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The Chemical Compositon of Urinary Stones at the Military Teaching Hospital of Cotonou

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Abstract **Original Research Article**

The Chemical composition of urinary stones at the Military Teaching Hospital of Cotonou. ***Objective*:** To determine the chemical composition of urinary stones in our patients. ***Patients and method*:** We collect surgically removed urinary stones from our patients and send them abroad for infrared spectroscopic analysis. ***Results:*** The infrared spectroscopic analysis was performed on urinary stones from 26 patients, i.e. 21 males (80.8%) and 5 females (19.2%). Their mean age was 48 years (range: 21-71). The mean proportions of chemical components in the stones were: 40.8% whewellite (0-97), 29.4% weddellite (0-95), 12.7% uric acid (0-90), 5.4% struvite (0-70), 5.2% carbonate apatite (0-20), 1.9% ammonium urate (0-20), 1.7% silicate (0-45), 1.3% protein (0-10), 1.2% whitlockite (0-10) and 0.1% hydroxyapatite (0-2). All stones were a mixture of 2 or 3 of the identified chemical components. Based on the main component, there were 3 groups of stones: the calcium oxalate stones (77%), the uric acid stones (15.4%) and struvite stones (7.7%). One calcium oxalate stone from a female comprised 45% silicate and 5% protein. There was no stone chemical composition difference between males and females. ***Conclusion:*** The stones from the 26 patients were mainly non pure calcium oxalate stones (73%), uric acid stones 8%) and struvite stones (4%).

Keywords: Urinary Stone – Calcium Oxalate –Uric Acid – Struvite – Silicate.

INTRODUCTION

The urolithiasis is a major urological concern throughout the world. The urinary stones' prevalence rate varies from 1% to 20% [1]. The surgical ablation of stones allows stopping or avoiding the obstruction or the infection of the urinary tract. But the patient can only avoid the stone's recurrence by complying with specific dietary measures adapted to his disease. However deciding a dietary advice for a patient (or even choosing the most suitable surgical procedure to treat a stone) is rooted in the knowledge of the chemical composition and the mechanism of the stone formation in each patient. The urolithiasis exists in Benin but nothing is known regarding the chemical types that affect the patients.

OBJECTIVE

This study intends to determine the chemical types of urinary stones which affect our institution's patients as no study this type has previously been performed in our country.

PATIENTS AND METHOD

As endoscopic and extracorporeal lithotripsy is not available in our institution, we perform open surgery for all urinary stones. We collected the removed stones and sent them abroad for infrared spectroscopic analysis (Figure 1).

Fig-1: A few samples of the stones removed from our patients

RESULTS

Twenty-six patients underwent a surgical removal of urinary stones. Their mean age was 47.7 years (range=21-71 years). Twenty-one (80.8%) of them were male, the five others (19.2%) were female. The stones were located in the renal pelvis in 11 (42.3%) patients, the bladder in 11 (42.3%) patients, the ureter in 3 (11.5%) patients and the urethrae in 1 (3.8%) patient (Table I).

Table-I: Stone location and demographic characteristics of the patients

Patients (n=26)	Stone location				Total (%)
	Renal Pelvis	Ureter	Bladder	Urethrae	
Male	7	3	10	1	21 (80.8)
Female	4	0	1	0	5 (19.2)
Total (%)	11 (42,3)	3 (11.5)	11 (42.3)	1 (3.8)	26 (100)

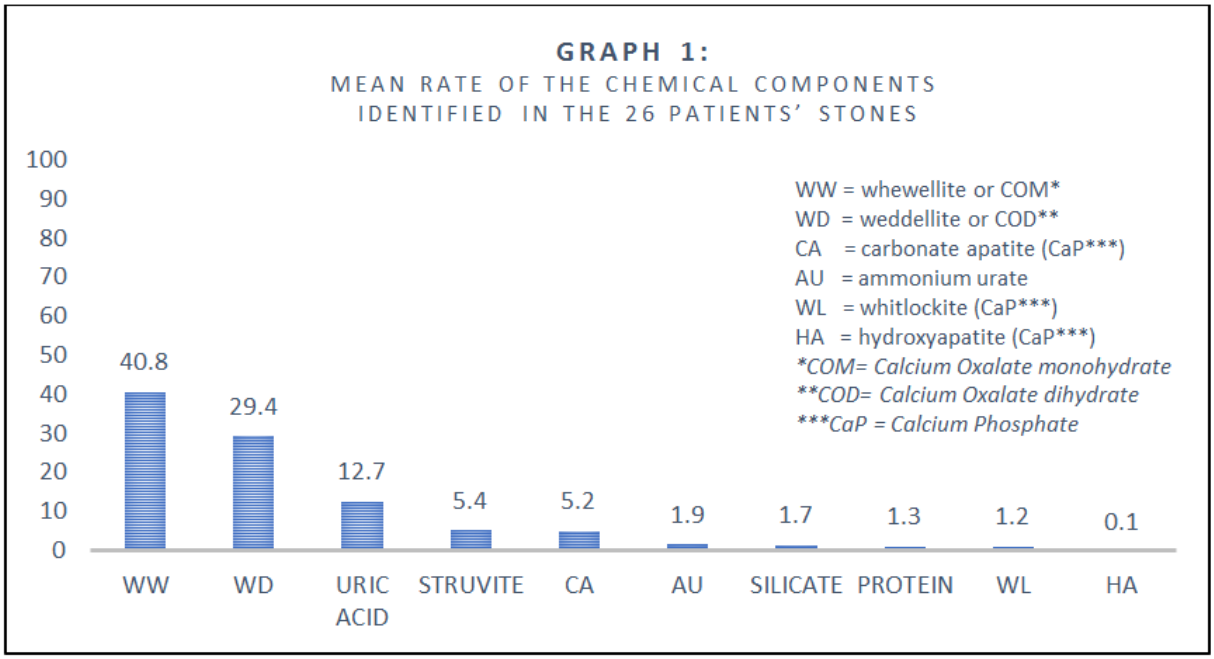
The chemical components identified in the patients' stones included the whewellite (calcium oxalate monohydrate or COM), the weddellite (calcium oxalate dihydrate or COD), the uric acid, the struvite, the silicate, the carbonate apatite (CA), the whitlockite (WL), the hydroxyapatite (HA), the ammonium urate (AU) and the proteins (Table II and Graph 1). Every patient's stone was a mixture of 2 or 3 chemical components (Table III).

Table-II: List and proportions of the components identified in the stones

STONES' COMPONENTS	COMPONENTS' RATE RANGE (%)	MEAN COMPONENTS' RATE (%)	PATIENTS (*n*)	PATIENTS (%)
Whewellite	0-97	40.8	23	88.5
Weddellite	0-95	29.4	17	65.4
Uric acid	0-90	12.7	4	15.4
Struvite	0-70	5.4	2	7.7
Carbonate apatite	0-20	5.2	18	69.2
Ammonium urate	0-20	1.9	3	11.5
Silicate	0-45	1.7	1	3.8
Protein	0-10	1.3	16	61.5
Whitlockite	0-10	1.2	10	38.5
Hydroxyapatite	0-2	0.1	1	3.8

* Whewellite = calcium oxalate monohydrate ** Weddellite = calcium oxalate dihydrate

*** Carbapatite, whitlockite and hydroxyapatite are varied forms of calcium phosphate



The calcium oxalate (whewellite or weddellite) was present in the stones of 25 (96%) patients. Its proportion in the stones varied from 0% to 97% with a mean of 70%. It's rate was high in 19 (73%) patients (mean=89.8%, range=70%-97%) and low in 5 (19%) patients (mean=14%, range=10%-25%). One female's stone contained 50% CaOx (i.e. 40% COM + 10% COD), 45% silicate and 5% protein. Among the 25 CaOx containing stones, 15 (60%) contained both COM and COD, 8 (32%) contained COM only and 2 (8%) contained COD only. Of the 15 stones mixing COM and COD, 9 (60%) comprised more COM than COD (mean COM rate=62% versus mean COD rate=17%), 6 (40%) comprised less COM than COD (mean COM rate=13% versus mean COD rate=73%). Among the 8 stones containing only COM as CaOx, 4 (50%) had a high COM rate (mean: 95.5%, range: 95%-97%) and the other 4 (50%) had a low COM rate (mean: 11.3%, range: 10%-15%). The 2 stones containing COD only as CaOx had a high rate of COD, i.e. 85% in one and 95% in the other. In sum the CaOx rate was minor in only 5 of the 25 stones containing it. It amounted to 50% in one stone and varied from 70% to 97% in the 19 others.

The calcium phosphate (carbonate apatite, hydroxyapatite or whitlockite) was detected in 20 (77%) patients' stones (mean rate=6.5%, range=0%-30%). The proportion of calcium phosphate in those stones varied from 2% to 30%: 5% or less in 13 stones, 10% to 20% in 6 stones and 30% in 1 stone. The calcium phosphate was combined to the calcium oxalate in 19 patients' stones. It was combined to struvite and ammonium urate in 1 patient's stone. Thus the CaP was a minor component of in every one of the 20 stones containing it.

The uric acid rate was detected in 4 male patients' stones ranging from 75% to 90%. It was combined to the calcium oxalate in 3 patients (mean: 85% versus 15%). The 4th patient's stone combined 75% uric acid, 15% CaOx and 10% ammonium urate.

The struvite was present in 2 patients' stones at a rate of 70%. It was combined to 20% ammonium urate and 10% calcium oxalate in the female patient, and to 20% ammonium urate and 10% carbonate apatite in the male patient.

Table-III: Main components of the stones

Type of Stones	Number of patients (%)	Mean rate (range) of components per type of stone (%)
CaOx* + CaP**	4 (15.4)	82.5 (70-95) + 17.5 (5-30)
CaOx + CaP + Protein	15 (57.7)	91.8 (70-97) + 5.9 (2-20) + 2 (1-10)
CaOx + Silicate + Protein	1 (3.8)	50 + 45 + 5
Uric acid + CaOx	3 (11.5)	85 (75-90) + 15 (10-25)
Uric acid + CaOx + Ammonium urate	1 (3.8)	75 + 15 + 10
Struvite + Ammonium urate + CaOx	1 (3.8)	70 + 20 + 10
Struvite + Ammonium urate + CaP	1 (3.8)	70 + 20 + 10

* CaOx = calcium oxalate ** CaP = calcium phosphate

Table-IV: Details of calcium oxalate rate in the stones

Number of patients = 25			
CaOx* type	**Rate range (%)**	**Mean rate (%)**	**Patients n(%)**
COM**	10 to 97	53.4	8 (32)
COD***	85 to 95	90	2 (8)
Mixed COM and COD	25 to 95	81.3	15 (60)

* CaOx = calcium oxalate ** Calcium oxalate monohydrate or whewellite
*** Calcium oxalate dihydrate or weddellite

Table-V: Details of calcium phosphate rate in the stones

Number of patients = 20			
CaP* type	**Rate range (%)**	**Mean rate (%)**	**Patients n(%)**
Hydroxyapatite (HA)	2 to 2	2	1 (5)
Whitlockite (WL)	3 to 3	3	1 (5)
Carbapatite (CA)	2 to 20	10.2	9 (45)
Mixed CA and WL	4 to 30	7.9	9 (45)

* CaP = calcium phosphate

DISCUSSION

We notice that all the patients' stones contained some amount of calcium oxalate or calcium phosphate. 19 patients' stones in which the calcium oxalate was the predominant constituent also contained some amount of calcium phosphate. Together with the ammonium urate, the calcium phosphate was also a minor component in 1 struvite stone. As a minor component together with the ammonium urate, the calcium oxalate was present in 5 stones: 4 uric acid stones and 1 struvite stone. So based on the main component, there were 3 groups of stones: the calcium oxalate stones (77%), the uric acid stones (15.4%) and the struvite stones (7.7%). One calcium oxalate stone from a female comprised 45% silicate and 5% protein.

So in our patients, the most frequent stones were the calcium oxalate ones as it is observed throughout the world [2-5]. The silicate which represents only 1.7% of all components of our stones is a rare component of urinary stones [6, 7].

Prolonged magnesium trisilicate treatment [7] for peptic ulcer or prolonged zonisamide treatment [6] for epilepsy is reported to lead to silicate stones disease. However our female patient had no history of disease or a long term use of any medicine. The origin of the silicate in her stone is unclear and continues to be investigated.

CONCLUSION

The 26 stones contained variable amount of whewellite, weddellite, uric acid, struvite, carbonate apatite, ammonium urate, silicate, protein, whitlockite and hydroxyapatite. Based on the main component, the 26 stones were 3 main types: the calcium oxalate stones (73%), the uric acid stones (15%) and the struvite stones (8%).

Abbreviations

CaOx = calcium oxalate, COM = calcium oxalate monohydrate, COD = calcium oxalate dihydrate, WW = whewellite, WD = weddellite, CaP = calcium phosphate, CA = carbonate apatite, WL = whitlockite, HA = hydroxyapatite, AU = ammonium urate.

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