African Urology 2024;4:67-70
https://doi.org/10.36303/AUJ.0135

AFRICAN UROLOGY
ISSN 2710-2750 EISSN 2710-2750

ORIGINAL RESEARCH

Urolithiasis: morphological and constitutional profile of stones at a university hospital in Senegal

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Objective: The objective of this study was to determine the physical and chemical composition of urinary stones treated at our centre.

Methods: This was a prospective, descriptive, monocentric study conducted over 18 months (May 2018 to November 2019). The following parameters were studied: age, gender, radiological findings, stone topography, stone collection method, morphological type of the stones, and the chemical composition of the stones. The stones were analysed at the Institut Pasteur laboratory in Dakar.

Results: A total of 45 patients were included in the study. The male-to-female ratio was 1 : 7. The mean age was 43.9 ± 20.5 years. The 40–60 age group was the most represented (33.3%). Kidney stones were present in 55.6% of patients. Ureteral stones represented 20% and bladder stones 24.4%. Conventional surgery (nephrolithotomy and ureterolithotomy) was the most frequent mode of stone collection (91%). Analysis after stone sectioning showed that the majority of stones were types IVa (57.8%), IIb (44.4%), and Ia (24.4%). On spectrophotometry, whewellite (91.1%) was the most frequent crystalline form of the stones followed by carbapatite (84.4%) and weddellite (48.9%). Calcium oxalate was the most common component in the stones (53.3%). The composition of the stones was heterogeneous in 93.3% of the cases.

Conclusion: The physical and chemical characteristics of the stones in our series show a predominance of calcium oxalate and calcium phosphate stones, which is now in line with the Western profile.

Keywords: urolithiasis, stones, spectrophotometry, urinary tract

Introduction

Urolithiasis is the presence of one or more stones in the urinary tract, a frequent disease that affects between 4% and 20% of the population depending on the country.[1] The epidemiological characteristics of urolithiasis are constantly changing. They reflect changes in nutritional behaviours, health conditions, environmental factors, or the prevalence of diseases that predispose to the risk of urinary lithiasis.[2] The physical and chemical analysis of urinary stones provides information that can contribute to effectively understanding the mechanisms involved in their formation.[3,4] Therefore, it should be the first step in the aetiological exploration of lithiasis.

To date, there is limited data on the physical and chemical characteristics of urinary stones in Senegal. As a result, the aetiological investigation of lithiasis disease is difficult in this setting. The objective of this study was to determine the physical and chemical composition of urinary stones treated at our centre.

Methods

This was a prospective, descriptive, monocentric study focusing on patients managed for urolithiasis at the Department of Urology-Andrology of the university hospital Aristide Le Dantec in Dakar between 1 May 2018 and 30 November 2019. All patients treated for urinary lithiasis with spectrophotometric analysis of the stones were included. Patients whose stones were not analysed were excluded. The parameters studied were age, gender, stone topography, stone collection method, morphological type of the stones, and chemical composition of the stones, specifying: crystalline species present in the stones, number of components present in the stones, the main components found, and correlations between the main composition and age, gender, and location. The collected stones were analysed at the Institut Pasteur laboratory in Dakar. These stones were washed and dried in a sterile container containing no compounds. The storage and transport temperature was between 15 °C and 25 °C. Each sample underwent a morphological and infrared study. Each stone has been the subject of morphological analysis and typing according to the classification of Michel Daudon. Data collection, calculation of means, standard deviations, and descriptive analyses were done using Epi Info 7 software.

Results

In total, 103 patients with urolithiasis were treated at our centre during the study period, of which 45 (43.7%) were included in this study. The male-to-female ratio was 1 : 7. The mean age of the patients was 43.9 ± 20.5 years. The 40–60 age group was the most represented (33.3%). Three patients had a history of surgery for urinary lithiasis.

Upper urinary tract stones accounted for 75.6% (*n* = 34) and lower urinary tract for 24.4% (*n* = 11). The locations of stones were renal, ureteral, and bladder in 55.6%, 20%, and 24.4%, respectively. Renal stones were predominant in the 20–40 and 40–60 age groups. Open surgery was the most frequent mode of stone collection (91%) (Figure 1).

The nucleus was present in 73% (*n* = 33) of the stones. The morphological distribution of the nucleus after observation with a binocular glass showed mostly types IIb and IVa (Table I). The

Table I: Distribution of stones according to morphological type

Morphological type	Of section (*n* = 45)		From nucleus (*n* = 33)	
	Frequency (*n*)	Percentage (%)	Frequency (*n*)	Percentage (%)
I				
Ia	11	24.4	5	15.2
Id	2	4.4	1	3.0
II				
IIa	8	17.8	4	12.1
IIb	20	44.4	15	45.4
III				
IIIa	1	2.2	-	-
IIIb	1	2.2	-	-
IIIc	4	8.9	4	12.1
IIId	2	4.4	1	3.0
IV				
IVa	26	57.8	20	60.6
IVb	2	4.4	1	3.0
IVc	7	15.5	5	15.2
IV uncommon	3	6.7	2	3.0
VIb	1	2.2	1	3.0

analysis after stone sectioning showed that the majority of stones had types IVa (57.8%), IIb (44.4%), and Ia (24.4%) (Table I).

The results of the morphological and constitutional analysis of the nucleus are presented in two categories: either as a single morphological type named pure stones or as different types simultaneously, also called mixed stones (Table II).

The study of the chemical composition of the stones showed that whewellite and carbapatite were the most frequent crystalline species in the stones with 91.1% and 84.4%, respectively (Table III).

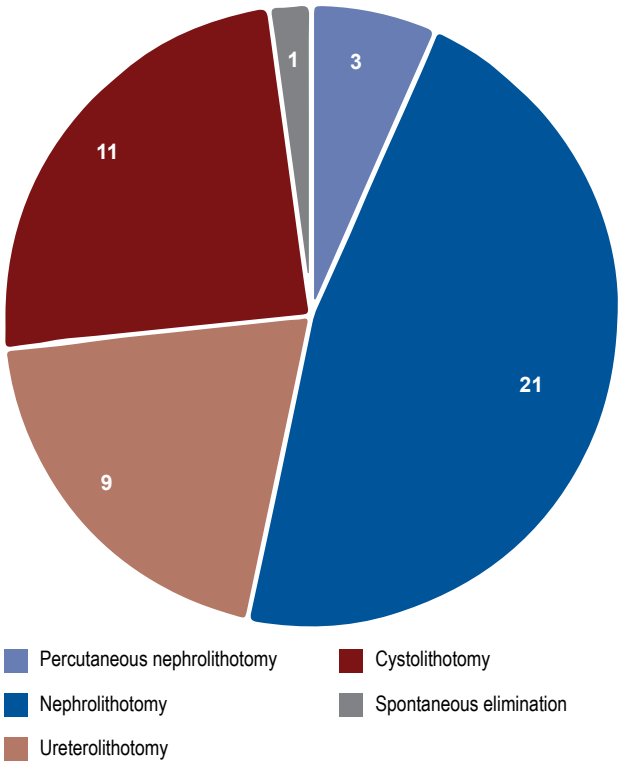

Figure 1: Distribution of patients according to type of stone collection

Analysis of the stones by Fourier-transform infrared spectrophotometry showed a predominance of three-compound stones (35.6%). Calcium oxalate was the major component of the stones, found in 53.3% of patients, with a preponderance of whewellite over weddellite. The most represented association was whewellite + weddellite + carbapatite with a rate of 22.3% (Table IV).

Discussion

This study included 45 out of 103 patients treated for urolithiasis in our centre during the study period. The most affected age group was 40–60. This finding was similar to the results reported by Boudhaye

Table II: Distribution of stones according to pure or mixed nuclei

Nucleus type	Frequency (*n*)	Percentage (%)
Pure nuclei	**12**	**36.3**
Ia	3	9.1
IIa	1	3.0
IIb	3	9.1
IIIc	1	3.0
IIId	1	3.0
IVa	3	9.1
Mixed nuclei	**21**	**63.7**
Ia + IVa	2	6.2
Id + IIIc	1	3.0
IIa + IIb	1	3.0
IIa + IIb + IVa	2	6.2
IIb + IIIc + IVa	1	3.0
IIb + IIIc + Iva + IVc	1	3.0
IIb + uncommon	1	3.0
IIb+IVa	6	18.2
IV uncommon + IVa	1	3.0
IV uncommon + VIb	1	3.0
Iva + IVc	4	12.1
Total	**33**	**100**

Table III: Crystalline species present in the stones

Components present in the stones	Frequency (*n*)	Percentage (%)
Calcium oxalate		
whewellite	41	91.1
weddellite	22	48.9
Phosphocalcic		
Carbapatite	**38**	**84.4**
Amorphous calcium carbonate phosphate	3	6.6
Whitlockite	2	4.4
Struvite	12	26.6
Purines		
Anhydrous uric acid	2	4.4
Ammonium acid urate	6	13.3
Sodium urate	2	4.4
Proteins	17	37.7

Table IV: Frequency of pure stones and the main associations

Component associations	Frequency (*n*)	Percentage (%)
Pure stones	3	6.7
Wh		4.5
UrAm		2.2
Stones with two components	9	20
Wh + Wd		4.5
Wh + CA		11.1
Wh + UrAm		2.2
Wh + AU0		2.2
Stones with three components	16	35.6
Wh + Wd + CA		22.3
Wh + CA + Prot		4.5
Wh + CA + UrAm		2.2
Wh + CA + AU0		2.2
CA + Str + PACC		2.2
CA + Str + Prot		2.2
Stones with four components	10	22.2
Wh + Wd + CA + Prot		8.9
Wh + CA + Str + Prot		6.7
Wh + Wd + CA + UrAm		2.2
Wh + CA + UrAm + UrNa		2.2
CA + PACC + Prot + Str		2.2
Stones with five components	6	13.3
Wh + Wd + CA + Str + Prot		4.5
Wh + Wd + CA + UrAm + Str		2.2
Wh + Wd + CA + UrNa + Prot		2.2
Wh + CA + Wk + Str + Prot		2.2
Wh + CA + PACC + Str + Prot		2.2
Stones with six components	1	2.2
Wh + Wd + CA + Wk + Str + Prot		2.2

AU0 (AcUr) – anhydrous uric acid, CA – carbapatite, PACC – amorphous calcium carbonate phosphate, Prot – protein, Str – struvite, UrAm – ammonium acid urate, UrNa – sodium urate, Wd – weddellite, Wh – whewellite, Wk – whitlockite

et al. in Mauritania and Menard et al. in France.[5-6] However, a lower age group (31 and 45 years) was reported in a study done in western Algeria.[7] In comparison, the mean age in our series did not show any difference compared with studies on urinary stones in the same country or the sub-region (Ze Ondo et al. [42.7 years] and Boudhaye et al. [47.2 years]).[5,8] On the other hand, there was a difference compared with studies from Western countries according to Menard et al. (50.7 years). This difference could be explained by the overall age of the Western population, which is higher than the mean age in our series.[6]

In our series, upper urinary tract stones were more frequent. This result is similar to those found by Djelloul et al. in western Algeria (77.4%) and Oussama et al. in Morocco (77.6%). Ureteral localisation results from the migration of kidney stones, so its frequency is related to that of kidney stones.[1,7,9] Kidney stones are currently most common in industrialised countries and are continuously increasing in developing countries. This increase could be explained by the lifestyle changes in our countries, which increasingly resemble the Western model. Nevertheless, a high proportion of bladder stones remain in our series, which is in line with the data in the African literature.[1,7] In our series, bladder stones were only found in men of all ages, with peaks between the ages of 40–60 and 60–80. This could be explained in part by urinary stasis and high urine concentration associated with low diuresis, especially in periods of life when lower urinary tract symptoms are particularly favoured by benign prostatic hypertrophy and urethral strictures.

Most of the stones were collected through conventional surgery, a mode more frequently performed in Africa. In 2012, Bouslama et al. reported a rate of 86.6% of stones removed by open surgery in eastern Algeria.[10] This fact shows the delay of new minimally invasive extraction techniques widely available in the rest of the world but not yet used in Africa, in general, and particularly in our centre. Moreover, the nature of the stones, which are often large and have evolved over a long period before being treated, is another factor. In France, 78.5% of stones are expelled spontaneously, and only 21.5% require urological procedures, mostly using minimally or non-invasive techniques. In the majority of cases, stones are treated by extracorporeal lithotripsy, percutaneous nephrolithotomy, and ureteroscopy.[9]

The morphological and constitutional analysis of the stones confirms a metabolic origin of the stones with the presence of types I and II, signifying the role of hyperoxaluria and hypercalciuria. Type III stones observed in our series are mainly type IIIc urates related to hyperuricosuria; in contrast to the results of Castiglione et al.[11] who mainly found types IIIa and IIIb uric acid due to hyperuricosuria and urinary acidity. This fact can be explained by a diet richer in purines in the West. Type IV, including IVa and IVc, in the nucleus suggests the participation of infection in lithogenesis in our series. Stones with a pure morphological type of the nucleus were more frequent in this series. This result is lower than the rate of 49.9% obtained by Castiglione et al., of which 2.5% was IVa. This confirms the preponderance of calcium stones and infection in our context.[11]

The mixed origin of the stones described in this series had a higher rate than the 49.3% rate observed in the series by Castiglione et al.[11] These associations reinforce the hypothesis that, in some patients, a stone of metabolic origin may evolve secondarily to a composition of typically infectious origin. Epidemiological studies show a clear preponderance of calcium and oxalate lithiasis, identified in 80% of the stones and representing the major component in about 70%

of cases.[9] In our series, calcium oxalates were the most frequent component. The monohydrate form (whewellite) was present in 91.1% of the stones and majority in 37.8%, less than the 74.2% and 67.5%, respectively, found by Castiglione et al. and Boudhaye et al. in Mauritania.[5,11] Whewellite is oxalic-dependent; its presence and its distribution into the stone are favoured by permanent or intermittent hyperoxaluria from a diet or, more rarely, by an important hyperoxaluria of absorptive or genetic origin. It is considered that certain culinary preparations with abundant use of pepper/spices, excessive consumption of tea/meat with low calcium intake, and insufficient diuresis may be a cause of dietary hyperoxaluria.

The dihydrate form of calcium oxalate (weddellite) was the main component in our series of the 15.5%. This was comparable to the 16.4% found by Bouslama et al. in Algeria.[10] On the other hand, a lower result was found by Oussama et al. (7.1%).[1] Boudhaye et al. in Mauritania and Daudon et al. in France found higher results, 20% and 25.3%, respectively.[5,9] Weddellite is calcium-dependent and is less common than whewellite. Indeed, it binds to other crystalline forms or converts to whewellite. This relatively low frequency of weddellite in our series suggests that hypercalciuria is less frequent in our context than elsewhere (France), probably related to different nutritional behaviours.

Analysis of the composition of stones according to anatomical location shows that calcium oxalate stones are located in the upper urinary tract. This trend was confirmed by the results of Djelloul et al. in Algeria, which had 70.9% of calcium oxalate stones in the upper urinary tract.[7] Infrared spectrophotometry analysis of the stones showed a heterogeneous composition of 93.3%. The stone can contain up to six different components. Three-component stones were the most common at 35.6%. This finding agrees with the results of the different series by Oussama et al. (42.2%) and Bouslama et al. (42.9%).[1,10] Pure stones were rare at 6.7%; Oussama et al. found a similar result at 6.5%.[1] The most frequent combination was the whewellite + weddellite + carbapatite mixture (22.3%), consistent with Bouslama et al. with 30.1%.[10]

Conclusion

The physical and chemical characteristics of the stones in our series showed a predominance of oxalic and phosphocalcic stones, which is currently in line with the Western profile. This fact testifies to the change in lifestyle, although infectious lithiasis is still more frequent in our countries than in the West.

Conflict of interest

The authors declare no conflict of interest.

Funding source

No funding source.

Ethical approval

This study was approved by the ethics committee of Hospital Aristide Le Dantec. Because this study was a retrospective review, consent was not required.

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