Metabolic Stone Composition

Mohammed Alwan[a], Abdulelah Ghilan[a], Nabil Alhaj[a].
[,a]Urology Department, Urology and Nephrology Center. A1-Thawra Modem General Teaching Hospital.
Corresponding author: Mohammed Alwan

Abstract

Objectives: To identify the types of stones composition and to detect the regions with high incidence of stones formation.

Methodology: During the period August 2007 – August 2009, a total of 382 patients admitted to Urology department at Al-Thawra General Teaching Hospital, Sana's, Yemen. All of them were diagnosed to have stones in different parts of the urinary tract. The treatment was carried on by surgical intervention, endoscopy, or shock wave lithotripsy (ESWL). The structural analysis of the stones was done by gross (macroscopic), microscopic, and chemical analysis.

Results: Three hundred eighty two patients with diagnosis of urinary stones disease were included in the study, the male to female ratio was 2.03:1, the young to adult ratio was 1.0: 2.8 and the mean age was 28.5 years. The findings in this investigation showed that pure calcium oxalate (32.5%) was the main stone component followed by mixed calcium oxalate and calcium phosphate (29.8%), calcium oxalate and uric acid (15.2%) and Calcium phosphate (11.5%). The three highest percentages of urolithiasis were found to be in Alamanah, Amran and Thamar respectively, while the lowest percentages were in Abian and Almahrah.

Conclusion: Stones composition in Yemeni patients admitted to Al-Thawra General Teaching Hospital was mainly formed of calcium oxalate, mixed calcium oxalate and calcium phosphate, calcium oxalate and uric acid, and lastly calcium phosphate. Te highest percentage were found in mountainous regions (Alamanah, Amran, and Thamar), while the lowest percentage were found in the coastal regions (Abian and Almahrah).

KEYWORDS: Stone composition, urolithiasis , yemen.

Introduction:

Urolithiasis is an entity, which has high morbidity and socioeconomical impact, and low mortality. Urolithiasis world frequency is estimated between 1 to 5 % in developed countries and 0.5-1% in developing countries. The overall probability of forming stones varies in various parts of the world: 1-5 % in Asia, 5-9% in Europe, 13% in North America, 20% in Saudi Arabia (Kim et al. 2002 and Lee et a!. 2002).

Stones in the upper urinary tract appear to relate to the life in the developed countries, while bladder stones are commonly observed in the third world, on account of very poor socio-economic condition. As nutrition improves in western countries, the formation of bladder stone gave way to upper urinary tract stones consisting calcium oxalate often mixed with calcium phosphate or uric acid (Ramello et al. 2000).

Geography influences the incidence and types of urinary calculi that occur within given area. The stone which, in turn, reflects the type of diet consumed. In the pediatric population, nutrition and metabolic causes of tubular reabsorption can contribute to stone formation. In developing countries, nutritional factors can be a major factor in the formation of stones in poor children. This is caused by a nutritionally poor acidogenic diet, high in cereal and low in animal protion, calcium and phosphate, which lead to the formation of urine with a relatively high content of ammonium and urate ions, and consequently to the formation of ammonium acid urate crystals and stones. In countries where there is also a high intake of oxalate from leaves and vegetables, urinary oxalate is increased and, as a result, the ammonium acid urate stone often contain calcium oxalate as well.

The stone problem is compounded by low urine volumes resulting in some areas from poor drinking water, and chronic diarrhea, and in

problem in the tropics, mountains and deserts is compounded by low urine volumes which has resulted in some areas from poor drinking water, diarrhea, and in other from hot climate and fluid losses through the skin.

In human, the peak incidence of urinary calculi is reported between the ages of twenties to forties (Fetter and Zimskined 1961).

However, most of the urinary stone diseases are diagnosed in the fifth decade (Kim et a!. 2002).

A slightly rate of renal stone disease is reported in males than females, about three males are afflicted for every female (Romelle et al. 2000).

In children, urolithiasis remains a significant problem with serious consequences. The types of stone formed depend mainly on the urine composition,

2. Statistically study stones in Yemeni, which represented in AlThawra Hospital.
3. To know main urolithiasis components among Yemeni population.
4. To know ration of urolithiasis between male and female, adult to young and the urban to the rural patients.
5. To know the ratio of upper to lower and right to left side urinary tract lithiasis.
6. To study the recurrence status of urolithiasis.

Material and Methods:

This prospective study was conducted during the period August 2007 to August 2009. All patients presented to Urology out patients clinic in Al-Thawra Teaching Hospital. After examined and investigated 382 patients were admitted in Urology Department with diagnosis of stones in different locations of the urinary system. The patient's ages ranged between 1-88 years, so the mean age was 28.5 years as shown in table 1.

Table 1: Patient's data:

Type of **Population**	No. of ***Cases***	**Percent**
Number of Patients	382	100%
Age:		
Young	102	26.7%
Adult	280	73.3%
Sex:		
Male	*256*	67

others from the hot climate and fluid losses through the skin. Calcium oxalate and uric acid stones are more frequent in males than females whereas calcium phosphate and struvile stones are more prevalent in females. Urolithiasis in the pediatric age group, although occurring less often than in adults, causes considerable morbidity.

Urolithiasis is a very frequent finding in Yemen, but no statistical study of stone was done. Furthermore, stone analysis is not performed in our country. In world, however, give important evidence for geography (mountains, desert, and tropical areas), metabolic basis, etc.

Therefore, this research is designed to study the following objectives:

1. The detect regions with high incidence of stone formation in Yemeni patients who admitted to Urology Department in Al-Thawra Modern General Hospital.

Each patient was subjected to full clinical history, complete examination, and laboratory investigations (urine analysis, complete blood count, blood urea and serum creatinine, urine culture and sensitivity whenever the urine is infected). Abdominal and pelvic uritrasonography were performed in uremic patients, patients presenting with acute retention of urine, and those complaining of abdominal pain or hematuri. IVU was used for patients who had stones in the upper urinary tract, evidence of hydronephrosis or hydroueter by ultrasound, and hematuria either gross or microscopic in the urinalysis.

Stone analysis includes:

1. Gross (macroscopic) analysis

Include: shape, color, weight, dimension, number

2. Microscopic examination

a. Microscopic examination of the stone surface:

Stone inspected thoroughly from all sides in reflected light under 20-50 times magnification while elevating the lamp above the level of the stage.

b. Microscopic examination of the main plane of stone (post microsection)

Main plane of stone is the cross section of the stone, it show the history of the calculus in the period between the development of the core and the surface.

c. Chemical analysis with specific eagents.

Management was determined depending on the site and the size of the stone as well as age of the

Female	126	33

and finally conservative treatment, sequentially as shown in table 3

Table 3: The main type of operation used:

Open surgery	266	69.64%
Endourology	104	27.23%
ESWL	10	2.62%
Conservative treatment	2	*0.52%*
Total	382	100%

Results:

Three hundred eighty two patients with diagnosis of urinary stones disease were included in the study as shown in table 4, the male: female ratio was 2.03:1, the young to adult ratio was 1.0: 2.8 and the mean age was 28.5 years.

patients and in renal stones also depends on intrarenal anatomy, stone distribution and presence of associated abnormality.

The main type of operation used for this research was open surgery followed by endoscopy, ESWL,

From the 382 examined patients in the study it was found that the three highest percentages of urolithiasis belonged to Alamanah, Ainaran and Thamar in sequence while the lowest percentages was recorded in Abian and Almaharah.

Table 4: Patients under study of Urolithiasis according to some geographical areas in Yemen.

No.	Geographical	Patients	%
1.	Mamanah	52	13.6
2.	Amran	48	12.6
3.	Thamar	46	12.0
4.	Sana’a	36	9.4
5.	Taiz	36	9.4
6.	Ibb	32	8.4
7.	Hadhramout	22	5.8
8.	Albidha’a	28	4.7
9.	Almahwect	18	4.7
10.	Mhodrah	14	3.7
11.	Raim’ah	12	3.1
12.	Lahj	10	2.6
13.	Haja’a	10	2.6
14.	Shabowh	8	2.1
15.	Aldhal’a	6	1.6
16.	Aljawf	6	1.6

17.	Ma'areb	4	1.0
18.	Aden	2	0.5
19.	Sa'adah	2	0.5
20.	Abian	0	0
21.	Almahrah	0	0
	Total	**382**	**100%**

From the 382 studied cases, about (44%) were found in the urban area and (50%) in the rural. The male was found to constitute (73.81%) in the urban and (60.75%) in the rural areas while the female was (26.19%) and (38.25%), respectively.

There were 342 upper urinary tract stones (kidney, ureter) and 40 lower urinary tract stone (bladder, urethra) in 32 patients. The ratio of upper to lower urinary tract stones was 8.6:1.

This investigation revealed that right upper urinary stone (43.0%) was more than that of the left (34.2%), therefore the ration was 1.3:1.

Many improved methods of dealing with stones have been developed in the past, but none has had as much impact as the development of endourology and extracorporeal shock wave lithotripsy (ESWL) in the last three decades. These two innovations have eliminated the need for open surgical removal of urinary calculi in the vast majority of patients.

The main type of operations used for this research was open surgery followed by endoscopy, ESWL and finally conservative treatment, sequentially as shown in table 5.

Table 5: Procedures used in the treatment:

Type of Procedure	**No. of cases**	**Percent**
Open surgery	266	69.64
Endourology	104	27.23
ESWL	10	2.62
Conservative treatment	2	0.52
Total	382	100

The findings in this investigation showed that pure calcium oxalate (32.5%) was the main lithiasic component followed by mixed calcium oxalate and calcium phosphate (29.8%), calcium oxalate and uric acid (15.2%) and Calcium phosphate (11.5%). Along with the remaining data were summarized in table 6.

Table 6: Urinary stone analysis.

Component	No.of cases	%
Calcium oxalate	124	32.5
Calcium oxalate + Calcium phosphate	114	29.8
Calcium oxalate + uric acid	58	15.2
Calcium phosphate	44	11.5
Calcium oxalate + calcium phosphate + uric acid	16	4.2
Struvite	4	1.1
Cystine	4	1.1
Uric acid! urates	4	1.1
Calcium oxalate + calcium phosphate + other stones (urates)	2	0 5 .
Calcium oxalate ± other stones (ammonium)	2	0.5
Calcium oxalate + struvite	2	0.5
Calcium phosphate + uric acid + other stone (ammoniuin + urate)	2	0 5 •
Calcium oxalate + Calcium phosphate + other stone (arnmonimn)	2	0 5 •
Calcium oxalate + uric acid + other stones (ammonium)	2	0 5 .
Calcium oxalate + calcium phosphate + uric acid + cystone	2	0 5 .
Total	**382**	**100**

The recurrence of urolithiasis was observed in (44) patients (about 11.52%) out of the 382 patients under the present investigation.

Recurrence was the highest in right kidney (50%) followed left kidney (40%). However, the recurrent of stones in left ureter and bladder were (4.6%) for each location whiles it was the least in the right ureter. The recurrence in male was much higher in female, i.e. (77.3%) vs. (22.7%).

The most recurrent stones were pure calcium oxalate (31.82%), mixed calcium oxalate and calcium phosphate (31.82%, calcium phosphate (18.18), and mixed calcium oxalate and uric acid (18.18%).

Discussion:

The understanding of the pathiophysiology of stone disease remains limited and stone recurrence continues to be a significant clinical problem. Several extrinsic factors, e.g. geography, climate, water, intake, diet and occupation, are considered risk factors for stone formation and recurrence. Other factors with undefined roles in stone formation are heredity, age and sex.

In our investigation, the ratio of male to female was 2.03:1, which was in total agreements with those reports recorded by (Lin et al, 1992, Kamel et al, 1997, Kim et al. 2002, Lee et al. 2002, Hossain et al. 2003, Robertson 2003 and Afaj and Sultan 2005).

A slightly higher rate of urinary stone disease is reported in males than females; about three males are afflicted for every female, (Romello et a!. 2000).

Obtained results in this investigation may be attributed to chronic dehydration which is likely to be (e.g., sugared cola). Shuster et al. (1985) found a positive association between urinary stone disease and consumption of such beverages.

Collected result in our study showed that about

the most important risk factor for the increased risk of urolithiasis in outdoor workers in the tropics, and should be easily prevented by increased water intake. Yemeni males are outdoor more than females due to the type of occupations.

Geography influences occur with in a given area. The subtropical and tropical temperature and gradually higher socioeconomic standards of living may contribute to the high prevalence of urolithiasis.

The prevalence of urinary calculi is higher in those who live in mountainous, desert, or tropical areas. Urolithiasis is a problem, which is generally increasing in the tropics as it is in most Western countries, (Leonardo and Reyes, 2003).

The three highest percentages or urolithiasis were found to be in Alamanah, Amran and Thamar in sequence while the lowest percentages were in Arabia and Almahrah. This result maybe due to that provinces with high incidence are near to Alamanah where our Urology and Nephrology center are located. In respect of Alamanah, it is the most populated area in our country; therefore, it had the first rank.

Another possible reason for this result could be the "softness" of drinking water. Under these conditions the urine of the average person will contain a low concentration of Mg insufficient to inhibit the formation of calcium oxalate (Kerr and Laing 1993; Leonardo and Reyes 2003). The relation between the composition of drinking water and urolithiasis was examined by other authors such as Churchill et al. (1978) who indicated that hardness of water. The incidence of urolithiasis tends to be higher in areas that have softer drinking water.

Another possible reason for the incidence of stone formation is
consumption of carbonated beverages

They added that between behaviors of urolithiasis in rural population was the same as that reported in other studies for urban areas. Therefore, their conclusion is in accordance with what was obtained in this investigation.

In this research, it was found that out of 382 stones, there were 342 upper urinary tract stones (kidney, ureter) and 40 lower urinary tract stone (bladder, urethra) in 382 patients. Therefore, the ration of upper to lower urinary tract stone was
8.6:1.

Stone in the upper urinary tract appear to relate to the (44%) of the patients belongs to urban and (56%) to rural areas. The male was found to form (73.81%) of the urban and (60.75%) of the rural area patients, while the female was (26.19%) and (39.25%), respectively.

The results in the present study were in agreement with those recorded by Pin et al. (1992) and Robertson (2003).

Obtained results relating to rural areas may be attributed to low urine volumes resulting in some areas from poor drinking water, which causes chronic diarrhea, and in others from the hot climate and fluid losses chronic through
the skin.

Additional possible reason for the
higher occurrence of stone formation in the rural areas may be attributed to the lack of Oxalobacter formigenes due to inflammatory bowel disease (Alliston et a!. 1986). However, Leonardo and Reyes (2003) reported higher urolithiasis patients in urban areas than that in rural areas.

In our study, obtained results relating to gender may be attributed to chronic dehydration which is likely to be the most important risk factor fro the increased risk of urolithiasis in outdoor workers in the tropics, and should be easily prevented by increased water intake. These results also suggest that there is a relation between exposure to high temperature and stone formation (Reyes et al. 2001; Kodama and Ohno 1989). Additionally, this result may be related to the strong correlation between urinary stone formation and both temperature and atmospheric pressure (M-Hadramy 1997). Moreover, Reyes et a!. (2002) attributed the incidence of stone formation to the hot period, intake of food rich in acid, carbohydrates, proteinspurines. and dairy products and low intake of fluids.

wave lithotripsy have eliminated the need for open surgical removal of urinary calculi in the vast majority of patients. Open surgery method was used due to late introducing of endourology in to our country.

In the present study, it was observed that calcium containing stone was the most frequent type (96.7%), followed by infection stone (1.1%), then uric acid (1.1%). Lin et al. (1992) reported the same finding in Taiwan (92.3%),
(4.7%) and (3.1%), respectively.

Additionally, Ansari et aL (2005) documented that

life-style, being more ftequent among affluent people, living in developed countries, with high animal protein consumption. However, bladder stones are nowadays mainly seen in the Third World, on account of very poor socio-economic conditions (Romello et al. 2000). The later has been decreasing in most countries with gradual improvements in levels of nutrition's, especially in proteins. However, as living standards increase, particularly in the urban areas of the more affluent developing countries, so the incidence of upper urinary tract stones in adults is increasing (Leonardo and Reyes, 2003; Robertson 2003).

This study conformed that right upper urinary stone formation was higher than that of the left, thus the ratio was calculated to be L3: 1 This result not in agreement with that of Odajima et a!. (1987) who documented to be 1: 1.3 in some Japanese patients.

In this study, the most common method of operation used was open surgery followed by endourology and Extracorporeal Shock Wave Lithotripsy (ESWL) post PCNL (sandwich procedure) which were in accordance with the results obtained by Leonardo and Reyes (2003) in respect of both surgery and endourology, respectively. Nevertheless, Stuart (2006) stated that
endourology and extracorporcal shock

calcium phosphate + magnesium ammonium phosphate) formed about
(2.7%).

High protein of animal origin increases acid, calcium, phosphate, oxalate, and uric acid excretion and decreases the citrate excretion. Individuals on a high-protein diet excrete more urinary calcium, cyclic adenosine monophosphate, and hydroxyproline. The increased fixed acid load, provided by a high-protein diet may cause mild resorption of bone and reduced renal tubular reabsorption of calcium, therefore, causing stone formation (Homes et al 1993; Fellstrom et al. 1984). On the other hand, ingestion of deficient amounts of calcium and potassium has also been noticed increase the occurrences of urolithiasis (Curhan 1983).

In our study, the result of recurrent urolithiasis is (11.52%) which was in agreement with that recorded by Bennani et al. (2000) i.e. (10%). However, Drach struvite (1.42%), apatite (1.7%) and uric acid stones (0.95%). The incidence of this type of stones varies considerably on account of environment factors, especially dietary intake and
lifestyle.

This investigation revealed several urolithiasis;
components forming
however, the highest was pure calcium oxalate (32.5%). This result was in accordance with other reports where this component range first among stone components. Hodgkinson (1979), Trinchieri (1996), Kamel Ct at. (1997), Bennani et al. (2000), Hossain et al. (2003) and Ansari et al. (2005) documented that calcium oxalate was the commonest constituents, however, they reported the following percentages (72.1%), (58.75%), (58.4%), (93.04%), respectively.

The second constituent forming the stone in this study was mixed calcium oxalate with calcium phosphate (29.8%). However, Sutor et al. (1974) reported that stones composed primarily of a mixture of calcium oxalate and calcium phosphate. These differences may be related to differences in the geographical locations.

Mixed calcium oxalate with uric acid held the third position in urolithiasis in our investigation i.e. (15%) followed by calciUm phosphate (11.5%). Ansari et a! (2005) noted that mixed stones (COM + COD and calcium oxalate + uric acid + calcium oxalate + calcium phosphate, and

- Urolithiasis in adult is more than young.
- Upper urinary tract stones are more than that of lower urinary tract.
- Right upper urinary stones are more than the left side.
- Most of the urolithiasis patients are rural.
- Pure calcium oxalate is the main lithiasic component and it is the most recurrence.
- Recurrence of urolithiasis is about 11.52%, mostly in right kidney.
- The recurrence in male is much higher
than in female.

REFERRENCES

1. Afaj All Sultan MA (2005). Mineralogical composition of the urinary stones from different provinces in Iraq. Scientific World Journal 5:24-38.
2. Al-Hadramy MS. (1997). Seasonal variations of urinary stone colic in Arabia. J Pak Med Assoc. 47 (11):281-4.

(1998) recorded higher percentage.

Recurrence in this investigation was (5 0%) in right kidney, (40%) in left kidney and (10%) in both left and right ureter and bladder. The recurrence in lae and female were (77.3%) and (22.7%), respectively. The result may be attributed to the higher incidence of urolithiasis in males than females.

The components of recurrent stones were pure calcium oxalate (31.82%), mixed calcium oxalate and calcium phosphate (18.18%), and mixed calcium oxalate and uric acids (18.18%). The same trend of these components were found in the patients under this investigation, therefore, the higher incidence of recurrence of the same components is expected.

From this study we included that:

• Urolithiasis in male is more than in female

3. Ansari MS. Gupta NP, Hemal AK, Dogra PN, Seth A, Aron M, Singh TP. (2005) Spectrum of stone composition: structural analysis of 1050 upper urinary tract calculi from northern India. mt J Ural. 12(1):12-6.

4. Churhill D, Bryant D, Fodor G (1978). Drinking water hardness and urolithiasis. Ann Intern Med. 88:5 13.

5. Hodgkinson A. (1976). Uric acid disorders in patients with calcium stones. Br J Urol. 48:1-5.

6. Hodgkinson A. (1979). Composition of urinary tract calculi from some developing countries. Urology mt. 34(1):26-35.

7. Hossain RZ, Ogawa Y, Hokama S, Morozumi M, Hatano T. (2003). Urolithiasis in Okinawa, Japan: a relatively, high prevalence of uric acid stones. Tnt J Urol. 10(8):411-5.

8. Kamel El-Reshaid, Hafeez Mughal aiid Madaii Kapoor. (1997). Epidemiological profile, mineral metabolic pattern and crystallographic analysis of urolithiasis in Kuwait Urolithiasis in Kuwait. European Journal of Epidemiology: 13 (2):229-234.

9. Romello A, Vitale C, Marangella M.(2000). Epidemiology of nephrolithiasis. J Nephrol, Nov-Dec; 13 Suppl 3:S45-50.

10. Stuart Wolf. (2006). Nephrolithiasis. JNEPHROL, 31 (suppl.3): S65-S70.

11. Sutor DJ, Wooley SE, Illingworth JJ. (1994). Some aspects of the adult urinary stone problem in Great Britain and Northern Ireland. Br J Urol; 46:275-288.