IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 2 Ver. V (February. 2017), PP 66-70
www.iosrjournals.org

Patternof Urinary Calculi ata Tertiary Hospital inSubsaharanAfrica

Ifeyinwa Nnakenyi[1], Emeka Nnakenyi[2], Martin Ugonabo[1]
[1]*Chemical Pathology Department, University Of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu*
[2]*Morbid Anatomy Department, University Of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu*

Abstract
Background: *Urolithiasis is stone formation in the urinary tract which can be removed surgically to relieve symptoms or passed spontaneously in urine. They are sent to the laboratory for analyses, because knowledge of the chemical composition of stones aids appropriate treatment in order to prevent reoccurrence. We therefore aimed to determine the chemical composition of urinary calculi in our patients.*
Method: *This was a retrospective study of the chemical composition of urinary calculi submitted to the Chemical Pathology laboratory at University of Nigeria Teaching Hospital, Enugu over a four year period. After conducting physical examination of the calculi received in the laboratory, a portion was crushed and analyzed using flame and chemical reagents.*
Results: *Forty-fivestones were obtained from 37(82%) males and 8 (18%) females of which 37(82%) were adults and 8 (18%) children. Calculi were obtained from the following anatomic sites: Kidney 9(20%), Ureter 2(4.4%), Bladder 22 (48.9%), and Urethra 12 (26.7%). The stones were all mixed stones with chemical composition of: calcium 38, oxalate 8, magnesium 44, ammonium 44, phosphate 44, carbonate 1.*
Conclusion: *Urinary stones were more prevalent among males and commonly found in the urinary bladder. The stones were mixed of which struvite (ammonium, magnesium, phosphate) was the most prevalent chemical found in the calculi which may suggest urinary tract infections as the causative factor.*
Keywords: *Struvite, urinary calculi, urolithiasis*

I. Introduction

Urolithiasis is stone formation in the urinary tract which could remain at their anatomic site of formation or migrate down the urinary tract causing symptoms along the way. The pathogenesis of urinary calculi formation goes as follows: saturation, super-saturation, nucleation, crystal growth, aggregation, crystal retention and lastly stone formation.[1]Although the main driving force behind calculi formation is the supersaturation of urine, other contributing factors include: age, sex, urinary tract infections, dehydration, genetic defects, metabolic disorders, poor dietary habit (high sucrose and animal protein), family history and increased secretion of stone forming components.[2]

Urolithiasis has a prevalence in economically developed countries ranging from 4% to 20%.[3] In the United States of America, the prevalence among African Americans is 1.7% compared to Caucasians (5.9%) and Mexican Americans (2.6%).[4] Therefore it is said to be relatively rare in blacks, even amongst Nigerians.[5] Despite these, African studies have shown that it is becoming an increasing common disorder in this environment.[6, 7] Osegbe DN reported seeing 105 cases in 7years (1980-1986), starting with 7 in 1980 and gradually increasing to 33 in 1986.[6]Msheliaet al also documented 21cases in 1999, then 49cases in 2003.[7]

The presence of urinary calculi usually presents with loin or back pain,haematuria, and sometimes acute urinary retention, therefore such stones can be removed surgically to relieve symptoms, or expelled from the body spontaneously in urine. The calculi obtained are then sent to the laboratory for analyses, where the preferred analytical methodsare infrared spectroscopy and xray diffraction, but polarization microscopy may also be used.[8]Unfortunately, these techniques are not readily available in this environment. Imaging techniques like abdominal ultrasound can be used in children and women;[9]while plain abdominal xray (kidney-ureter-bladder radiography), intravenous urography, and computerized tomography can be used in adults. But these methods will only detect the presence and location of the stone and not reveal the chemical constituents of the stones, except that the opacity or lucency of the calculi image could be an indication of the presence or absence of calcium.

Knowledge of the chemical composition of stones gives an indication of the causative factor which would aid further evaluation anddirect appropriate treatment in order to prevent recurrence. Stone type and disease severity determine low or high recurrence,[10] therefore chemical analyses are encouraged. The low cost and ease of analysis using chemical reagents still warrants it use in a resource-poor setting like ours. We therefore aimed to determine the chemical composition of urinary calculi in our patients.

II. Methods

This was a retrospective study of the chemical composition of urinary calculi submitted to the Chemical Pathology laboratory over a four year period (2013-2016) at the University of Nigeria Teaching Hospital, Enugu, which is a tertiary hospital with a bed-capacity of over 500, located in southeast Nigeria.Urinary calculi from first time stone formers, obtained via surgery and/or spontaneous emission were included in the study, while gall bladder stones were excluded.Ethical approval was obtained from the hospital's Health Research and Ethics committee.On receipt in the laboratory, the calculi was washed with water and dried on filter paper. Physical examination of the calculi was performed to note the number of stones and appearance. The size was measured with a metre rule to get the length and width in millimeters (mm), then the weight was measured on a digital weighing scale calibrated prior with a 5g standard weight and recorded in grams (g). Afterwards, aportionwas crushed for analyses.

Flame analysis

A small portion of the crushed calculi was heated in a platinum dish until it glowed. If the sample was not appreciably changed by ashing, the calculi composed of inorganic salts. But if it charred and burnt almost completely, the calculi weredesignated as primarily organic indicating the presence of uric acid, xanthine andcysteine.[11]

Chemical analysis

Portions of the crushed calculi were placed into test tubes for the following analyses:

Carbonate- 3mls of 5% hydrochloric acid was added to a small portion of crushed stone in a test tube and heated. If effervescence occurred, carbonate was present.[11]

Calcium- After the carbonate analysis, the solution was adjusted to pH 5 with ammonium hydroxide and acetic acid, then 1ml of ammonium oxalate was added. If a white precipitate formed, it showed the presence of calcium.[12]

Oxalate- a small portion of crushed calculi was placed in a platinum dish and heated for 3mins. It was then cooled and the residue was placed in a test tube, to which 2ml of 5% hydrochloric acid was added. If effervescence occurred, and there was no effervescence in the carbonate procedure, then oxalate was considered present.[11]

Ammonia- To a small portion of crushed stone in a test tube, a few drops of water was added. Then 3-4 drops of 10% potassium hydroxide were added to the bottom of the tube. Thereafter, a piece of moistened pink-red litmus paper was held over the mouth of the test tube while shaking gently. If the pink litmus paper changed to blue, ammonia was considered present.[11]

Magnesium- A small portion of crushed calculi was heated with 4ml of 5% hydrochloric acid for 3mins. Then it was cooled and the solution was placed in a test tube to which titan yellow and sodium hydroxide were added. If an orange-red colour appeared, magnesium was considered present.

Phosphate- 1ml of concentrated nitric acid was used to dissolve some crushed calculi. Then an equal volume of ammonium molybdate was added. The solution was heated to boiling, and if a yellow precipitate was formed, phosphate was considered present.[12]

Data analysis

Data was entered into Microsoft Excel 2010 spreadsheet and analyzed with SPSS version 20 (Chicago IL, USA) statistical package. Descriptive statistics were computed with standard methods and presented as mean ± standard deviation (SD), median (interquartile range), range, counts (percentages), and frequency tables.

III. Results

Forty-five stones were obtained from 37 (82%) males and 8 (18%) females (male:female ratio = 4.6:1) of which 37 (82%) were adults and 8 (18%) were children less than 18years. All the children were male.
The mean±sdage among adults was: males 47±12.9yrs and females 39±8.8yrs, while the children were 4±2.4yrs. Calculi were obtained from the upper urinary tract (24.4%) and lower urinary tract (75.6%) with the following anatomic distribution: Kidney 9 (20%), Ureter 2 (4.4%), Bladder 22 (48.9%), and Urethra 12 (26.7%)(Table 1).

Table 1 Anatomical distribution of urinary calculi

Anatomic site	Children (<18years)	Adults (>18years)		Total Number (%)
	All Male	Male	Female	
Kidney	1	8	0	9 (20%)
Ureter	0	2	0	2 (4.4%)
Bladder	5	12	5	22 (48.9%)
Urethra	2	7	3	12 (26.7%)
			Total	**45 (100%)**

Majority (91.1%) of the stones received were single as only 4 patients (8.9%) had multiple stones. The weight of the calculi were median (interquartile range) of 1.8 (0.56-4.0)g and 5.7(0.2-27.1)g in males and females respectively. The sizes of the calculi ranged from 6 – 36mm by 4 –47mm in males and 10 – 46mm by 10 – 45mm in females.

The stones were all mixed stones with chemical composition of: calcium 38, oxalate 8, magnesium 44, ammonium 44, phosphate 44, carbonate 1 (Table 2).

Table 2 Chemical composition of urinary calculi

Chemical composition	Number
Calcium	38
Oxalate	8
Magnesium	44
Ammonium	44
Phosphate	44
Carbonate	1

IV. Discussion

We observed 45 cases of urinary calculi over 4years which was similar to a study conducted in Southeast Nigeria that described 50 patients in 5years,[13] but more than the 45 seen by Esho over 11years in Southwest Nigeria.[14]These differed from a study conducted in northern Nigerian which documented a much higher incidence of 140 urolithiasis patients over a 4 year period; [15] as well as Mungadiet al who reported 121 cases in 8 years.[16] This may be due to the warmer weather in the north compared to southern Nigeria,[17]and religious Islamic fasting practices,[18]resulting in dehydration and urine concentration, sincesupersaturation of urine has been proposed as the main pathogenesis of calculi formation.[1]

Urolithiasis cuts across age groups, with as much as 14.8% cases reported in children.[19]Our study observed 17.8% in children less than 18years with a mean age of 4years. Paediatric patients have been described as high risk stone formers because of the increased propensity of recurrence due to the aetiology of the stone formation which is usually structural and/or metabolic.[20]

The prevalence of calculi usually peaks between the third and fifth decade of life.[21]Among all our adult (greater than 18years) patients, the mean age was 45.6years, similar to the mean age of 40.75years reported by Orakwe.[22]Monu described a greater occurrence of stones between the 3rd and 6th decades, with the highest occurrence of stones being in the 4th decade (ages 30-39).[13] Also a study in Thailand reported the peak age of incidence as 41-50years.[23]

Urinary stone formation is more common in males than females. The male: female ratio reported varies from 2.7:1,[19] to 5:1, [24] to 12:1.[7]This may be because males have a longer and narrower urethra than females, as well as higher urinary saturation of calculi forming salts.[21, 25]

The anatomic sites where calculi have been obtained varies between upper urinary tract (UUT)- kidneys, ureters and lower urinary tract (LUT)- bladder, prostate, urethra. Although a study documented that UUT stones are relatively uncommon in Nigeria,[18]Ekwere reported 79% from UUT and 21% from LUT.[19] This differed fromEmokpae et al who reported 44.3% from UUT and 55.7% from LUT.[15]The latter supports our findings of majority calculi in the LUT (75.6%) as opposed to the UUT (24.4%). This was because the urinary bladder was the most frequent anatomic site observed in this study similar to others. [14, 15, 24]

Calculi may be solitary or multiple, of which the latter may be found at the same site or at various sites. Four of our patients had multiple stones at the same anatomic site. This was similar to the report byMonu of 5 patients with multiple stones at one anatomic site.[13]They also observed 6 patients with stones in multiple sites involving both kidneys, kidney and ureter or bladder and urethra.[13] Mbonuet al also reported 5 patients had stones in multiple sites.[24]

Chemical analysis is important in determining the stone type, which is a deciding factor for further testing such as urine analysis as well as management of urolithiasis.[26]Our study showed majority of the stones were composed of struvite(magnesium ammonium phosphate) and calcium phosphate, but few calcium oxalate and calcium carbonate. This differed from the study by Mshelia et al which reported that struvite constitutes only 4.3% while calcium was 76.9%.[7]Similarly, Emokpaeet al reported majority of their stones had calcium phosphate, followed by calcium oxalate.[15]Struvite and calcium phosphate are precipitated from alkaline urine which is a result of the infection by urease-splitting bacteria such as Proteus spp which breaks down urea to release ammonia that makes the urine alkaline. While calcium oxalate and uric acid stones are formed when the urine is acidic. Therefore, the chemical composition of calculi can aid identifying the cause of the stone formation, which will guide the management.

Stone formation can be due to several factors. Ekwereshowed calculi secondary to obstructive uropathy (29%), urinary tract infections (30%), prolonged catheterization (9%), hyperuricaemia (6%), foreign body in the bladder (3.8%), hyperparathyroidism (2.5%), and idiopathic (32%);[19]while Mbonuet al reported 80% were secondary to obstruction, infection and immobilization and only 15% were idiopathic.[24]In children, urinary calculi are usually associated with urinary tract anomalies and infection rather than with metabolic disturbance.[27]

Limitations

We did not report the probable contributing factors in our patients because the information was not stated on the laboratory request form submitted to the laboratory. This would have been overcome if the study design was prospective like that by Ekwere,[19] thereby all relevant information can be obtained during stone collection.Other studies reported the presence of uric acid, xanthine and cystine,[7, 15] which we did not test for.This was because the required methodology was not readily available to us since xanthine, fibrin or urostealith require infrared absorption spectroscopy.[28, 29] Also our stones were majorly inorganic in composition. Quantitative analyses to determine the percentage composition of calcium oxalate, magnesium ammonium phosphate and hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$) have been described,[11]however they were not performed because there is no single procedure that will achieve accurate quantitation of the composite constituents. Assumptions would have to be made for the chemical state of the constituents. For example, it is assumed that calcium oxalate is in the monohydrate form,but some stones contain appreciable quantities of the dihydrate component which will result in underestimation of the amount of calcium oxalate present.

V. Conclusion

In this study, urinary stones were more prevalent among males and commonly found in the urinary bladder. The stones were heterogenous of which struvite (ammonium, magnesium, phosphate) was the most prevalent chemical found in the calculi which may suggest urinary tract infections as the causative factor. This will lead to appropriate urine culture and antibiotic therapy. Further prospective studies can be done to identify more chemical constituents in urinary stones and quantify them, as well as determine their peculiar contributing factors.

Acknowledgements:

We acknowledge ChidiDuru for analyzing the urinary stones.

References

[1]. Balaji KC, Menon M. Mechanism of stone formation. UrolClin North Am. 1997;24(1):1-11.
[2]. Walsh PC, Retik AB, Wein A, Vaughan ED, Saunders WB (eds). Campbell's Urology. 7th ed. Philadelphia, WB Saunders Company.
[3]. Trinchieri A. Epidemiology of urolithiasis. Arch ItalUrolAndrol. 1996;68:203-250.
[4]. Stamatelau KK, Francis ME, Jones CA, Nyberg LM, Curhan GC. Time trends in reported prevalence of kidney stones in the United States: 1976-1994. Kidney Int. 2003; 63:1817-23.
[5]. Esho JO. The rarity of urinary calculus in Nigeria. Trop Geogr Med. 1978;30(4): 477-81.
[6]. Osegbe DN. The rise in urolithiasis in Nigeria. BMJ 1987;295:19-26.
[7]. Mshelia DS, Gali BM, Naaya UH, Habu SA. Chemical composition of urinary calculi in Maiduguri Nigeria. Afr J Med Med Sci. 2005;34(2): 185-8.
[8]. Abdel-Halim RE, Abdel-Halim MR. A review of urinary stone analysis techniques. Saudi Med J. 2006; 27(10):1462-7.
[9]. Palmer JS, Donaher ER, O'Riordan MA, Dell KM. Diagnosis of pediatric urolithiasis: role of ultrasound and computerized tomography. J Urol. 2005;174(4):1413-6.
[10]. Keoghane S, Walmsley B, Hodgson D. The natural history of untreated renal tract calculi. BJU Int. 2010;105(12):1627-9.
[11]. Hodgkinson A. A combined qualitative and quantitative procedure for the chemical analysis of urinary calculi. J Clin Path. 1971;24:147-51.
[12]. Sawsan MA, AimanHK, MooaidSH. Chemical analysis of urinary calculi using local kit. Jour Babylon Uni. 2014;22(5):1-3
[13]. Monu JU. Pattern of urolithiasis in Benin city Nigeria. J Natl Med Assoc. 1989;81:695-8.
[14]. Esho JO. Experience with urinary calculus disease in Nigerians as seen in Lagos University Teaching Hospital. Niger Med J. 1976;6:18-22.
[15]. Emokpae MA, Gadzama AA. Anatomical distribution and biochemical composition of urolithiasis in Kano, northern Nigeria. Int J BiolChem Sci. 2012;6(3): 1158-66.
[16]. Mungadi IA, Ntia IO, Opara WE, Sani AA. Urolithiasis in Sokoto, north-western Nigeria. Sahel Med Jou. 2006; 9(1):10-4.
[17]. Khan AS, Rai ME, Gandapur, Pervaiz A, Shab AH, Hussain AA, et al. Epidemiological risk factors and composition of urinary stones in Riyadh Saudi Arabia. J Ayub Med Coll Abbottabad. 2004;16(3):56-8.
[18]. Olapade-Olaopa EO, Agunloye A, Ogunlana DI, Owoaje ET, Marinho T. Chronic dehydration and symptomatic upper urinary tract stones in young adults in Ibadan, Nigeria. West Afr J Med. 2004;23(2):146-50.
[19]. Ekwere PD. Urinary calculus disease in south-eastern Nigeria. Afr J Med Sci. 1995; 24(3):259-95.
[20]. Türk C, Knoll T, Petrik A, Sarica K, Skolarikos A, Straub M, et al. Guidelines on urolithiasis. 2015. European Association of Urology urolithiasis guidelines panel. http://www.uroweb.org/guidelines/online-guidelines/. Accessed on 21st November 2016.
[21]. Frank M, De Vries A. Prevention of urolithiasis. Education to adequate fluid intake in a new town situated in Judean Desert Mountains. Arch Environ Health. 1966;13(5):625-30.
[22]. Orakwe JC. Urinary excretion of calcium by urinary stone disease patients and normal subjects in southwest Nigeria and Scotland. Nig J Surg Res. 2000;2(1): 1-5.
[23]. Tanthanuch M, Apiwatgarron A, Pripatnanont C. urinary tract calculi in southern Thailand. Jour Med AssocThia. 2005; 88(1):80-5.

[24]. Mbonu O, Attah C, Ikeakor I. Urolithiasis in an African population. IntUrolNephrol. 1984; 16:291-6.
[25]. Welshman SG, McGeown MG. The relationship of urinary cations, calcium, magnesium, sodium, and potassium in patients with renal calculi. Br J Urol. 1975; 47(3): 237-42.
[26]. Semins MJ, Matlaga BR. Medical evaluation and management of urolithiasis. TherAdv Urol. 2010; 2(1):3-9.
[27]. Trinchieri A. Epidemiology of urolithiasis: an update. Clin Cases Miner Bone Metab. 2008; 5(2):101-6.
[28]. Klein B, Seligson HT. Identification of urinary tract calculi by infrared spectroscopy. Standard Methods Clin Chem. 1963; 4:23-9.
[29]. Tsay YC. Application f infrared spectroscopy to analysis of urinary calculi. J Urol. 1961; 86:838-54.