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Original article

An epidemiological study on the composition of urinary stones in Morocco in relation to age and sex

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Abstract

Objective: To study the composition of urinary stones, evaluate the percentage of each stone type and assess the association between the stone type and the sex and age in Moroccan stone formers.

Subjects and methods: This epidemiologic study of urolithiasis was carried out in the Rabat-Salé region (Morocco) between 2008 and 2013. A series of 828 urinary stones from 537 men and 265 women was analyzed using Fourier transform infrared spectroscopy in order to evaluate the percentage of each stone type. The results were compared to the patients' demographic data in order to assess the association between the stone type and the sex and age.

Results: The overall sex ratio (male/female) was 2.03:1, and the majority of patients were aged between 40 and 60. The majority of stones were composed of calcium oxalate (66.6%), followed by anhydrous uric acid (18.1%), carbapatite (7.9%), struvite (4.4%) and cystine (0.6%). Anhydrous uric acid stones in this study accounted for a relatively higher rate in males and females compared to that reported in other studies. Our results also showed a higher percentage of carbapatite stones in females compared to males and an increase of the prevalence of anhydrous uric acid stones with age. In addition, the percentage of calcium oxalate stones decreased, while that of carbapatite stones increased with age.

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Introduction

Urolithiasis is characterized by the formation of a stone in the kidneys or urinary tract. The prevalence is estimated to be about 1–5% in Asia, 5–9% in Europe, 13% in North America and 20% in Saudi Arabia [1–3]. In addition, the recurrence rate is increasing and exceeds 50% over a 5 to 10-year period [4]. Therefore, prevention of stone formation is of great importance in the first place.

Shockwave lithotripsy (SWL), ureteroscopy (URS), percutaneous nephrolithotomy (PCNL) and open surgery are all effective methods to remove urinary calculi, and knowing the urinary stone composition is frequently a key factor in determining the most appropriate management [5]. Urinary stone analysis is a tool for assessing the possible etiology and the physiopathology of stone formation [6]. Fourier transform infrared spectroscopy (FT-IR) is now considered a standard method for stone analysis. It requires a minimal sample volume and is very sensitive and selective for all stone components [6,7].

Stone analysis is a routine test for patients with urolithiasis in Western countries, but not in Morocco. To our knowledge, there are no large-scale data about stone composition. Hence, we evaluated the percentage of each stone type and established the association between the stone type and the sex and age of the patients.

Subjects and methods

Between January 2008 and September 2013, 828 stones were collected from 537 men (67%) and 265 women (33%) attending the urological and nephrological services of the Hospitalo-University Centers in Rabat-Salé. The stones were obtained from spontaneous passage, endoscopy (URS and PCNL), SWL and open surgery.

The patients' average age was 49 (range 20–87) years for the men and 48 (range 18–86) years for the women. For 26 stones, no information concerning the sex of the patient was available. The overall male/female ratio was equal to 2.03:1.

All stone samples were washed using distilled water and dried at 60 °C for 24 h. Every stone was analyzed entirely from the core to the surface. The fragments of stones collected by endoscopic methods were recomposed to establish their original shape as effectively as possible.

A pulverized stone sample (5%) was mixed with potassium bromide (KBr) using a pestle and mortar. From this mixture, a calculus + KBr tablet was prepared at 10 tons of pressure under vacuum for 2 min [2,7]. In a final step, the tablet was analyzed using the JASCO FT-IR Spectrophotometer 460-PLUS.

The results were analyzed by chi-square test. A statistical significance was defined as $P < 0.05$.

Results

A first classification of the stones according to sex and age showed that stones affect all age groups regardless of sex, with a predominance of the age group 31–60 years (Table 1), and a higher prevalence of stones in male patients.

Table 1 Anatomical location of the stones according to age.

Location	Age range					
	18–30 years		31–60 years		>60 years	
	N	%	*N*	%	*N*	%
Kidney	26	71.8	159	67.7	33	44
Ureter	10	25.6	50	21.2	8	10.7
Bladder	1	2.6	26	11.1	34	45.3

Furthermore, the anatomical location was largely renal (62.9%), with an increase of bladder stones after the age of 60 with a prevalence of 45.3%.

Extracorporeal lithotripsy was the most common method for urinary stone removal, accounting for 43.7%. Conventional surgery was still common, representing 35.6% of cases compared to 14% of spontaneous expulsion and 6.8% endoscopic treatment.

In this series, 13 stone types were identified: calcium oxalate monohydrate (COM), calcium oxalate dihydrate (COD), carbapatite (CARB), struvite (STR), whitlockite, brushite, amorphous carbonated calcium phosphate (ACCP), uric acid (URI) (anhydrous and dihydrate), urates ammonium and sodium (URA), cystine (CYS) and proteins which are found in almost all stones. Most of the stones had a mixed composition ranging from 2 to 5 components with a predominance of a combination of COM, COD and CARB.

Among the 828 stones, 66 contained struvite (8.0%). The review by sex shows that 26/265 women (9.8%) and 39/537 men (7.2%) had struvite stones, indicating that an increased bacterial infection was frequently involved in the formation of urinary calculi in both sexes.

The stones were classified according to their major components (Table 2). The preponderant type of stone was COM (56.4%), followed by URI (18.1%), CARB (7.9%), COD (10.2%), STR (4.4%) and CYS (0.6%). The other (OTH) types accounted for less than 1% of the cases.

COD occurred more frequently in males than in females ($P < 0.05$), whereas carbapatite and urate stones were more prevalent in females than in males ($P < 0.05$).

We also studied the frequency of the main components in terms of age (Table 3). CaOx was mainly found in the age group 18–30 years, while anhydrous uric acid was more common after the age of 60 ($P < 0.05$).

Examination of crystalline phases showed that COD was 2–6 times less frequent than COM depending on the age, while the prevalence of COM varied widely from 53.4% (31–60 years) to 31.2% after 60 years. A small proportion of CaPh was noted in the age group 18–30 years (6%); this proportion rose slightly in older age groups. URI accounted for 6% of stones in patients aged between 18 and 30 years, then its frequency increased gradually to 49.5% in the age group above 60 years. In contrast, struvite stones represented 6% of stones in the age group 18–30 years, and then its incidence decreased slightly in older age groups. Similarly, ammonium urate stones represented 2% of lithiasis in patients aged between 18 and 30 years, while their incidence dropped to less than 0.6% with increasing age.

Table 2 The percentage of each stone type classified according to the major component of the stone for both genders.

Components	Overall[a]		Female		Male		*p*-Value
	N	%	*N*	%	*N*	%	
CaOx	550	66.6	159	60.0	377	70.2	0.040
- COM	466	56.4	148	55.8	304	56.6	0.838
- COD	84	10.2	11	4.2	73	13.6	0.000
CaPh	68	8.1	27	10.2	35	6.5	0.067
- CARB	66	7.9	27	10.2	34	6.3	0.050
- Whitlockite	2	0.2	0	–	1	0.2	–
Struvite	36	4.4	17	6.4	19	3.5	0.064
Purins	164	19.8	56	21.1	102	19	0.474
- Uric acid	150	18.1	48	18.1	98	18.2	0.962
- Urates	14	1.7	8	3.0	4	0.7	0.013
Cystine	5	0.6	4	1.5	1	0.2	0.025
Others	5	0.6	2	0.8	3	0.6	–

CaOx: calcium oxalate; COM: calcium oxalate monohydrate; COD: calcium oxalate dihydrate; CaPh: calcium phosphate; CARB: carbapatite.
[a] For 26 stones no information on the patient's sex was available.

Table 3 Distribution of the main components in terms of age.

Components	18–30 years		31–60 years		>60 years	
	N	%	*N*	%	*N*	%
COM	30	60.0	190	53.4	29	31.2
Uric acid	3	6.0	55	15.4	46	49.5
COD	6	12.0	41	11.5	4	4.3
CARB	3	6.0	28	7.9	10	10.8
Struvite	3	6.0	15	4.2	4	4.3
Urates	1	2.0	2	0.6	–	–
Cystine	0	–	2	0.6	–	–
Others	4	8.0	23	6.5	–	–

COM: calcium oxalate monohydrate; COD: calcium oxalate dihydrate; CARB: carbapatite.

Discussion

This series of stones was collected from urology departments of hospitals of the Rabat-Salé region. The proportion of surgical stone removal was much higher than that reported in series from industrialized countries [4]. Several reasons can be mentioned: first, the very small number of lithotripters in Morocco's public hospitals on one hand and the high cost of extracorporeal lithotripsy accessible mainly in private clinics on the other. And, finally, the fact that the stones have often developed long before the patients are admitted to the urology services, which explains that the stones are often voluminous.

The distribution of stones according to age showed a male predominance which complies with reports from other countries of the world. In industrialized countries, urolithiasis affects mainly adults in the 3rd to 4th decade of life, and the male/female ratio is generally between 1.5:1 and 2.5:1 and would fall even below 1.5:1 today, at least in the United States, as suggested in some recent studies [4,8,9]. The male/female ratio of 2.03:1 found in our study is similar to that reported in France (M/F = 2.1:1) [4] and lies between that of 1.26:1 reported in Spain by Sanchez-Martin et al. [10] and the one of 2.68:1 observed in Japan by Hossain et al. [11].

A study of the anatomical location of the stones showed a trend toward the upper urinary tract. In fact, the majority of stones were formed in the kidney. On the other hand, the stone location changed with age; the proportion of bladder stones increased, while the proportion of renal stones decreased. The age group most affected by kidney stones was the one between 31 and 60 years with a peak at the age of 53. These results are similar to those of Daudon et al. [4] and Yasui et al. [12].

In this study, the main component of nephrolithiasis was CaOx as in all the series published in the literature of the last decade (Table 4). It prevailed in 66.6% of cases, followed by URI in 18.1% and CaPh in 8.1%. Comparing these results with those of large series published in developed countries [3,4,8,9,13] shows similarities but also some differences.

Overall, the nature of the stones in Morocco is similar to those found in industrialized countries, confirming the theory of the

Table 4 Comparison with literature (results in percentages observed in each series).

Components	Our study ($n = 828$)	Djellou [14] ($n = 1354$)	Hesse [15] ($n = 17,213$)	Sum [2] ($n = 5248$)	Daudon [4] ($n = 51,747$)
CaOx	66.6	67	64	67.1	71
- COM	56.4	50.3	47.7	52.7	50.1
- COD	10.2	16.7	16	14.4	21.7
CaPh	8.1	16.7	5.4	22.1	13.6
Struvite	4.4	4.8	7	1.7	1.3
Uric acid	18.1	8.8	12.1	6.1	10.8
Urates	1.7	1.8	0.6	0.2	0.5
Cystine	0.6	0.7	0.4	1.1	0.9

CaOx: calcium oxalate; COM: calcium oxalate monohydrate; COD: calcium oxalate dihydrate; CaPH: calcium phosphate.

evolution of urolithiasis in developing countries with regard to chemical composition, distribution of patients by sex and anatomical location [4,16,17]. Apart from urate stones mainly containing ammonium urate, which show a relatively high prevalence in our present series and in the study carried out by Djellou et al. from Algeria [14], but whose prevalence declined compared to our previous series [7], it is difficult to find any other abnormality in the chemical composition compared to the data in the literature. While the crystal species COM, oxalo-dependent, in our series represents 56.4% of stones which is slightly higher than the percentage observed in France, COD, calcium-dependent, is less common (10.2% vs 21.7% in France), suggesting a higher prevalence of hyperoxaluria and a lower prevalence of hypercalciuria in our series than in other studies. With the exception of the United States, where the proportion of weddellite crystals reported by Denstedt [9] is 2–3 times higher than in other studies. The distribution of stone components in our study was also comparable to series published in Germany, China and France, except for phosphates which were less abundant in German series. In our study, CaPh crystals were observed with a lesser frequency than that reported in France. However, since our series relied on stone analysis data derived from stones gathered after spontaneous passage or intervention, we may have missed a substantial number of fragments of CaPh stones that were treated with shock wave lithotripsy [3]. Struvite stones, indicative of urinary tract infection caused by urease-producing bacteria, represented 4.4% of stones in our series with a frequency twice as high in women as in men (6.4% vs. 3.5% in men). Their prevalence in our study was 8.0% vs 8.9% in France and considerably less than that reported in a recent series studied in the Maghreb region [14]. These infection stones are related to hygiene problems, poor detection of infections and their inadequate care.

In our study, URI was mainly observed in patients over 60 years, as has already been reported by other authors [16,18]. The main cause of an increased frequency of uric acid stones with increasing age is insulin resistance the prevalence of which increases with the patient's age and body mass [18,19]. We do not have anthropometric data of our patients, but in our country, much as in industrialized countries, the proportion of overweight subjects increases with age, which may therefore increase the risk of uric acid stones [3].

Conclusion

Physical analysis of urinary stones provides important information on stone composition, distribution, and risk factors. The epidemiological characteristics of stones in our study are similar to those reported in studies from industrialized countries and reflect the gradual increase in the socio-economic level of Morocco. The small number of data about urinary stones in Morocco indicates that stones are more often located in the upper urinary tract like in industrialized countries. The oxalo-dependent stones represent the main form of urolithiasis, both in men and in women, with a slight decrease in urinary infections, indicating a slight improvement in hygiene and/or management of urinary tract infections in Morocco.

Conflict of interest

The authors declare that they have no conflict of interest.

References

[1] Amato M, Lusini ML, Nelli F. Epidemiology of nephrolithiasis today. Urol Int 2004;72(Suppl 1):1–5.
[2] Sun X, Shen L, Cong X, Zhu H, He L, Lu J. Infrared spectroscopic analysis of 5,248 urinary stones from Chinese patients presenting with the first stone episode. Urol Res 2011;39(5):339–43.
[3] Knoll T, Schubert AB, Fahlenkamp D, Leusmann DB, Wendt-Nordahl G, Schubert G. Urolithiasis through the ages: data on more than 200,000 urinary stone analyses. J Urol 2011;185(4):1304–11.
[4] Daudon M, Traxer O, Lechevallier E, Saussine C. Épidémiologie des lithiases urinaires. Prog Urol 2008;18(12):802–14.
[5] Daudon M. L'analyse morphoconstitutionnelle des calculs dans le diagnostic étiologique d'une lithiase urinaire de l'enfant. Arch Pediatr 2000;7:855–65.
[6] Selvaraju R, Raja A, Thiruppathi G. FT-IR spectroscopic, thermal analysis of human urinary stones and their characterization. Spectrochim Acta A: Mol Biomol Spectrosc 2014;137C:1397–402.
[7] Benramdane L, Bouatia M, Idrissi MOB, Draoui M. Infrared analysis of urinary stones, using a single reflection accessory and KBr pallet transmission. Spectrosc Lett 2008;41:72–80.
[8] Michelle L, Bernd H. History, epidemiology and regional diversities of urolithiasis. Pediatr Nephrol 2010;25(1):49–59.
[9] Denstedt JD, Fuller A. Epidemiology of stone disease in North America. In: Talati JJ, Tiselius HG, Albala DM, Ye Z, et al., editors. Urolithiasis. London: Springer; 2012. p. 13–20.
[10] Sanchez-Martin FM, Millan RF, Esquena FS, Segarra TJ, Rousaud BF, Martinez RR, et al. Incidence and prevalence of published studies about urolithiasis in Spain. A review. Actas Urol Esp 2007;31(5):511–20.
[11] Hossain RZ, Ogawa Y, Hokama S, Morozumi M, Hatano T. Urolithiasis in Okinawa, Japan: a relatively high prevalence of uric acid stones. Int J Urol 2003;10:411–5.
[12] Yasui T, Iguchi M, Suzuki S, Okada A, Itoh Y, Tozawa K, et al. Prevalence and epidemiologic characteristics of lower urinary tract stones in Japan. Urology 2008;72(5):1001–5.
[13] Brien G, Schubert G, Bick C. 10,000 analyses of urinary calculi using X-ray diffraction and polarizing microscopy. Eur Urol 1982;8(4):251–6.
[14] Djellou Z, Djellou A, Bedjaoui A, Kaid-Omar Z, Attar A, Daudon M, et al. Lithiase urinaire dans l'Ouest algérien: étude de la composition de 1354 calculs urinaires en relation avec leur localisation anatomique, l'âge et le sexe des patients. Prog Urol 2006;16:328–35.
[15] Hesse A, Schneider HJ. Results of the standardization and centralization of stone analysis in the German Democratic Republic. In: Urolithiasis research; 1976. p. 295–8.
[16] Hesse A, Brandleb E, Wilbertc D, Kohrmannd KU, Alken P. Study on the prevalence and incidence of urolithiasis in Germany. Comparing the years 1979 vs. 2000. Eur Urol 2003;44:709–13.
[17] Jing Z, GuoZeng W, Ning J, JiaWei Y, Yan G, Fang Y. Analysis of urinary calculi composition by infrared spectroscopy: a prospective study of 625 patients in eastern China. Urol Res 2010;38(2):111–5.
[18] Millan F, Gracia S, Sanchez-Martin FM, Angerri O, Rousaud F, Villavicencio H. A new approach to urinary stone analysis according to the combination of the components: experience with 7949 cases. Actas Urol Esp 2011;35(3):138–43.
[19] El Fellah H, Iken A, El alj H, Nouini Y, Lachkar A, Benslimane L, et al. Aspects épidémiologiques de la lithiase urique: influence de l'âge, du sexe et du diabète. J Maroc Urol 2009;15:15–20.