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Biochemical Assessment of Uroliths Extracted in Patients with Urolithiasis in a Tertiary Health Institution

Oloyede T[1], Habibu RA[1], Ojedokun S[2] and Haladu H[1]*

[1]Department of Chemical Pathology, Federal Teaching Hospital, Nigeria

[2]Department of Chemical Pathology, LAUTECH Teaching Hospital Ogbomoso, Nigeria

***Corresponding author:** Halima Haladu, Department of Chemical Pathology, Federal Teaching Hospital, Katsina, Nigeria; Email: halibra2000@gmail.com

Research Article

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Abstract

Background: Urolithiasis is found across the world, knowing the chemical composition of uroliths can help in patient management and prevention of recurrence. Therefore, this study aimed to assess the biochemical compositions of extracted stones.

Methods: The study is a two-year retrospective cross-sectional study which analysed forty-two stones received from the surgical department following removal. The stones were crushed, and the powdered form was subjected to flame test and subsequent chemical analysis using the McIntosh and Salter method. Patients' records were reviewed for biodata and other medical details. Data were analysed using SPSS version 20.

Results: The predominant anatomical location of stones among subjects was Ureter (42.9%, n=18), 28.6% of stones were located in the Kidney, 14.3% in the Bladder, and 7.1% were located in the renal pelvis and urethra. Subjects below 18 years have the highest occurrence of stones across different anatomical locations. There is a significant association between Age group and anatomical location, p-value = 0.005. Also, males have the highest occurrence of stones across different anatomical locations except in the pelvic region. There was a significant association between sex and anatomical location, p-value = 0.013.

Conclusion: Calcium oxalate stones are the most common stone type. However, age and sex have a marked influence on the type of stone formed.

Keywords: Uroliths; Urolithiasis; Stone Components

Abbreviations

AUA: American Urological Association; EAU: European Association of Urology.

Introduction

Uroliths are hardened masses of minerals and other materials that develop in the urinary tract, also referred to as stones or calculi [1]. Bladder stones are the most prevalent, though they can appear elsewhere in the urinary tract [2].

They result from chemical substances in the urine in higher than usual amounts, with the excess precipitating to form stones [3]. These compounds include, but are not restricted to, calcium phosphate, uric acid, cystine, magnesium ammonium phosphate (struvite), and calcium oxalate, which can exist as either monohydrate or dihydrate

[2]. Infections, diet, genetics, drug metabolites, amino acids, and foreign materials such as suture material can also cause urolith formation [2].

Urolithiasis is found across the world [4], although it is more prevalent in developed nations [5]. Determining the chemical composition of uroliths is essential for effective patient management and the prevention of recurrence. Understanding the makeup of urinary stones can also aid in determining the risk factors for their development and properly directing treatment [2]. Anyone with first-time stone diagnosis should have their stones examined after removal, according to recommendations from the American Urological Association (AUA) [6] and the European Association of Urology (EAU) [7].

In Nigeria, kidney stone analysis is not a common practice, despite various guidelines and recommendations from urological societies [6,7]. Therefore, this study aimed to identify the major components of uroliths retrieved during surgeries from patients managed for urolithiasis in Federal Teaching Hospital Katsina Nigeria.

Method

Study Design

This was a 2-year retrospective cross-sectional study conducted at the Department of Chemical Pathology, Federal Teaching Hospital, Katsina, Nigeria.

Study Procedure

The study involved the chemical analysis of uroliths from forty-two consecutive patient samples received from the surgical department following urinary tract stone removal within the study period.

Prior to chemical analysis, the stones were washed with distilled water, air-dried and weighed. Each stone was then cut into two and examined for a nucleus. The presence of a nucleus required separate analysis of the nucleus and periphery. The stone was then crushed using a porcelain mortar and pestle and the powdered form was subjected to flame test and subsequent chemical analysis using the McIntosh and Salter method. Patients' records were carefully reviewed for age, sex, race and location of stones.

Statistical Analysis

Data was analyzed using SPSS version 20 and reported as frequencies for categorical variables, and mean (standard deviation) for continuous variables. Chi-square test was used to compare categorical variables. A p-value <0.05 was used to denote statistical significance.

Results

The age of subjects ranged between 2 and 57 years, the majority (n= 30, 7.14%) of the subjects were < 18 years. There were more males than females (Male: 73.8%, Female: 26.2%) with female to male ratio 1: 2.82. The predominant anatomical location of stones among subjects was Ureter (42.9%, n=18), 28.6% of stones were located in the Kidney, 14.3% in the Bladder, and 7.1% were located in the renal pelvis and urethra. However, the majority of the Stones were Black (n =18, 42.9%) in colour, 38.1% (n=16) were brown, 16.7% (n=7) were yellow, and 2.4% (n=1) were white. The weight of stones in the study ranges between 0.5 and 7.5 grams with 0.75 median weight (Table 1).

Characteristics	Frequency (n) = 42	Percentage (%)
Age (Years)		
< 18	30	71.4
18 – 29	5	11.9
30 - 49	6	14.3
> 49	1	2.4
Sex		
Male	31	73.8
Female	11	26.2
Anatomical Location		
Bladder	6	14.3
Kidney	12	28.6
Ureter	18	42.9
Pelvic	3	7.1
Urethral	3	7.1
Colour		
Black	18	42.9
Yellow	7	16.7
Brown	16	38.1
White	1	2.4
Weight		
Minimum	0.5	
Maximum	7.5	
Standard deviation	1.52	
Median	0.75	

Frequency: Number of subjects, median age: 7.5

Table 1: Demographic and Stone characteristics of the subjects.

Subjects below 18 years (<18) have the highest occurrence of stones across different anatomical locations. There is a significant association between Age group and anatomical location among subjects, p-value = 0.005. Also, male subjects have the highest occurrence of stones across different anatomical locations except in the renal pelvis region where females have the highest occurrence However, there was a significant association between sex and anatomical location, p-value = 0.013 (Table 2).

Variables	Anatomical Location					p-value
	Bladder	Kidney	Ureter	Pelvic	Urethral	
Age (Years)						
< 18	6 (20.0)	11 (36.7)	10 (33.3)	0 (0.0)	3 (10.0)	*0.005
18 – 29	0 (0.0)	1 (20.0)	4 (80.0)	0 (0.0)	0 (0.0)	
30 - 49	0 (0.0)	0 (0.0)	4 (66.7)	2 (33.3)	0 (0.0)	
> 49	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0	
Sex						
Male	6 (19.4)	10 (32.3)	12 (38.7)	0 (0.0)	3 (9.7)	*0.013
Female	0 (0.0)	2 (18.2)	6 (54.5)	3 (27.3)	0 (0.0)	

*p-value < 0.05 indicates significance

Table 2: Stone Anatomical Location by Age Group and Sex.

Table 3 compares the median weight of stones across age, sex, and anatomical location of stones of subjects in the study population. The median weight of the stones was higher among subjects who were > 49 years (2.000) followed by subjects who were < 18 years (0.800) and a median of 0.500 among subjects who were between 18 – 29 years and 30 – 49 years. There was no statistically significant difference between the median weight of stone across the age group, H = 2.035, p-value = 0.565. Also, the median weight of stones was similar among male (0.800) and female subjects (0.500), U = 102.500, p-value = 0.082. However, the median weight of stones differed significantly across the anatomical location of stones in the study (Bladder; 0.500, Kidney; 2.600, Ureter; 0.500, Pelvic; 2.000, Urethral; 0.800), H = 20.419, p-value < 0.001 (Table 3).

Variables	N	Median	Statistic	P-value
Age (Years)				
< 18	30	0.8	H = 2.035	0.565
18 – 29	4	0.5		
30 - 49	5	0.5		
> 49	1	2		
Sex				
Male	29	0.8	U = 102.500	0.082
Female	11	0.5		
Anatomical Location				
Bladder	6	0.5	H = 20.419	*<0.001
Kidney	12	2.6		
Ureter	16	0.5		
Pelvic	3	2		
Urethral	3	0.8		

H: Kruskal-Wallis statistic, U: Mann Whitney U statistic, p-value <0.05 indicates significance

Table 3: Relationship between Age group, Sex, Location of Stone and Stone Weight.

There were 2.4% (n=1) stones containing Cystine, 2.4% (n=1) contained Phosphate, 9.5% (n=4) contained Ammonium, and 2.4% (n=1) contained Magnesium. Predominately, 76.2% (n=32) contained Calcium, 14.3% (n=6) contained Uric Acid and 85.7% (n=36) contained Oxalate. However, 3.2% of the male subject population tested positive for Cystine (Male; 1, Female; 0) and Phosphate (Male; 1, Female; 0), 36.4% (n=4) tested positive for Ammonium (Male; 0, Female; 4), 3.2% Male for Magnesium (Male; 1, Female; 0), 80.6% (n=25) Male and 63.6 (n=7) for Calcium, 3.2% (n=1) Male and 45.5% (n=5) Female tested positive for Uric Acid, and 93.5% (n=29) Male and 63.6% (n=7) Female tested positive for Oxalate (Table 4).

Chemical Composition	n (%)		
	Overall	Male	Female
Cystine	1 (2.4)	1 (3.2)	0 (0.0)
Phosphate	1 (2.4)	1 (3.2)	0 (0.0)
Ammonium	4 (9.5)	0 (0)	4 (36.4)
Magnesium	1 (2.4)	1 (3.2)	0 (0.0)
Calcium	32 (76.2)	25 (80.6)	7 (63.6)
Uric Acid	6 (14.3)	1 (3.2)	5 (45.5)
Oxalate	36 (85.7)	29 (93.5)	7 (63.6)

Table 4: Chemical Composition of Stones.

Of all the stones located in the Ureter, 22.2% (n=4) contained Ammonium, 50% (n=9) contained Calcium, 22.2% (n=4) contained Uric Acid, and 66.7% contained Oxalate. Also, of all the stones located in the kidney, 8.3% contained Cystine, 8.3% contained Phosphate, 8.3% contained Magnesium, 100% (n= 12) contained Calcium, 8.3% (n=1) contained Uric Acid, and 100% (n=12) contained Oxalate.

Furthermore, of all stones located in the bladder, 83.3% (n=5) contained calcium, 16.7% contained Uric Acid, and 100% (n=6) contained Oxalate (Table 5)

Chemical Composition	n (%)		
	Ureter	Kidney	Bladder
Cystine	0 (0.0)	1 (8.3)	0 (0.0)
Phosphate	0 (0.0)	1 (8.3)	0 (0.0)
Ammonium	4 (22.2)	0 (0)	0 (0.0)
Magnesium	0 (0.0)	1 (8.3)	0 (0.0)
Calcium	9 (50.0)	12 (100.0)	5 (83.3)
Uric Acid	4 (22.2)	1 (8.3)	1 (16.7)
Oxalate	12 (66.7)	12 (100.0)	6 (100.0)

Table 5: Chemical Composition of Stones across Different Anatomical Locations.

Discussions

The study analyzed forty-two urinary stones extracted over two years from three major locations of the urinary system including the kidneys, ureter and bladder. The study observed that the predominant anatomical location of stones among subjects was the ureter followed by the Kidney, bladder, and only a few were in the renal pelvis and Urethra. Studies have reported differing common locations for urinary stones.

The most frequent anatomic site reported from Kano [3] and another southeast [1] institution in Nigeria was the urinary bladder as opposed to our findings and another report from Abuja [2] Nigeria where the common anatomical site was the upper urinary tract. This could be due to differences in sample size, or the number of stones received for examination. According to the findings of our study, subjects below 18 years have the highest occurrence of stones across different anatomical locations in contrast to another report where majority of patients with stones were middle-aged [8].

The majority of the stones were black, while only a few were white. The median weight of stones in the study was 0.75. The median weight of the stones was higher among subjects who were > 49 years and differed significantly across the anatomical location with kidney stone weight higher than other locations.

There is a significant association between age group and anatomical location among subjects, male subjects have the highest occurrence of stones across different anatomical locations except in the pelvic region where females have the highest occurrence. This resonates with a report where urolithiasis occur in males sixfold more than in females [3]. However, there was a significant association between sex and anatomical location.

Most of the stones contained Calcium, followed closely by Oxalate and others contained Uric Acid, Cystine, Phosphate, Ammonium, and Magnesium in support of other reports where majority of the stones were found to be Calcium oxalate [3,9].

Uroliths contents by locations also differs as observed in this study. More than half of ureter stones contained oxalate while the kidney and bladder stones contained mainly of calcium, and oxalate.

Calcium oxalate urolithiasis is the most prevalent form of urinary stone, accounting for roughly 50% of all cases [10]. Hypercalciuria is often associated with calcium kidney stones with poorly understood aetiology.

There is evidence that high dietary calcium intake can expedite kidney stone development [11]. Also, the development of uric acid and calcium oxalate stones is substantially correlated with obesity, unlike stones comprising calcium phosphate or cystine [12].

Conclusion

Calcium oxalate stones are the most common stone type. However, age and sex have a marked influence on the type of stone formed.

Ethical Approval

Written informed consent was obtained from participants, and ethical clearance was obtained from FTH Katsina Research and Ethics Committee with reference number.

Conflict of Interest

Authors declared no conflict of Interest.

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