SHORT COMMUNICATION

Analysis of chemical composition of urinary calculi from Northern border area of Saudi Arabia

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Abstract

The present study aimed to investigate the chemical composition of urinary calculi in people living in the northern border area of Saudi Arabia and to formulate suggestions for prevention of renal stones.

Urinary stones were obtained from patients attending the Urology Departments of Prince Abdul Aziz Bin Musaad Hospital and Central Hospital, Arar, Saudi Arabia. Stones were analyzed using kit for semi-quantitative colorimetric determination of carbonate, calcium, magnesium, ammonium, oxalate, phosphate, uric acid and cysteine; manufactured by LTA s.r.l. Milano 15/F, 20060 Bussero (Milano), Italy. From a total of 55 urinary stones, 49 (89%) were retrieved from males, while 6 (11%) from females. Ages of patients ranged from 15 to 75 years with the mean of 50.22±14.46 and majority of patients were between 31-50 years (69.08%). Most of the patients were overweight (70.91 %) in both the genders. Calcium oxalate stones were 60%, uric acid 18.18% and calcium phosphate 10.90%, while other forms of stones were scarce. It is concluded that upper urinary tract stones were predominant, comprising mostly of calcium oxalate and urate, which could be prevented by control of obesity; moderate intake of meat, dairy products, fruit vegetables (with minimal oxalates); and plenty of fluids.

Keywords: Urinary Calculi, Chemical Analysis, North Border Area, Saudi Arabia.

Introduction

Urolithiasis, the process of stone formation in humans, is a common global health problem and occurs due to multiple factors, such as, less fluid intake, dietary habits, sedentary habits, metabolic cause, hyperparathyroidism, urinary tract infection and urinary outflow obstruction. Moreover, urolithiasis may be due to increased excretion of certain stone forming substances, as calcium, oxalate, phosphate, uric acid and sodium; and decreased excretion of certain stone inhibiting materials as citrate, magnesium, sulfate and pyrophosphates. In the last few decades trend of open surgery, which was being practiced since Hippocratic era, changed to minimal invasive alternatives.[1]

Analysis of chemical composition of urinary calculi can provide guidelines for the conservative management, as to avoiding the precipitating factor in diet, such as, red-meat for uric acid stones, tomatoes for oxalate stones and milk for calcium phosphate stones.[2] The kidney stone analysis can be done by, spectroscopy, X-ray diffraction, chemical analysis by semi-quantitative titrimetric and calorimeter method, mass spectrometry and laser-induced breakdown spectroscopy, employed according to feasibility or resources.[2,3]

Recently, a study conducted in the Eastern Province of Saudi Arabia reported that the prevalence of calcium oxalate stones was 74.2%, uric acid stones 12.8% and mixed calcium oxalate/ phosphate/ uric acid stones 10.4%.[4] The present study was aimed to analyze the chemical composition of urinary calculi in the Northern Border Region of Saudi Arabia and to propose recommendations for their prevention.

Methods and Results

This was a prospective study, conducted at the Urology Departments of Prince Abdul Aziz Bin Musaad Hospital and Central Hospital, Arar, Saudi Arabia from September 2016 to April 2017.

All patients having urinary stones from kidney down to urethra were included in the study. Stones were obtained by open operative measures, or via minimally invasive techniques or passing out spontaneously. While patients coming from areas other than northern region, patients with known cases of primary and secondary hyper parathyroidism, patients with malignancies of any kind and patients with haemolytic disorders were excluded.

The demographic data including profession, lifestyle, dietary habits, daily water intake and urine output; relevant history of the disease, co-morbidities, family history of renal stones, physical examination, investigations; surgical intervention, site of stone retrieved and any complications observed were recorded is a structured questionnaire.

The stones were analyzed using a kit for semi-quantitative

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Table-1: Chemical constituents of the urinary stones.

Type of stone	No. patients passing stones	Percentage
Calcium oxalate	33	60
Uric acid	10	18.18
Calcium phosphate	6	10.90
Calcium magnesium phosphate	3	5.45
Magnesium phosphate	1	1.81
Calcium carbonate	1	1.81
Magnesium ammonium phosphate	1	1.81

Table-2: Distribution of calculi according to location.

Site of stone	No. of patients passing Stones	Percentage
Right kidney	16	29.09
Left Kidney	10	18.18
Right ureter	5	9.09
Left Ureter	3	5.45
Urinary bladder	15	27.2
Urethral	1	1.81
Spontaneously expelled calculi	5	9.09

colorimetric determination of carbonate, calcium, magnesium, ammonium, oxalate, phosphate, uric acid and cysteine; manufactured by LTA s.r.l. Milano 15/F, 20060 Bussero (Milano), Italy.

Out of 55 urinary stones obtained from 55 patients managed in the Urology Departments of Prince Abdul Aziz Bin Musaad Hospital and Central hospital, Arar, Saudi Arabia, 49 (89%) were retrieved from males while 6 (11%) from females, giving a male to female ratio of 8.1:1. The age of the patients ranged from 15 to 75 years (Mean = 50.22 ± 14.46 years). A fair majority of patients (69.08%) were between 31-50 years of age. Most of the patients were overweight (70.91 %), including 35 out of 49 males and 4 out of 6 females

Regarding the chemical composition, calcium oxalate was the commonest constituent, in 33(60%); patients followed by pure form of uric acid, 10 (18.18%); calcium phosphate, 6(10.90%) and calcium magnesium phosphatein, 3 (5.45%) patients, whereas, magnesium phosphate, calcium carbonate and magnesium ammonium phosphate stones were found in one patient each (1.81%), (Table-1). Calculi were mainly localized in the kidneys, 26 patients (47.27%); followed by urinary bladder, 15 (27.2%); ureters, 8 (14.54); and impacted in penile urethra, 1 (1.81%), whereas, in 5 (9.09%) patients stones passed spontaneously (Table-2).

Discussion

The prevalence of urolithiasis is likely to be high in Saudi Arabia, because of peculiar geographical conditions (Hot and dry weather), dietary habits (Red meat) and obesity. Lifetime risk in Saudi Arabia is 50 times higher than in the West.[5]

In the present study renal stones occurred mostly in third and fourth decade (69.08%), the age group more likely to be exposed to adverse environmental conditions, and correspond to studies conducted in other regions of Saudi Arabia.[5] The male to female ratio was 8.1:1, which could be related to the culture in Saudi Arabia where men spend most of their time out-doors, while women stay in-doors. High prevalence of nephrolithiasis in males may also be due to hormonal factors, because androgens appear to increase urinary oxalate excretion and kidney calcium oxalate deposition.[6]

In the present study most of the patients having stones were obese or overweight (70.91%). Obesity is linked to urolithiasis due to increased appetite, which may lead to intake of lithogenic substances such as calcium, oxalate and uric acid. Obesity also causes an alteration in acid-base metabolism, resulting in a lower urinary pH and increased risk of uric acid stone.[5]

Urolithiasis with higher proportion of calcium oxalate stones in the present study could be related to multiple risk factors, such as excess calorie intake, fruit, vegetable rich in oxalates (Tomato, cabbage & cucumber, etc.), chocolate, tea, coffee, smoking and low intake of fluids, accompanied by the peculiar climatic conditions.[7] Uric acid calculi are associated with red-meat protein and low urine pH; and the red meat consumption (Camel, cow, sheep and goat) is prevalent in all over Saudi Arabia.[5] As noticed urinary tract infections, which is more common in women, plays an important role in phosphate stone formation.[8]

The kidney stone analysis can be done by, Infrared spectroscopy, X-ray diffraction, Scanning Electron Microscopy, Mass Spectrometry, Laser Breakdown Spectroscopy and chemical analysis (Qualitative and quantitative), etc. Each method has its own benefits and draw-backs, which have already been discussed in detail by some reviewers.[3,9] The more sophisticated methods, which require costly instruments like Infrared spectroscopy, Polarizing Microscopy and Thermogravimeter have been reported to show overall accuracy of 80-85% in the estimation of renal stone composition. Whereas, the semi-quantitative colorimetric determination of renal stones used in the present study also gave good results, with an accuracy of 75%. These quantitative chemical methods are still being practiced in many laboratories in UK and Europe.[3,9]

Results of the analysis of renal stones are important to

formulate suggestions for dietary changes for their prevention. In the present study around 90% patients had calcium oxalate (60%), uric acid (18.18%) or calcium phosphate (10.90%) stones, while other forms of stones were scarce. These occurrence rates are perhaps related to the peculiar weather, diet and profession (Sheep, goat and camel grazing) in the Northern Region of Saudi Arabia. These types of renal stones could be easily prevented by control of obesity; moderate intake of meat, dairy products, fruit, vegetables (with minimal oxalates); and plenty of fluids. Therefore, the study would provide some useful information for the detection and prevention of renal stones in the community of Northern Region of Saudi Arabia.

Regarding the information about the composition of the core and surface of stones, which can be obtained by Infrared Spectroscopy, the authors propose that the suggested dietary changes for a particular type of renal stone, estimated by quantitative chemical method will prevent an increase in its size, whatever the core of the stone, and the smaller stone/s or crystals of core substance would pass out in urine with adequate fluid intake. If the core is the major component, than its chemical detection and appropriate dietary changes would prevent its formation altogether. Therefore, detection of renal stones by quantitative chemical methods, when carefully applied would be of great benefit for the prevention of kidney stones.

Recommendations for Prevention of Urolithiasis

In the present study urinary stones were predominantly composed of calcium oxalate (60%) and diet rich in oxalates is a major factor in their formation. Calcium supplements and calcium-containing foods (Cheese, yogurt, milk, sardines, beans and lentils) bind dietary oxalate and are suggested for their prevention.[10] Uric acid stones are associated with hyperuricosuria, obesity, high protein intake and low urine pH. The restriction of dietary protein (Red meat), control of obesity and intake of citrus fruits (Lemons, oranges and grapefruit) to raise urine pH is recommended for their prevention. Calcium phosphate and struvite stones can be prevented with acidification of urine achieved with cranberry juice or betaine.[11] Plenty of fluids, exercise, and control of obesity, moderate intake of animal proteins, and mixed fruit and vegetables are also recommended.

Conclusions

In the present study urolithiasis in the Northern Region of Saudi Arabia was mostly found in upper urinary tract, with male predominance and majority of patients were in their third and fourth decade. Calcium oxalate stones were the commonest, followed by uric acid and phosphate stones. For prevention of oxalate stones a diet low in oxalate, moderate calcium intake and supplements of fruit and vegetables is recommended. To decrease uric acid stones a restriction of dietary protein (Red meat), control of obesity and consumption of more citrus fruits (Lemons and oranges) is needed. To prevent phosphate and struvite stones, urine should be rendered acidified with moderate intake of proteins (White meat, sardines and dairy products). Generally, patients passing urinary stones are advised to take plenty of water, mixed fruits and vegetables low in oxalates.

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