxalocalcic ones; in fact, over 80% of kidney stones consist mostly of calcium oxalate (CaOx), primarily combined with calcium phosphate (CaP) and occasionally uric acid (UA) [13].

The three most common forms of calcium phosphate stones are apatite (basic form), brushite (calcium hydrogen phosphate dihydrate), and whitlockite (tricalcium phosphate). Elevated urine pH and varying amounts of calcium and citrate, are the main risk factors for their development [13, 14]. Struvite stones, also referred to as "infection stones," make up 7–8% of all stones in the worldwide and are typically brought on by an increase in ammonia production due to an infection with urease-producing organisms [14,15]. To reduce the chance of a recurrence, identify urolithiasis's causes, implement dietary readjustment strategies, and, if required, start medication treatment, it is crucial to test the biochemical parameters of the blood and urine [16]. Given this context, the goal of this study is to identify the makeup of the stones and the relationship between them and blood biochemical parameters in urolithiasis patients.

2. METHOD

This study was conducted in the kidney and urology departments at Zafaraniya Hospital, in the period between February 2024 and April 2024. Blood samples were collected from 45 patients, 23 males and 22 females. with lithiasis and 40 healthy people without the disease. Weight, height, age. This study eliminated patients without biochemical blood analysis data. Samples from patients 20 years of age and above were used to examine the connection between blood biochemical markers and the development of stones. Participants provided informal consent, and the study was authorized by the hospital and university ethics committees in accordance with the World Medical Association's Code of Ethics (Declaration of Helsinki).

Inclusion criteria: Female-male patients with kidney stones aged between 20 and 60 years.

Exclusion criteria: Any patient suffering from obesity, kidney dysfunction, unilateral kidney disease, kidney failure, a patient suffering from shock, chronic diseases such as liver, stomach, intestines, bone diseases, tumors, and any medications that affect renal protein levels will be excluded.

Blood sample collection and laboratory analysis: 5 ml of venous blood was collected from participants. Blood samples were divided into aliquots. After allowing 5 milliliters of blood to coagulate, the serum was extracted using centrifugation at 5000 rpm for 15 minutes at room temperature. Measurements of creatinine, urea, and uric acid were made using the isolated serum. Spectrophotometry was used to measure calcium, phosphate, and sodium (sample taken without a tourniquet) on the same day.

3. RESULTS AND DISCUSSION

3.1 Results

Statistical Analysis: SPSS was used to assess the results' significance (version 25.0, SPSS Inc., Chicago, IL, USA). The independent sample student's LSD ANOVA test and Receiver operating curve (ROC) were used to analyze the data. Table 1 compares all female patients to the control group. No statistically significant differences were found between the patients and the control group with regard to age, weight, or GFR level. Where the p-value was higher than (0.05). Urea, Uric acid, creatinine, calcium, sodium, and phosphate were significantly higher in females suffering from kidney stones than in controls, where the p-value was less than (0.05).

Table (1): LSD for studied parameters between control and patients' female

Parameters	Control female (mean ± SD)	Patient female (mean ± SD)	*p*- value
Age	37.38±9.10	38.11±8.04	0.76
Wt	81.53±7.38	80.69±7.31	0.68
GFR	109.47±9.71	104.5±11.44	0.97
Po_4	3.81±0.45	3.53±0.44	0.26*
Na	147 ±10.85	138.23±7.89	0.002*
Ca	9.30±0.34	9.21±0.43	0.401
Creatinine	0.84±0.15	0.98±0.30	0.04*
U.A	4.77±1.26	6.02±0.91	0.001*
Urea	37.5±7.06	42.96±9.22	0.021*

In table 2, the comparison between all male patients and the control group is shown, as there were no statistically significant differences in age, weight, or levels of GFR, calcium, and phosphate between the patients and the control group. Where the p-value was higher than (0.05). Urea, Uric acid, creatine, and sodium were significantly higher in males suffering from kidney stones than in controls, where the p-value was less than (0.05).

Table 2: LSD for studied parameters between control and patients' male

Parameters	Control male (mean ± SD)	Patient male (mean ± SD)	*p*- value
Age	32.69±7.30	34.26±8.04	0.01
Wt	81.23±11.9	76.47±7.92	0.184
GFR	97.60±9.15	97.88±8.77	0.930
Po_4	3.92±0.34	3.89±0.32	0.781
Na	150.92 ±7.43	145.31±7.42	0.041*
Ca	9.70±0.59	9.79±0.42	0.631
Creatinine	1.03±0.32	1.2±0.30	0.05*
U.A	5.31±1.2	7.69±1.19	0.001*
Urea	38.69±9.72	49.42±9.59	0.002*

P - value equal or less than 0.05 is statistically significant. The difference is tested by ANOVA, LSD is used when there is statistically significant differences

The receiver operating characteristics curve (ROC)

The Receiver Operating Characteristic (ROC) is a statistical analytic technique used to determine the optimal specificity and sensitivity. Diagnostic test sensitivity. This is accomplished by the use of a storyline that Demonstrates the correlation between sensitivity and specificity, specifically by calculating 1-specificity.

Table 3: ROC Data Analysis for Females

Parameter	AUC	SE	*p*-value	Cut-off value	Sensitivity	Specificity
GFR	0.708	0.073	0.011	104.1	84%	66%
P04	0.670	0.076	0.037	3.7	72%	62%
Na	0.745	0.070	0.003	148.5	72%	70%
Ca	0.526	0.082	0.749	9.2	52%	54%
Creatinine	0.686	0.076	0.023	0.85	65%	55%
U.A	0.813	0.060	> 0.001	5.2	77%	72%
Urea	0.664	0.071	0.045	38.5	62%	69%

The GFR parameter has an 84% sensitivity and a 66% specificity when used to detect kidney stones in females, as demonstrated by the results in the above table. The parameters then approach each other, for example, ureic acid (77% sensitivity and 72% specificity), sodium (72% sensitivity and 70% specificity), and phosphate (72% sensitivity and 68% specificity). The parameters urea and creatinine were less sensitive and specific, with urea having a sensitivity of 62% and a specificity of 69%, and creatinine having a sensitivity of 62% and a specificity of 69%. Therefore, urea and creatinine are considered ineffective parameters for determining kidney stone disease.

Table 4: ROC Data Analysis for Males

Parameter	AUC	SE	*p*-value	Cut-off value	Sensitivity	Specificity
GFR	0.483	0.111	0.873	91.97	78%	55%
Po_4	0.549	0.107	0.645	3.95	61%	53%
Na	0.701	0.100	0.060	148.5	69%	64%
Ca	0.466	0.112	0.749	1.15	69%	53%
Creatinine	0.703	0.099	0.057	40.69	84%	76.5%
U.A	0.929	0.043	0.001	6.2	84%	77%
Urea	0.729	0.092	0.032	42.5	73%	77%

The results in the table 4 above show that the parameters creatinine and uric acid are effective against males with kidney stones, with a sensitivity of 84% and a specificity of 77%, and they are close. After that, parameters such as GFR come with a sensitivity of 78% and a specificity of 55%, and urea has a sensitivity of 73% and a sensitivity of 77%. Then comes sodium, with a sensitivity of 69% and a specificity of 64%, then calcium, with a sensitivity of 69% and a specificity of 53%, and their sensitivity to the disease is close.

The phosphate parameter was less sensitive and specific, with a sensitivity of 61% and a specificity of 53%. Therefore, phosphate is considered an ineffective parameter for identifying kidney stone disease.

3.2 Discussion

In this study, 85 blood samples were collected, divided between 45 samples 23 males and 22 females from people with kidney stones and 40 samples from the control group. Several factors (urea, uric acid, creatinine, glomerular filtration rate, and electrolytes, including calcium, sodium, and phosphate) have been studied to determine which are most effective and associated with disease. Weight and age were also calculated. The observation of high and variable uric acid release, especially in the case of uric stones, explains kidney dysfunction in the elderly, which led to the discovery that urea, carnitine, and uric acid are directly related to infection [17]. Moreover, increased release of amino acids in affected individuals causes a rise in urea and the development of cystine stones [18]. There are several factors lead to a rise in urea in those with stones, including Decreased kidney function: Kidney stones can impair kidney function, reducing the kidneys' ability to Filter the blood and remove waste, leading to a buildup of urea in the blood. Dehydration: A lack of fluids in the body can lead to a concentration of chemicals in the blood, including urea, increasing their levels. Diet: Eating large amounts of protein can increase urea production, as protein is broken down into ammonia, which is then converted to urea in the liver.

Urinary tract obstruction: Kidney stones can cause an obstruct in the urinary tract, the preventing effective elimination of waste by the kidneys. Medications: Some medications can affect kidney function or increase urea production. As for creatinine, studies have shown that increasing creatinine levels is associated with increasing its levels in the tubules (10% to 40). %).[20,21] Tubular creatinine secretion increases with chronic kidney disease, which leads to an overestimation of the glomerular filtration rate [19,22].

One of the most important factors that leadto this is Urinary tract obstruction: Stones can cause an obstruction in the urinary tract, preventing the flow of urine. This blockage can lead to a buildup of waste products in the blood, including creatinine. Inflammation or infection: Stones may cause inflammation or infection of the urinary tract (such as pyelonephritis), which may affect kidney function and increase creatinine levels. Pressure on the kidneys: Large stones can put pressure on kidney tissue and affect its ability to filter blood efficiently, leading to high creatinine levels [23]. Consequently, the glomerular filtration rate is affected in those affected due the Effects of stone location: If kidney stones do not obstruct urine flow or cause a complete obstruction of the urinary tract, they may not significantly affect overall kidney function. Renal adaptation: The kidneys can adapt and compensate for the pressures resulting from kidney stones in some cases, which helps maintain the glomerular filtration rate[24].

Early diagnosis and treatment: In many cases, kidney stones are diagnosed early and treated effectively, which helps maintain kidney function and glomerular filtration rate. Diverse types of stones: Some types of kidney stones may not cause significant damage to kidney function, while others may have a greater impact [25]. However, patients with kidney stones should remain vigilant about their health condition and monitor kidney function regularly so that there is no negative impact on the glomerular filtration rate or kidney function in general[26].

The deficiency of calcium and high phosphate levels in patients with kidney stones can be due to several factors, including: Type of stones: Not all kidney stones are composed of calcium and phosphate. There are other types of stones, such as uric acid stones, which do not depend on the levels of calcium and phosphate in the blood. Hormonal regulation: Blood calcium and phosphate levels can be well regulated by hormones such as parathyroid hormone and calcitonin, even in cases of kidney stones. Kidney efficiency: Some patients may have highly efficient kidneys that can effectively regulate and filter calcium and phosphate, preventing their levels from rising in the blood. Dietary factors: Some patients may follow a diet that reduces the absorption of calcium and phosphate, preventing their levels from rising in the body. Medications: Some medications can help regulate calcium and phosphate levels and prevent them from rising[27,30].

As for sodium, it is directly related to nutrition and excessive intake of sodium salts, especially in women, and this leads to the formation of stones, as well as for several reasons such asexcessive sodium intake: Eating large amounts of sodium leads to an increase in the concentration of sodium in the urine, which leads to increased calcium. excretion, which may contribute to the formation of kidney stones. Dehydration: Not consuming enough water increases the concentration of sodium in the blood and urine, which increases the risk of kidney stones. Hormonal disorders: Hormonal disorders such as hyperthyroidism or adrenal disorders can raise sodium levels. Medications: Some medications, such as some diuretics, can raise sodium levels. Other medical conditions: Chronic kidney disease or high blood pressure can also cause high sodium levels. [31]-[34].

4. CONCLUSION

The level of both Uric acid and Carnitine is significantly high, in addition to electrolytes and calcium Increase in kidney stone disease. We note that urea, uric acid, and creatinine are excellent indicators for the detection of Kidney stones because they are vital of signs Kidney disease. As for electrolytes, represented by calcium, sodium, and phosphate, they depend mainly on nutrition and increasing their quantities, and this increase leads to their accumulation in the kidneys, and thus stones are formed. However, beyond that Investigations with many patients registered for The monitoring period is longer It is required to confirm previous findings in kidney stones.

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