Pathophysiological and Demographic Study of Urolithiasis in Renal Patients of Balochistan

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ABSTRACT

The urinary tract (UT) is complex system to conduct and perform excretory function in the body. It is divided into two parts upper urinary tract (UUT) and lower urinary tract (LUT). The UUT formed by the kidneys and ureters, while lower LUT associated with urinary bladder and urethra. The persistent flow of urine from upper urinary tract and lower urinary tract plays important role for the excretion of urine and cleansing of urinary tract. Usually the primary function of the kidneys is filtration of blood for the removal of urinary system through urination. The lower parts of the urinary tract is the collection, storage, transportation and drain out urine from body. Stones in the urinary tract (urolithiasis) may be traced out to the ancient times of history of civilization. The occurrence of urolithiasis is multifactorial and its etiology is not understood. Though the pathogenesis of urinary tract stones has adapted to a different way at the present time. The aim of this research was to study the pathophysiology of and chemical composition urolithiasis by diagnostic and analytical techniques in Balochistan, Pakistan. Study was designed to identify the urolithiasis using imaging techniques. Urinary tract stones such as calcium oxalate and calcium phosphate, uric acid stones, crystals of magnesium ammonium phosphate, cystine stones, ammonium urate, mixed calcium oxalate-phosphate and mixed uric acid-calcium oxalate stones were observed. Stones of miscellaneous composition were not exceptionally encountered. A pure uric acid versus a uric acid having calcium oxalate stone could elicit entirely different primary pathophysiology.

Keywords: Urolithiasis, Urinary Tract Stones, Ultra Sonography.

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INTRODUCTION

Urolithiasis has a major impact on quality of life, working place and health system of patient due to its high recurrence (1, 2, 4, 5). The prevalence, incidence and chemical composition of urolithiasis and its formation varies may be due to its factors worldwide. The difference of calculi among the countries reflects with many factors such as age, gender, type and location of stone in urinary tract, race, diet, environment, socio-economic advancement in high technology imaging like ultrasonography and computed tomography (CT) (3). Clinically stones may be silent for a long time in and grow in size, pass spontaneously from urinary tract or may cause infection, obstruction and kidney loss. Therefore, it is most important and helpful to identify the calculi in early stage. The ultrasonography technique is easy to use, harmless and cost effective for the accurate identification of renal stone.

Urinary stone formation is a cause of urological diseases which mainly affect the life style of human beings. The main clinical feature is renal colic and the main causes of urolithiasis is still unclear. The prevalence and incidence varies according to age and environmental conditions. The prevalence of urolithiasis and its distribution varies all over the world. A very high significance incidence area of calculi includes Central Europe, Mediterranean, Scandinavian countries, British Isles

and Australia, some part of China, Malaysia, West India and Pakistan. Also Asian continent considered most common belt area of stone formation in people (2).

The occurrence of urolithiasis is multifactorial and its etiology is not understood until now. Although no single factor is involved in patho-physiology of calculi formation in urinary tract, it may be due to infections, metabolic disturbances, hormonal influence and obstructions in the urinary tract or significantly excretion of chemical components such as calcium, oxalate, phosphate, magnesium and cystine (4). The aim of this research was to study the pathophysiology and chemical composition of urolithiasis by diagnostic and analytical techniques in Balochistan, Pakistan.

A study conducted in 2018 (15) to determine the prevalence incidence and chemical composition of urolithiasis. However, the incidence of urolithiasis found 4.0-4.7% in 1979-2001, 1.47% in 2000 in Germany. The recurrence rate of urinary stone was estimated approximately 42%. The epidemiological study reveals that urolithiasis risk factors expressed the stone formation in the urinary tract approximately 5-10% of the population in industrialized countries but it was observed very rare in Japan. The incidence might be due to different causes of life style like climate, physical work, food and water intake (4).

MATERIAL & METHODS

Study Design

The descriptive study was carried out at Center for Advance Studies Vaccinology and Biotechnology (CASVAB) University of Balochistan, Quetta. The research was carried out after the approval of Advance Studies & Research Board University of Balochistan, Quetta. Proforma/questionnaire was prepared to collect the demographic data and history of the patients. Blood, urine and stone samples were collected from Urology Department, Postgraduate Medical Institute, Sandeman Provincial Hospital, Quetta for analysis.

Mean age of the patients was 45 ± 3 years. Both genders (Male & Female) were included in the study. Known cases of malignancy were excluded. Similarly, the patients with debilitating diseases like malnutrition and immunodeficiency, were also excluded from the study.

Demographic Data

The demographic information was collected on the bases of either interviewing the patients or from the hospital records at the time of sample collection. A proper questionnaire was developed before conducting the study. After consent of patients the demographic information, detailed history was obtained from the different patients according to their age groups. The population was divided into six age groups: Group1 (6-10 years of age), group 2 (11-20 years of age), group 3 (21-30 years of age), group 4 (31-40 years of age), group 5 (41-50 years of age) and group 6 (51-60 years of age) irrespective to the gender, ethnicity and area etc.

Sample Collection

Urine samples were collected in sterilized plastic container for microscopic examination. The urinary tract stone

samples were collected and analyzed for chemical composition. Blood, Urine and stone samples will be collected from Urology Department, Postgraduate Medical Institute, Sandeman Provincial Hospital Quetta.

Five ml blood sample was collected from each individual into sterile tubes. From whole blood RBCs and WBCs was performed using hematological auto-analyzer. Remaining blood was centrifuged and serum/plasma was separated and stored for further analysis of urea, creatinine using Micro-Lab. urinary tract urolithiasis was identified using imaging techniques (X-ray and Ultrasonography).

Data Analysis

The data was analyzed statistically using computer package SPSS version 10. Frequency and percentage was computed to present all the categorical variables by mean $\pm$ SD, Chi-square.

RESULTS AND DISCUSSION

In the present study, pathophysiology of urolithiasis has been observed by epidemiological data based on human population and basic experiments using imaging techniques (X-ray and Ultrasonography). Pathophysiology, composition of stones, causes of stone formation and clinical evidences have been investigated thoroughly. Important observations obtained from the population were noted. Table I includes most frequently occurred conditions of kidney stones observed in the study.

The chemical composition of stones is summarized in Table II. Nature and major characteristics of the stones have been analyzed. Stones were mostly of calcium in nature (calcium oxalate and calcium phosphate were observed in higher percentage i.e 50-60% and 20-60% respectively). Calcium stones were well circumscribed and radio-opaque which were

Table I. Pathophysiology of urolithiasis via primary disability

Cause	Pathophysiology	Chemical Composition of Stones	Clinical Investigation/Evidences
All Urinary Stones			
Reduced urine volume (production of solutes increased)	Increased loss of water or reduced intake	Conservation of renal water	All stones Urine volume < 1 L per day Osmolarity > 600 mOsm/kg
Calcium stones			
Hypercalciuria (saturation of calcium salts increases)	Absorptive hypercalciuria	Increased absorption in gut	Calcium oxalate or phosphate Urine calcium concentrations > 6 mmol/L (240 mg) per day
Uric acid stones			
Low pH of urine or hyperuricosuria	High acid load Metabolic syndrome	Titrate urate to poorly soluble uric acid	Uric acid Urine < pH 5.5
Cystine stones			
Cystinuria	Congenital mutations of dibasic amino acid transporter subunits rBAT and b0+AT	Renal leak of basic amino acids	Cystine High urine concentrations of cystine (150 > μ mol/mmol creatinine)
Infection stones			
Infections of UT*	Urea-splitting organisms	Production of ammonium and bicarbonate from urea	Magnesium ammonium phosphate Carbonate apatite High Urine pH Pyuria Positive culture for urease and organism

*Urinary tract

the most important and distinguishing characteristics of these stones. Uric acid stones were present in 5-10%, these were radiolucent and rarely staghorn in nature. Crystals of magnesium ammonium phosphate (struvite) were also observed in lower percentage (5-10%) and these stones might be staghorn in nature. Mildly opaque cystine stones were

observed in slightly low percentage (1-2.5%), might be staghorn in nature. Ammonium urate (0.5-1.0%) were also observed in our results. Stones of mixed nature was another observation of the present investigation. Mixed calcium oxalate-phosphate 35-40% and mixed uric acid-calcium oxalate 5% were seen. Stones of miscellaneous composition were not

exceptionally encountered. A pure uric acid versus a uric acid having calcium oxalate stone could elicit extremely different primary pathophysiology, due to the presence of hypercalciuria.

Table II. Chemical composition of kidney stones

	Stone Percentage	Characteristics
Crystal		
Calcium oxalate-monohydrate	50–60%	Radio-opaque Well circumscribed
Calcium oxalate-dehydrate	50–60%	
Calcium phosphate	20–60%	
Uric acid	5–10%	Radiolucent
Magnesium ammonium phosphate	5–15%	Maybe staghorn
Cystine	1–2.5%	Slightly opaque
Urates of ammonium	0.5–1%	
Miscellaneous stones		
Calcium oxalate-phosphate (Mixed)	35–40%	
Uric acid-calcium oxalate (Mixed)	5%	

This study showed the pathophysiological process of urolithiasis in patients residing in Balochistan. The outcome of the study provides awareness to the people, about the burden of disease and its risk factors. The new imaging techniques provide good results for the identification of urolithiasis to reduce or control the morbidity and mortality rate in Balochistan. Moreover, to improve their life style and provide guideline to the patients to avoid from foods and drinks which may create problems such as deposition of stone in urinary tract.

Table III. Blood analysis of patients included in the study

Parameters	value	unit	Mean Patient value
Blood urea nitrogen	12	Mg/dl	5-23
creatinine	0.8	Mg/dl	0.5-1.5
Uric acid	344	Mg/dl	2.3-6.1
Hemoglobin	14.2	Mg/dl	12-16
Hematocrit	43.51	%	36-46
Prothrombin time	13	s	12-14
Partial Thromboplastin time	37	s	30-45
Blood sugar	78	Mg/dl	70-140
Urine analysis	Protein 1+		

Urinary stone formation is the third major urological disease both male and female. Mainly, there are two main contributing factors: genetic and environmental, responsible for urinary tract stone formation. The recurrence rate is reported approximately higher side e.g increasing from 50 % to 70 % within last 10 years. The significant main cause of burden in health care cost amongst the areas of Thebes, Viotia, Greece. The urine sample representing from the rural areas of Thebes were checked/ analysed in respect of stones formation during the life period and acute stage of urinary stone formation in 2005 (6). The 442 cases were discussed in the entire study which we had. It was found that 15 % prevalence of urolithiasis in the rural areas of Balochistan. The incidence rate was slightly higher in male as compared to females and almost in above 17 years of age groups. No urinary stone formation was detected below the age group of 17 years. The prevalence rate of urinary stone formation was very high amongst the upper age group of both males & females during the life time prevalence of urine stone formation. Moreover, it was noticed

that in the rural areas of Balochistan was higher than those of reported patients in the study performed in males & females amongst the general population of the Balochistan.

The prevalence of increasing urinary stone formation may be due to different variations in the socio-demographic and other causative agents. However, urolithiasis is more common in educated and busy individuals occupied in heavy tasks and stressful conditions. Urinary tract infection, decreased fluid intake and family history of stone formation may also lead towards urolithiasis (9). Epidemiological data of our study showed that the risk factor of urolithiasis in majority of patients was low fluid intake followed by urinary tract infection. Moreover, urinary stone formation is diagnosed on the basis of persistent episode of renal-ureteral colic or frank hematuria. Majority of the patients are mainly diagnosed by abdominal ultrasound scan and unrelated symptoms. We have also used ultrasound scanning in addition to X-rays for urolithiasis diagnosis. While on the other side urinary stone disease may be evaluated through different aspects like epidemiological changes, advances in the method which is used for diagnosis, treatment and prophylaxis of patients (2, 7).

Panel: Latest advances in surgical management of urolithiasis

Miniaturisation of flexible ureteroscopes

- Improved ability to access all locations, including the lower pole of the kidney, the historic stumbling block for ureteroscopic approaches

Holmium:YAG (yttrium-aluminum-garnet) laser

- Any stone, irrespective of composition, can be fragmented
- Can be introduced through the smallest calibre endoscopes

Improved ureteral access sheaths

- Allow multiple entries and exits without causing repeated trauma to the ureter

Newly designed baskets

- Allow stones to be displaced from the difficult-to-access lower pole calyx to a more accessible upper pole calyx, where they can be fragmented ureteroscopically
- Provide an efficient means to retrieve stones remote from the nephrostomy tract with a flexible endoscope, precluding the need for additional percutaneous punctures

Similarly, a study was conducted from July, 2011 to June 2013 and it was observed that the incidence of urinary tract infection is very high with inflammatory bowel syndrome patients than general population while few cases were found in Crohn's disease (CD). The evidence of the calculi was identified after the confirmation of calculi by taking radiological examination like plan film, Intravenous Urography (IVU), ultrasound, CT scan and having clinical features such as urinary colic pain, past history of urolithiasis along with demographic variables, medications previous CD surgery (5). Historical evidences show that humans suffered from stones in urinary bladder and kidneys, since many decades, reported about the strong colicky pain associated with urolithiasis (8). History of bladder stones is five thousand years old, the fact was revealed in 1901 while examining mummies at a funeral site in Egypt (12). The epidemiology of urolithiasis poorly investigated in Pakistan. Mostly, the incidence and prevalence rate of urolithiasis is based on hospital admissions. The prevalence rate of stone diseases in Pakistan is 12%, in Bangladesh 4%, in India 10%, in Saudi Arabia 20%, in Thailand 10% and in Japan 7% respectively (10). Generally, urolithiasis is considered chronic urological disease, which affects both genders male and female at any age. Urolithiasis is common problem and the prevalence rate varies in world, it is changed from last several decades with prevalence ranging from 7-13% in North America, 5.5-9% in Europe and 1-5% in Asia.

However, among the other countries Urolithiasis is more prevalent in Pakistan (11, 16).

CONCLUSION

Knowledge about the pathophysiology of urolithiasis might be helpful towards direct treatment and correction of the primary abnormalities.

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