Scientific Research Publishing

Open Journal of Nephrology, 2024, 14, 502-517
https://www.scirp.org/journal/ojneph
ISSN Online: 2164-2869
ISSN Print: 2164-2842

Profile of Renal Lithiasis in the Nephrology Department of the Ibn Sina University Hospital Center in Rabat

N'mili Manal, Zniber Amal, El Kadiri Nada, Ouzeddoun Naima, Bouattar Tarik, Benamar Loubna

Nephrology Department, Faculty of Medicine and Pharmacy, Ibn Sina University Hospital Center in Rabat, Rabat, Morocco
Email: manoulty@gmail.com, amal04zniber@gmail.com, nada.elkadiri@gmail.com, ouzeddoun.naima@hotmail.fr, tbouattar@hotmail.fr, louba24@yahoo.fr

How to cite this paper: Manal, N., Amal, Z., Nada, E.K., Naima, O., Tarik, B. and Loubna, B. (2024) Profile of Renal Lithiasis in the Nephrology Department of the Ibn Sina University Hospital Center in Rabat. *Open Journal of Nephrology*, **14**, 502-517.
https://doi.org/10.4236/ojneph.2024.144045

Received: September 3, 2024
Accepted: November 18, 2024
Published: November 21, 2024

Abstract

Introduction: Renal lithiasis is a very common condition worldwide, linked to the presence of calculi in the urinary tract. It is multifactorial, recurrent and serious. It is the 3rd leading cause of chronic kidney disease (CKD) in Morocco. The aim of our study is to describe the clinical, paraclinical and management aspects of renal lithiasis in our patients, to determine the factors of recurrence of renal lithiasis and to identify the factors of progression of renal failure. **Materials and Methods**: This is a retrospective, descriptive and analytical study conducted in the nephrology department of CHU IBN Sina in Rabat, over a 3-year period from 2020 to 2023. We included 160 patients with renal lithiasis having a follow-up in our training. We analyzed their epidemiological, clinical, paraclinical and therapeutic profile. **Results**: The mean age of our patients was 56 +/− 16.6 years, with a M/F sex ratio of 1.02. Lithiasis was expressed by renal colic in 71% of cases, and by stone emission in 31% of cases, although discovery was incidental in 16% of cases. At the time of the first consultation, 59% of patients had renal failure (RF), 15% of whom were at the stage of chronic end-stage renal disease. Crystalluria and calculus spectrophotometry were performed in only 30% and 22% of patients respectively. All patients benefited from hygienic and dietary measures according to the nature of the stone, as well as additional urological management. Recurrence of renal lithiasis was reported in 36% of cases. In univariate analysis, advanced age, male gender, diabetes, hypertension and the presence of recurrent urinary tract infection were factors in the progression to CKD (OR = 0.979, p = 0.035; OR = 0.527, p = 0.48; OR = 4.127, p = 0.015; OR = 1.926; p = 0.015, OR = 2.5 p = 0.019, respectively). In multivariate analysis, only diabetes and high baseline creatinine were factors in the progression to CKD. Recurrence of renal

lithiasis was reported in 36.5% of cases. Only the presence of a history of familial lithiasis and of renal cysts on imaging were significantly associated with a risk of renal lithiasis recurrence in univariate analysis. (OR = 3.06, p = 0.035; OR = 5.27, p = 0.017, respectively). **Conclusion**: Renal lithiasis is a disabling pathology that can be complicated by recurrence and chronic end-stage renal failure. Early diagnosis and identification of factors leading to the recurrence and progression of chronic renal failure could improve management.

Keywords

Renal Lithiasis, Chronic Kidney Disease, Cristalluria

1. Introduction

Renal lithiasis, commonly known as kidney stones, is a disorder characterized by the formation of one or more stones within the urinary tract [1]. It is a multifactorial condition that is both common and highly recurrent. Over the past half-century, the prevalence of renal lithiasis has significantly increased, correlating with lifestyle changes such as diet and physical inactivity [2].

While renal lithiasis is generally manageable, complications arise in cases of recurrence or delayed diagnosis, particularly when it contributes to the progression of chronic kidney disease (CKD) [3]. In Morocco, it ranks as the third leading cause of CKD [4]. Renal stones can obstruct the urinary tract, leading to elevated intrarenal pressure, hydronephrosis, and kidney parenchymal damage. Additionally, recurrent infections, often associated with urinary stasis or incomplete stone clearance, further aggravate kidney damage, accelerating the progression of CKD.

One of the challenges in managing renal lithiasis lies in its long clinical latency. Stones are often incidentally discovered during imaging for unrelated conditions or following episodes of acute renal colic. In cases where stones are not passed or surgically retrieved, diagnostic alternatives, such as crystalluria analysis, can help assess lithiasis activity and predict the risk of recurrence.

The morpho-constitutional and infrared spectrophotometric analysis of stones is invaluable for identifying their chemical composition, which is crucial for tailoring treatment strategies. Calcium oxalate stones account for over 80% of cases, though less commonly, calcium phosphate stones may also be found. Genetic studies play a pivotal role in diagnosing hereditary forms of lithiasis, such as cystinuria and primary hyperoxaluria.

Effective management of renal lithiasis requires a multidisciplinary approach that focuses on prevention by addressing modifiable risk factors, including dietary habits, hydration, and metabolic conditions [3]. Early intervention and personalized treatment are critical to reducing the risk of recurrence and minimizing renal damage, thus preventing the progression of CKD.

Aim of our study

1) To describe the clinical and paraclinical aspects and management of adult renal lithiasis in the Nephrology, Dialysis and Kidney Transplant Department at the Ibn Sina University Hospital Center in Rabat.

2) To classify the different types of kidney lithiasis.

3) To determine the risk factors for recurrence of renal lithiasis.

4) To identify the progression factors to chronic kidney disease.

2. Material and Method

2.1. Study Design and Population

This is a retrospective, descriptive and analytical study covering a three-year period, from January 2020 to January 2023, in the nephrology department of the Ibn Sina University Hospital in Rabat.

We included all adult patients (>18 years old) referred for nephrological management of renal lithiasis, discovered on imaging, or revealed by the emission of a calculus.

We excluded patients with missing data.

We reviewed patients' records during this period and collected demographic data including age, gender and medical background.

On admission:

- We identified factors favouring renal lithiasis, such as diet and fluid intake, history of gout, recurrent bladder infections, urinary tract malformations and family medical history.
- We recorded the results of radiological examinations: Kidney, Ureter, and Bladder X-ray (KUB), Urinary tract ultrasound and uroscanner.
- We systematically collected the biological assessment as follows:

- Blood creatinine in mg/l with estimated glomerular filtration rate in ml/min/1.73m^2 (eGFR), blood calcium, blood uric acid and fasting blood glucose.
- On the 24-hour urine sample, we recorded pH, urinary urea, creatininuria, calciuria and natriuresis.
- Crystalluria and cytobacteriological examination were performed on the early morning urine sample.
- Spectrophotometric analysis of the stone was performed whenever the stone was retrieved.

Definitions:

The estimated glomerular filtration rate (eGFR) is calculated using a Modification of Diet in renal disease (MDRD) equation. CKD is defined by an eGFR of less than 60 ml/min/1.73m^2 (KDIGO classification).

Recurrence is defined by the occurrence of at least two episodes of kidney lithiasis.

2.2. Statistical Analysis

Statistical analysis is performed using Jamovi software.

Quantitative variables are expressed as mean ± standard deviation or median with interquartile range, and analyzed using the Student's T test.

Qualitative variables are expressed as percentages and counts and analyzed using the chi-square test.

Factors for the progression of kidney failure and factors for the recurrence of kidney lithiasis are studied using a binary logistic regression model in multivariate analysis.

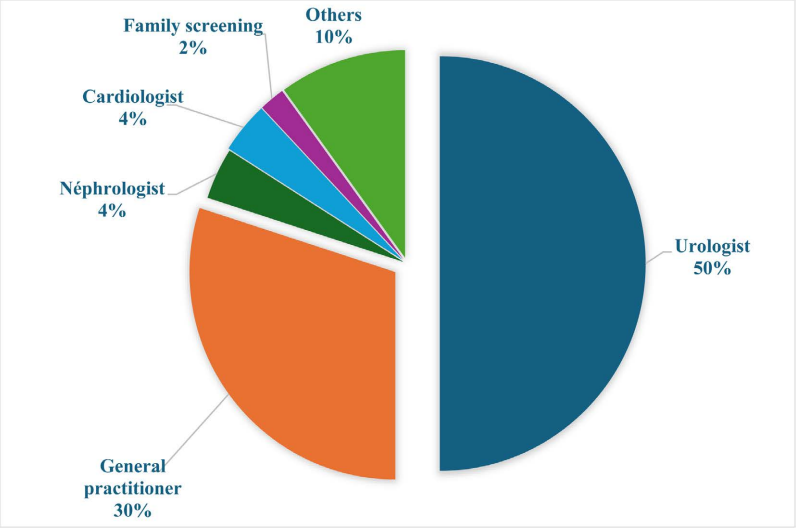
A p value < 0.05 is considered statistically significant.

3. Results

3.1. Patient Characteristics

During the 3-year study period, after excluding patients with incomplete files, we were able to gather 160 cases of renal lithiasis referred to our nephrology department.

After a renal colic episode, patients are primarily referred to nephrology by our urologist colleagues and general practitioners for the purpose of investigating the etiology of the calculus (Figure 1).



*Others: rheumatologist, internist, gastroenterologist, endocrinologist and pediatrician.

Figure 1. Distribution of our patients according to referring physician.

The mean age of our patients is 56 +/− 16.6 years, with extremes ranging from 23 to 91 years, and a M/F sex ratio of 1.02.

The 41 - 65 age group is the most representative, it represents the group that is physically active, and this is probably due to a lack of hydration during the day. (Figure 2).

Among the medical background, arterial hypertension (AH) was found in 36.5% of our patients, followed by diabetes in 14%, while a history of familial lithiasis was noted in 14.6% of cases.

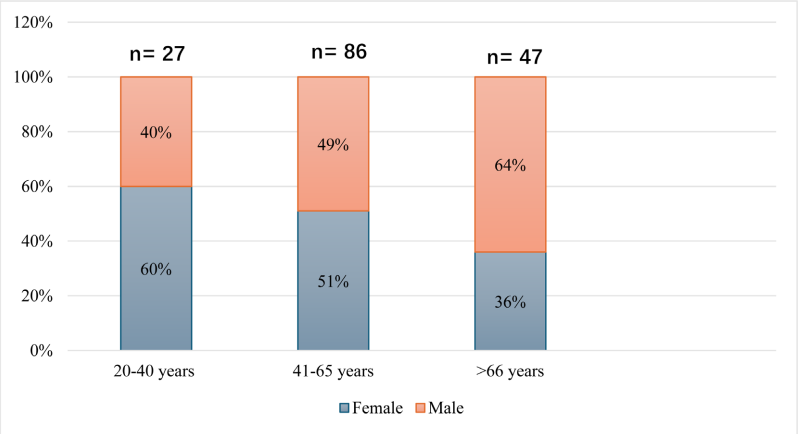


Figure 2. Patient distribution by gender and age group.

Circumstances in which renal lithiasis was discovered were dominated by renal colic in 71% of cases, stone passing in 31% of cases, recurrent urinary tract infection in 40%, and incidental diagnosis in 16% of cases. Table 1 summarizes the various clinical characteristics of our patients on admission.

Table 1. Clinical characteristics of our patients on admission.

Characteristics	Number (n= 160)	Percentage (%)
Personal background		
Diabetes	22	14
High blood pressure	58	36.5
Gout	8	5
Tuberculosis	6	34
Hyperparathyroidism	4	2.5
Urinary tract malformations	12	7.5
Family background		
Family history of lithiasis	23	14.6
Reason for consultation		
Renal colic	113	71
Recurrent urinary tract infection	63	40
Low back pain	58	37
Stone passing	49	31
Hematuria	44	28
Incidental findings on imaging	25	16
Micturition disorders	22	14
Sabliuria	8	5

3.2. Nephrological Data

On admission, 42% of our patients had normal renal function (n = 67), and 58% of patients had kidney failure at various stages of CKD (Table 2).

Table 2. Patients' renal profile at an initial consultation.

CKD stages	eGFR (ml/min/1.73m²)	Number N = 93	Percentage %
3	30 - 59	55	60
4	15 - 29	24	25
5	<15	14	15

Ultrasound identified stones in 60% of cases. Uroscans, performed on 32% of patients, revealed lithiasis in 88% of cases, specifying both location and Hounsfield density. Pyelo-caliceal dilatation was observed in 30% of cases. In addition, uroscanner enabled the diagnosis of urinary malformations in 7% of cases. Table 3 summarizes uroscanner data.

Table 3. Data collected on uroscanner.

Characteristics	Number (n=52)	Percentage (%)
Calculation location		
Calyx	**83**	**53**
Ureter	**31**	**20**
Pelvis/Pyelon	**27**	**17**
Laterality		
Bilateral	**32**	**20**
Hounsfield density (UH)		
>1000	**11**	**34**
850 - 950	**4**	**12**
650 - 850	**10**	**31**
650 - 350	**15**	**46.5**
Urinary tract diseases and malformations (n = 12)		
Ureteral stenosis	**3**	**25**
Pyelo-ureteral junction syndrome	**3**	**25**
Mega ureter	**2**	**16.6**
Vesicoureteral reflux	**2**	**16.6**
Congenital single kidney	**2**	**16.6**

An analysis of morning urine crystalluria was performed on 30% of patients, revealing the presence of crystals in 32% of them, mainly Whewellite crystals, and this is undoubtedly due to dietary habits. Unfortunately, 68% of crystalluria did not reveal any crystals (Figure 3).

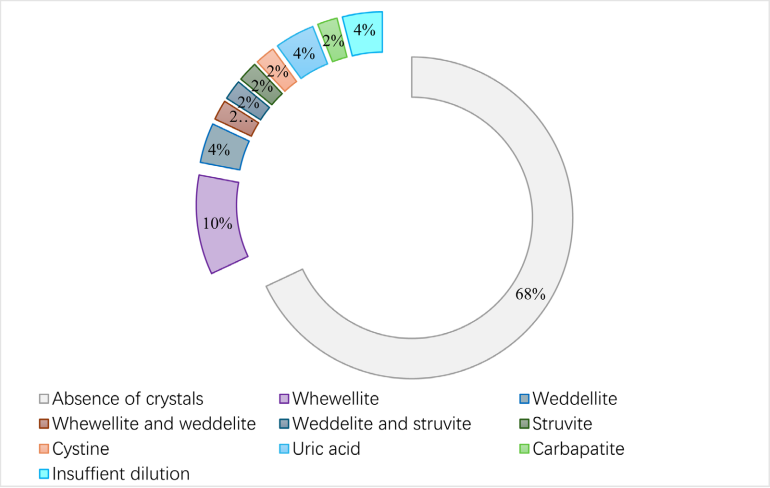


Figure 3. Distribution of the main constituents of our patients' crystalluria.

Morphological studies using spectrophotometry were performed on 21% of patients and showed that oxalocalcic stones were the most frequent, favoured by high-protein diet and lack of hydration (Figure 4).

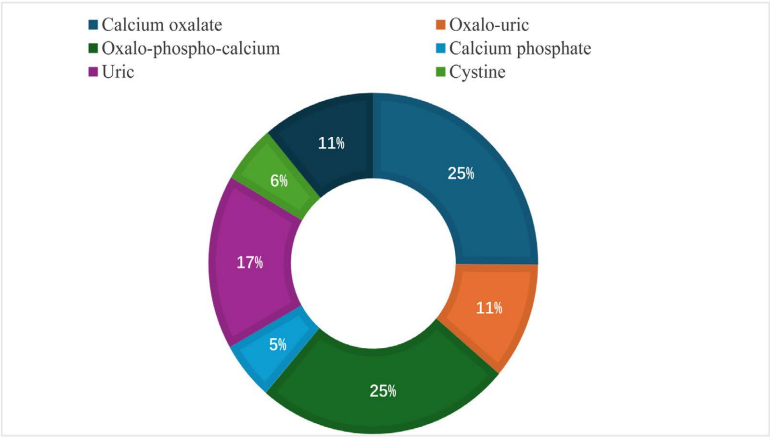


Figure 4. Distribution of the main components of our patients stones.

3.3. Management of Renal Lithiasis

The management of renal lithiasis involves both nephrologists and urologists, and takes into specific consideration the nature of the stone.

Firstly, hygienic-dietary measures were involved in all our patients, including:

1) Good hydration, well distributed throughout the day, to maintain a proper diuresis of normal density, and a controlled blood pressure.

2) Sodium intake of a maximum of 6 grams per day, taking into account the "hidden" salt in some foods, mainly bread, sparkling water, cereals, cheeses and cold meats.

3) A calcium intake not exceeding 1 gram per day for men and 1.2 grams per day for menopausal women.

4) A diet rich in vegetables and fiber to adjust the body's pH and provide sufficient citrate.

5) A daily protein intake of 1g/kg of theoretical weight.

6) Regular physical activity.

7) Elimination of toxic behaviors such as smoking and alcoholism Metabolically, we required glycemic control, correction of dyslipidemia and hyperuricemia.

We systematically tested for all abnormalities favoring urinary stasis, as well as all urinary tract infections, 38% of which were treated with appropriate antibiotics. Urological management is summarized in Figure 5.

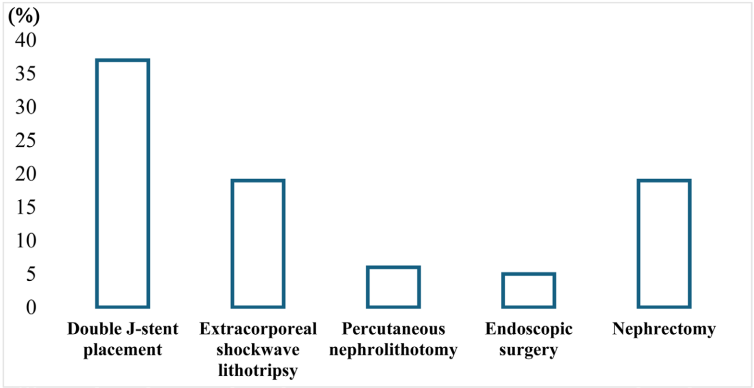


Figure 5. Urological management of kidney stones.

Nephrectomy was indicated in 20% of cases in the following situations: multi lithiasis damaged kidney, silenced kidney, pyonephrosis and acute obstructive pyelonephritis on calcified JJ catheter.

3.4. Outcome

The evolution of renal function was marked by improvement in 33% of cases, stabilization of renal function in 65% of cases, and decline in 14% of cases.

Of the 67 patients with normal kidney function, 6 progressed to CKD. Table 4 describes the evolution of patients with CKD.

For CKD patients, advanced age, male gender, diabetes, high blood pressure and recurrent urinary tract infections were factors in the progression of CKD in univariate analysis. (OR = 0.979, p = 0.035; OR = 0.527, p = 0.48; OR = 4.127, p = 0.015; OR = 1.926; p = 0.015, OR = 2.5, p = 0.019, respectively) (Table 5).

In multivariate analysis, only diabetes and high baseline creatinine were factors in CKD progression.

Table 4. Outcome of patients with CKD.

CKD stages	Number n = 93 M0	Percentage (%)	Outcome	Number n = 80 MA	Percentage (%)
3	55	34	**Stable** to stage 3 in 29 P **Favorable** to stage 2 in 14P + stage 1 in 2P **Declining** to stage 4 in 8 P + stage 5 in 2 P	40	25
4	24	15	**Stable** to stage 4 in 11 P **Favorable** in stage 2 in 3 P + in stage 3 in 4P **Declining** to stage 5 in 6P	26	16
5	14	9	**Stable** in stage 5 in 6P **Favorable** in stage 3 in 1P + in stage 4 in 7P **HD** in 6P **DP** in 2P	14	9

M0: Admission, MA: Progression after 1 year of follow-up, P: Patients, HD: Hemodialysis, PD: Peritoneal dialysis.

Table 5. Progression factors of chronic kidney failure in univariate analysis.

	Univariate analysis		
Variables	**OR**	**IC 95%**	**p value**
Age	0.979	[0.959 - 0.998]	0.035
Sex F-M	0.527	[0.279 - 0.996]	0.048
Diabetes	4.127	[1.320 - 12.902]	0.015
High BP	1.926	[0.985 - 3.765]	0.05
Gout	1.399	[1.399 - 6.07]	0.650
HPT	2.530	[0.25 - 24.8]	0.426
Malformation	1.48	[0.416 - 5.29]	0.543
Recurrent urinary tract infections	2.508	[1.16 - 5.43]	0.019

Recurrence of renal lithiasis was reported in 36.5% of cases. In univariate analysis, the existence of a history of familial lithiasis and of renal cysts on imaging were significantly associated with the risk of lithiasis recurrence (OR = 3.06, p = 0.035; OR = 5.27, p = 0.017, respectively) (Table 6).

Table 6. Univariate analysis of renal lithiasis recurrence factors.

Variable	OR	IC 95%	p value
Age	1.019	[0.999, 1.03]	0.07
Sex	1.75	[0.907, 3.38]	0.09
Family history of lithiasis	**3.069**	[1.084, 8.691]	**0.035**
HPT	5.50	[0.55, 54.17]	0.144
Diabetes	1.56	[0.628, 3.88]	0.338
Gout	1.76	[0.342, 9.0]	0.5
Creatinine T0	1.01	[0.961, 1.031]	0.306
Renal cysts	**5.279**	[1.340, 20.79]	**0.017**

4. Discussion

Renal lithiasis is a frequent pathology. Its prevalence varies from country to country, with a significant increase worldwide. It represents 1-5% in Asia, 5-9% in Europe, 7% - 15% in North America and 20% in Saudi Arabia [5]. In Morocco, it is reported at a rate of 6.14% [6].

Sex distribution varies from one study to another. Most series report a male predominance [7]-[9]. Our series does not follow the rule, with a M/F ratio of 1.02.

Similarly, an epidemiological study of urinary calculi carried out in Fez showed a slight predominance of urinary lithiasis in men, with a sex ratio M/F of 1.3 [10]. A Japanese study showed that the risk of kidney stones was 2.5 times higher in men than in women [11]. Furthermore, studies in the USA have reported that the risk of kidney stones is higher in women than in men [12]. This may be explained by the role played by sex hormones in the development of kidney stones [13]. In fact, estrogens and androgens are among the factors influencing the formation of oxalate and calcium urinary stones in men. Estrogens, on the other hand, prevent the formation of kidney stones in women [14].

The mean age of our patients was 55.9 years. A lower mean age compared with our result of 44.45 years was reported in another Moroccan study in 2018 [15]. In addition, studies carried out in three countries, namely the USA in 2017, Congo in 2022 and Cameroon in 2021, reported different results from ours: 40.4, 42.05 and 40.95 years respectively [16]-[18].

In our study, the main revealing sign of renal lithiasis was renal colic in 71.5% of cases, although it was discovered incidentally in 16% of cases. This result is similar to that found in studies previously performed in Marrakech [15] and Cameroon [19], at 84% and 67.5% respectively. This may be explained by the main location of calculi in the upper urinary tract, before migrating into the ureter and then being expelled via the natural ducts [20].

In our study, ultrasound was performed on all patients, while only 32% underwent uroscanner. The latter revealed lithiasis in 88% of cases. This result contrasts

with two studies carried out in Dakar, Senegal, in 2015 and in Marrakech, Morocco, in 2018, which reported that uroscanner was performed on 95.6% and 91.5% of patients respectively [15] [21]. Another study carried out in Burkina Faso found that uroscanner was performed on 8% of patients [22].

It should be noted that the absence of calculi on imaging in some patients can be explained by: natural discharge of calculi, previous urological management before referral for follow-up in our clinic.

The precarious economic situation of patients can be an obstacle to the performance on certain examinations, which are sometimes costly. However, an abdominal CT scan without injection of contrast medium is still the key to diagnosing and assessing the impact of lithiasis on the urinary tract.

The majority of calculi in our study were located in the upper urinary tract, with a predominance of calyceal calculi, in line with the literature [20]. Bladder location remains preferential in patients over 60 years of age, probably related to sub-bladder obstructions and urinary stasis.

Hounsfield density can provide information on the predominant chemical composition of the calculus. Density measurement can vary from 200 to 2460 HU. The reliability of the UH value is optimal on thin sections less than or equal to 3 mm, and with wide-window image parameters to detect the heterogeneous appearance of certain calculi. Several studies have attempted to associate calculus density measurement with its chemical nature and hardness. In our population, calculi are most frequently of calcic density, and our results concur with those of Daudon *et al.* and Menard *et al.* [23]. The median density of our calculi was 750 Hounsfield units; Bosquet *et al.* in France found a mean density of 713 HU [24].

Calculus analysis by spectrophotometry is of major interest, and should be performed on at least one occasion in the course of a patient's lithiasis history, and repeated in the event of recurrence after a long period without calculus, as the cause may change [25]. In our series, it was performed on only 21% of patients, the chemical composition of which was predominantly calcium oxalates. If the stone is not collected, crystalluria can help establish the diagnosis in certain cases, and very often points to the metabolic abnormalities involved in stone formation. In this way, it can be used to assess lithiasis activity and thus the risk of recurrence. In our study, it was performed on only 30% of cases due to lack of economic resources, with crystals present in 32%. Calcium oxalate was the main component, in full concordance with the literature [26].

Numerous factors have been described in the literature as being associated with the development of renal lithiasis: male sex, hypertension, obesity, diabetes, hepatic steatosis and smoking [27]. Some of these factors were also found in our study, essentially hypertension and a history of kidney failure in multivariate analysis.

According to the results of an Iranian study [28], overweight people are at greater risk of developing kidney stones, whereas there is no significant relationship between obesity and kidney stones. Furthermore, some studies have

established a direct relationship between increased BMI and kidney stone formation [12] [29], while Nowfar *et al* USA have also found that the incidence of nephrolithiasis is directly related to obesity in both sexes [30].

Similarly, Eisener *et al* [31] revealed that an increase in BMI was associated with several risk factors for urinary tract disease, including increased urinary sodium and decreased pH in men, and increased uric acid, urinary sodium and decreased urinary citrate in women. From a physiological point of view, obesity is associated with increased calcium and uric acid excretion, as well as increased urinary acidity, all of which contribute to an increased risk of kidney stone formation [12].

Our results show that 14% of patients are diabetic and that the risk of kidney stones in this population is high, which is similar in several studies [12] [32] [33]. In a similar way, Weinberg *et al.* [34] found that the severity of type 2 diabetes was an important risk factor for kidney stone disease. Also, Chung *et al.* reported that patients with kidney stones had an increased risk of diabetes after 5 years' follow-up [33]. However, the relationship between diabetes and kidney stones is explained by the fact that insulin receptors are expressed in the epithelium of the renal tubules, and insulin is involved in the production of ammonia in the renal tubules. In the diabetic state, when insulin resistance occurs, there is a disturbance in the elimination of ammonia from the renal tubules. The result is acidic urine and the formation of urinary calculi [34].

In our study, 36.5% of cases were hypertensive. Kalani *et al.* [35] found that 29.7% of patients with nephrolithiasis were hypertensive, which is in line with our results. Similarly, Shang *et al.* [36] showed that the risk of nephrolithiasis was directly associated with the incidence of high blood pressure. In addition, it has been shown that patients with arterial hypertension as a factor related to metabolic syndrome are more likely to suffer from kidney stones. Metabolic acidosis and hypocitraturia in these individuals play a key role in kidney stone formation [37].

Other factors mentioned in the literature include water hardness in different geographical areas, weather conditions and toxic habits such as smoking and alcoholism [27] [38].

We reported a recurrence of renal lithiasis in 36.5% of cases. Only the presence of a history of familial lithiasis and renal cysts on imaging were significantly associated with the high risk of recurrence of renal lithiasis. In addition to a family history of lithiasis, several other factors favouring recurrence of renal lithiasis have been described in several studies, including male sex, overweight, pregnancy and the presence of several stones on imaging at the time of the first episode [39] [40].

5. Conclusions

Renal lithiasis, characterized by the formation of kidney stones, is a condition marked by severe pain and potential complications, including recurrence and progression to end-stage renal disease [ESRD]. In our study, high blood pressure and a history of renal failure were identified as primary factors contributing to the progression of renal lithiasis. This suggests that patients with these conditions are

at a higher risk of experiencing worsening kidney function due to stone-related complications.

Conversely, our findings indicate that the risk of recurrence of renal lithiasis is significantly associated with a history of familial lithiasis and the presence of renal cysts as observed through imaging. This highlights that genetic predisposition and structural changes in the kidneys play a crucial role in the likelihood of stone recurrence.

Understanding these factors is critical for improving patient management. Early diagnosis, combined with a thorough assessment of individual risk factors, can guide targeted interventions and preventive measures. By addressing these factors, healthcare providers can better manage the condition, potentially reducing the frequency of recurrence and slowing the progression towards chronic renal failure.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Khan, S.R., Pearle, M.S., Robertson, W.G., Gambaro, G., Canales, B.K., Doizi, S., *et al*. (2016) Kidney Stones. *Nature Reviews Disease Primers*, **2**, Article No. 16008. https://doi.org/10.1038/nrdp.2016.8

[2] Raja, A., Wood, F. and Joshi, H.B. (2019) The Impact of Urinary Stone Disease and Their Treatment on Patients' Quality of Life: A Qualitative Study. *Urolithiasis*, **48**, 227-234. https://doi.org/10.1007/s00240-019-01142-0

[3] Thervet, E. (2017) Traité de néphrologie. Lavoisier Médecine Sciences.

[4] De Broe, M.E., Gharbi, M.B. and Elseviers, M. (2016) Maremar, Prevalence of Chronic Kidney Disease, How to Avoid Over-Diagnosis and Under-Diagnosis. *Néphrologie & Thérapeutique*, **12**, S57-S63. https://doi.org/10.1016/j.nephro.2016.02.013

[5] Farshid, S., Aghdashi, A., Fallahi, H., Valizadeh, R. and Rahimi, M.M. (2020) Evaluation of Osteoporosis Frequency in Patients with Recurrent Kidney Stones. *ACTA MEDICA IRANICA*, **58**, 494-499. https://doi.org/10.18502/acta.v58i10.4911

[6] Laziri, F., Rhazifilali, F. and Amchhoud, I. (2009) Etude rétrospective de la lithiase urinaire dans l'Hôpital Hassan II de la province de Settat (Maroc). *African Journal of Urology*, **15**, 117-123. https://doi.org/10.1007/s12301-009-0028-1

[7] Ziemba, J.B. and Matlaga, B.R. (2017) Epidemiology and Economics of Nephrolithiasis. *Investigative and Clinical Urology*, **58**, 299-306. https://doi.org/10.4111/icu.2017.58.5.299

[8] Hesse, A., Brändle, E., Wilbert, D., Köhrmann, K.-U. and Alken, P. (2003) Study on the Prevalence and Incidence of Urolithiasis in Germany Comparing the Years 1979 vs. 2000. *European Urology*, **44**, 709-713. https://doi.org/10.1016/s0302-2838(03)00415-9

[9] Suarez Arbelaez, M.C., Nackeeran, S., Shah, K., Blachman-Braun, R., Bronson, I., Towe, M., *et al*. (2023) Association between Body Mass Index, Metabolic Syndrome and Common Urologic Conditions: A Cross-Sectional Study Using a Large Multi-Institutional Database from the United States. *Annals of Medicine*, **55**, Article

2197293. https://doi.org/10.1080/07853890.2023.2197293

[10] El Habbani, R., Chaqroune, A., Sqalli Houssaini, T., Arrayhani, M., El Ammari, J., Dami, F., *et al.* (2016) Étude épidémiologique sur les calculs urinaires dans la région de Fès et sur le risque de récidive. *Progrès en Urologie*, **26**, 287-294. https://doi.org/10.1016/j.purol.2016.02.004

[11] Safarinejad, M.R. (2007) Adult Urolithiasis in a Population-Based Study in Iran: Prevalence, Incidence, and Associated Risk Factors. *Urological Research*, **35**, 73-82. https://doi.org/10.1007/s00240-007-0084-6

[12] Scales, C.D., Smith, A.C., Hanley, J.M. and Saigal, C.S. (2012) Prevalence of Kidney Stones in the United States. *European Urology*, **62**, 160-165. https://doi.org/10.1016/j.eururo.2012.03.052

[13] Altaf, J., Arain, A.H. and Kella, N.L. (2013) Chemical Analysis of Urinary Stones and its Locations Associated to Urinary Tract. *Journal of Liaquat University of Medical and Health Sciences*, **12**, 203-207.

[14] Khan, A. (2018) Prevalence, Pathophysiological Mechanisms and Factors Affecting Urolithiasis. *International Urology and Nephrology*, **50**, 799-806. https://doi.org/10.1007/s11255-018-1849-2

[15] Mennani, F.E. (2018) Prise en charge de la lithiase rénale: Critères de choix des modalités thérapeutiques. PhD. Thèse, Université Cadi Ayyad.

[16] Rezaee, M.E., Ward, C.E., Pollock, M. and Shetty, S.D. (2017) Association between Multiple Chronic Conditions and Urolithiasis. *International Urology and Nephrology*, **49**, 1361-1367. https://doi.org/10.1007/s11255-017-1611-1

[17] Ondziel-Opara, S.A., Atipo, A.M.O., Okemba, G.O., Mouss, R.B.B., Nyanga, Y.I.D., Odzebe, A.W.S., *et al.* (2022) Epidemiological Profile of Patients Suffering from Urolithiasis in African Urological Environments from 2016 to 2020. *Open Journal of Urology*, **12**, 157-167. https://doi.org/10.4236/oju.2022.122016

[18] Kamadjou, C., Eyongeta, D.E., Moby, E.H., Kuitche, J. and Angwafor, F. (2021) Intraluminal Lithotripsy with Rigid Ureteroscopy for Proximal and Distal Ureteral Stones: Results of a Single Center in Cameroon. *Open Journal of Urology*, **11**, 486-495. https://doi.org/10.4236/oju.2021.1112049

[19] Mbouche, L.O., Mbassi, A.A., Eluondou, J.C.N., Aabe, J.A., Kamga, J., Fouda, P.J., *et al.* (2023) Epidémiologie et diagnostic de la lithiase urinaire: Étude transversale dans une population camerounaise. *Pan African Medical Journal*, **45**, Article No. 61. https://doi.org/10.11604/pamj.2023.45.61.38677

[20] Daudon, M., Traxer, O., Lechevallier, E. and Saussine, C. (2008) Épidémiologie des lithiases urinaires. *Progrès en Urologie*, **18**, 802-814. https://doi.org/10.1016/j.purol.2008.09.029

[21] Niang, L., Paré, A.K., Ndoye, M., Samassékou, A., Avakoudjo, D.J.G., Agounkpé, M.M., *et al.* (2016) Ureteroscopie Retrograde: Expérience de l'Hôpital Général Grand Yoff de Dakar. *African Journal of Urology*, **22**, 110-114. https://doi.org/10.1016/j.afju.2016.01.002

[22] Kaboré, F.A., Kambou, T., Zango, B., Ouattara, A., Simporé, M., Lougué/Sorgho, C., *et al.* (2013) Épidémiologie d'une cohorte de 450 lithiases urinaires au CHU Yalgado Ouédraogo de Ouagadougou (Burkina Faso). *Progrès en Urologie*, **23**, 971-976. https://doi.org/10.1016/j.purol.2013.04.014

[23] Kaulanjan, K., *et al.* (2018) Étude épidémiologiques des lithiases aux Antilles. *Progrès en Urologie*, **28**, 114-119.https://doi.org/10.1016/j.purol.2017.10.005

[24] Bosquet, E., Peyronnet, B., Khene, Z., Pradere, B., Mathieu, R., Bensalah, K., *et al*. (2017) Faisabilité de l'urétéroscopie souple en ambulatoire pour la prise en charge des calculs urinaires: Une étude rétrospective monocentrique. *Progrès en Urologie*, **27**, 799. https://doi.org/10.1016/j.purol.2017.07.233

[25] Courbebaisse, M., Prot-Bertoye, C., Bertocchio, J.-P., Baron, S., Maruani, G., Briand, S., *et al*. (2017) Lithiase rénale de l'adulte: Des mécanismes au traitement médical préventif. *La Revue de Médecine Interne*, **38**, 44-52. https://doi.org/10.1016/j.revmed.2016.05.013

[26] Oussama, A., Kzaiber, F., Mernari, B., Hilmi, A., Semmoud, A. and Daudon, M. (2000) Analyse des calculs urinaires de l'adulte dans le Moyen Atlas marocain par spectrophotométrie infrarouge à transformée de Fourier. *Progrès en Urologie*, **10**, 404-410.

[27] Khalili, P., Jamali, Z., Sadeghi, T., Esmaeili-Nadimi, A., Mohamadi, M., Moghadam-Ahmadi, A., *et al*. (2021) Risk Factors of Kidney Stone Disease: A Cross-Sectional Study in the Southeast of Iran. *BMC Urology*, **21**, Article No. 141. https://doi.org/10.1186/s12894-021-00905-5

[28] Moftakhar, L., Jafari, F., Ghoddusi Johari, M., Rezaeianzadeh, R., Hosseini, S.V. and Rezaianzadeh, A. (2022) Prevalence and Risk Factors of Kidney Stone Disease in Population Aged 40-70 Years Old in Kharameh Cohort Study: A Cross-Sectional Population-Based Study in Southern Iran. *BMC Urology*, **22**, Article No. 205. https://doi.org/10.1186/s12894-022-01161-x

[29] Curhan, G.C. (2007) Epidemiology of Stone Disease. *Urologic Clinics of North America*, **34**, 287-293. https://doi.org/10.1016/j.ucl.2007.04.003

[30] Nowfar, S., Palazzi-Churas, K., Chang, D.C. and Sur, R.L. (2011) The Relationship of Obesity and Gender Prevalence Changes in United States Inpatient Nephrolithiasis. *Urology*, **78**, 1029-1033. https://doi.org/10.1016/j.urology.2011.04.011

[31] Eisner, B.H., Eisenberg, M.L. and Stoller, M.L. (2010) Relationship between Body Mass Index and Quantitative 24-Hour Urine Chemistries in Patients with Nephrolithiasis. *Urology*, **75**, 1289-1293. https://doi.org/10.1016/j.urology.2009.09.024

[32] Zeng, G.H., Mai, Z.L., Xia, S.J., *et al*. (2017) Prevalence of Kidney Stone in China 2017. *British Journal of Urology International*, **120**, 109-116. https://doi.org/10.1111/bju.13828

[33] Chung, S., Chen, Y. and Lin, H. (2011) Increased Risk of Diabetes in Patients with Urinary Calculi: A 5-Year Follow up Study. *Journal of Urology*, **186**, 1888-1893. https://doi.org/10.1016/j.juro.2011.07.011

[34] Weinberg, A.E., Patel, C.J., Chertow, G.M. and Leppert, J.T. (2014) Diabetic Severity and Risk of Kidney Stone Disease. *European Urology*, **65**, 242-247. https://doi.org/10.1016/j.eururo.2013.03.026

[35] Kalani, L., Rashidi, N., Mehranfard, S., Bahrami, H., Majidipour, N., Moghaddam, A.S., *et al*. (2020) Epidemiology of the Urinary Stones: A 6-Year Retrospective Study at Dezful-Iran. *International Journal of Pharmaceutical and Phytopharmacological Research*, **10**, 79-85.

[36] Shang, W., Li, Y., Ren, Y., Yang, Y., Li, H. and Dong, J. (2017) Nephrolithiasis and Risk of Hypertension: A Meta-Analysis of Observational Studies. *BMC Nephrology*, **18**, Article No. 344. https://doi.org/10.1186/s12882-017-0762-8

[37] Howles, S.A. and Thakker, R.V. (2020) Genetics of Kidney Stone Disease. *Nature Reviews Urology*, **17**, 407-421. https://doi.org/10.1038/s41585-020-0332-x

[38] Churchill, D. (1978) Drinking Water Hardness and Urolithiasis. *Annals of Internal*

Medicine, **88**, 513-514. https://doi.org/10.7326/0003-4819-88-4-513

[39] Vaughan, L.E., Enders, F.T., Lieske, J.C., Pais, V.M., Rivera, M.E., Mehta, R.A., *et al*. (2019) Predictors of Symptomatic Kidney Stone Recurrence after the First and Subsequent Episodes. *Mayo Clinic Proceedings*, **94**, 202-210. https://doi.org/10.1016/j.mayocp.2018.09.016

[40] Sofia, N.H., Manickavasakam, K. and Walter, T.M. (2016) Prevalence and Risk Factor of Kidney Stone. *Global Journal for Research Analysis*, **5**, 183-187.